Proceedings of the 5th International Conference on M4D Mobile Communication Technology for Development

M4D 2016, General Tracks

Orlando P. Zacarias and Caroline W. Larsson (eds.)
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Foreword

We have come a long way since the first Mobile Communication Technology for Development (M4D) conference was held in Karlstad, Sweden in 2008. We have seen an evolution of mobile devices, communication platforms, and usage patterns.

The HumanIT research centre at Karlstad University has actively engaged in the promotion and growth of M4D as a critical area of research and practice. This is the fifth segment of the M4D biennial conferences series and the range of topics since 2008 has evolved in concert with the explosive growth of devices and usages: from 2008, when discussions bordered on access and use, to recent topics around big data, privacy and security as well as surveillance concerns. The uniqueness of M4D events is that to engage with these urgent topics, the conferences have gathered – generally – the academics, and the practitioners. What the conferences have witnessed is that conversations across as well as between these camps are not only possible, they can be progressive and beneficial to the development of M4D. As the D implies in the acronym, the discussions have been locked within development discourses, primarily because the global south/developing regions account for majority of new mobile telephony subscriptions and uptake. It is also in the global south that mobile technologies are hailed as enablers towards social transformation across sectors.

M4D discussions do acknowledge an affinity with Information Communication Technologies for Development (ICT4D). As a field ICT4D has engaged with discourses around strengthening and/or contributing to sustainable development. The emergence of M4D from the field of ICT4D has been in recognition of the explosive uptake and distribution of mobile devices in developing contexts, their supposed ease of use, reach and potential to bridge, social, economic and technical differences. Heeks (2008)¹ in his keynote speech at the inaugural M4D, cautioned academics and practitioners that it is all too easy to be seduced by novel technologies and software platforms. He cautioned against the tendency to frame ‘new’ technologies as resources for development without adequately engaging with development studies, or contexts. In a sense this caution can be seen in the scientific publications as M4D struggles to

converse across disciplines (Donner, 2010). But over and above this struggle perhaps surprisingly comes the scientific challenge from some of the M4D doyens to “retire the term M4D” (Donner, 2015).

Jonathan Donner’s latest book on mobiles for development, “After Access: Inclusion, Development, and a More Mobile Internet” takes a critical look at the transformative potential of mobile devices, in particular the mobile phone. Mobile phones and their expansive reach in the developing world have been hailed as the technologies within the field of ICT4D as the devices that will contribute to shrinking the social technical divides. Donner notes that while the uptake of these devices has been phenomenal, the physical access and the effective and efficient use of the same have not developed in tandem. For many users in the global South their first encounter with the internet is through a mobile device which has encouraged a positivistic outlook on the global South playing catch up, from the development corners. He conceptualises an “after access lens” that analyses how internet as a tool in the hands of many through mobile devices can be said to contribute to development. Donner’s book while acknowledging a more mobile internet ends by advocating for the retirement of M4D as a term unique or removed from ICT4D. Too much focus has been on the hand-held devices. Instead Donner calls for focus on the servers and systems beyond that enable the mobility in the first place. We aim to continue this discussion at M4D2016.

As we prepare to meet in Maputo, Mozambique, we are as always excited to take up new discussions such as Donner’s proposal. Voices from the Portuguese speaking regions have been few and rare, in the past M4D conferences, we realise the barriers that language as a medium contributes to this lack, which is why we are enthusiastic about sharing experiences and learning from Mozambique on what has worked and what has not worked with mobile technologies in the context of development. We have encouraged paper submissions in Portuguese, and as also part of this focus on Mozambique, we want to acknowledge and recognise our keynote speakers, Dr Gertrudes

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Macueve and Dr Américo F. Muchanga, who with vast experience and knowledge of the field will share with the M4D community, how mobiles have shaped the lives of Mozambicans. We are exceptionally grateful to University of Eduardo Mondlane that is hosting the conference this year. They have worked tirelessly to prepare for M4D2016. We would also like to recognise the following sponsors, SPIDER (The Swedish Program for ICT in Developing Regions), IPID (International Network for Post-graduate Students in the area of ICT4D), Ministry of Science and Technology, Higher Education and Technical and Professional Training in Mozambique, University of Eduardo Mondlane, and Dr Américo F. Muchanga.

You are warmly welcome to Maputo, Mozambique!

Caroline Wamala Larsson  
Director of HumanIT, Karlstad University, Sweden  
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Keynote Speech Abstracts
Mobile technologies and the transformation of the financial sector in Mozambique

Gertrudes Macueve

Executive Director and Board Member at the Central Bank of Mozambique

gertrum@gmail.com

Abstract
There are no other technologies than mobile telephones that have ever been in the hands of many people, especially the poor, in many countries, in very remote areas and in a short period of time. Their capability of converging various technologies in one, by aggregating the value of the telephone, radio, TV, computer and internet, added to the capabilities of mobility, ubiquity and others make them useful means that contribute to the solution of peoples’ constraints and improving their capabilities, what we call development. Interesting fact from them is that, on one side, they do not require advanced knowledge to be used, and on the other side, they instigate people from all ages, to learn not only the technology itself but also numerology as well as literacy.

The financial sector is an example of where mobile technologies have made considerable difference in developing countries, by allowing financial services to reach where traditional bank services do not, due to many reasons and as well as easy financial services. Notwithstanding, full contribution to country’s development can be gained with the increase of local production of related hardware, software, interoperability of services and research. Therefore, through qualitative research methods, this paper concludes that mobile technologies contribute to a country’s development, are promising technologies and services need to be expanded to other sectors of the society as well as communication services need to be improved in order to ensure confidence in transactions.
Mobile – A key driver of innovation and development

João Gaspar
General Manager, JG Consulting Mozambique
jgconsultingmz@gmail.com

Abstract

Mobile phone technology is without doubt the one that most quickly was adopted by the population worldwide having reached a penetration of 80% in less than 18 years. It is estimated that 100% of the population has access to a mobile phone by the year 2020.

In the first decade of this century there were two moments that were decisive for the massification of mobile phone and its usage in applications complementary to the voice service. The advent of prepaid billing solutions and the invention of the Smartphone concept.

In the sub-Saharan Africa region, existed 690 million mobile subscribers in 2015 being holders of 170 million SmartPhones. These numbers should grow significantly until 2020 reaching a 100% coverage of the population and about 1.1 billion subscribers and more than 700 million SmartPhones with consequent increase of the volume of data transmitted.

Mobile technology is without doubt the best platform for the provision of vertical services to people of all social levels and geographies, being sometimes the only instrument of communication possible in remote locations. However there are still many rural communities that are isolated, or technologically excluded, from the rest of the population and the country, being essential for the development of these communities that Government entities and operators create conditions for rapid cellular coverage even if only with basic voice and Messaging services.

Recent studies confirm the economic benefits that mobile technology has brought to the region, estimated a total contribution (direct and indirect) of over $ 100 billion USD which corresponded to 5.7% of GDP in 2014. This figure is likely to continue to rise to 8% of GDP in 2020 being expected a value of financial contribution of about $ 166 billion USD.

Mobile technology does not bring only financial gain for the people, companies and government directly and indirectly involved in the ecosystem, but can also contribute to support the development of basic needs of populations, as demonstrated in the M4D Utilities Fund program released by the GSMA with the support of the UK Government. This program implemented between 2013-2016 supported companies to create innovative mobile technology-based solutions and benefited 2 million people in the areas of energy, water supply and sanitation.
The development of the most deprived populations, both financially as a human, can be supported on mobile technology as a tool for training, information and communication with central systems and applications. However it is necessary that boosters of this technology whether the equipment manufacturers, software houses and research and innovation institutions, as such universities, think of the needs of the individual by integrating the various applications and services provided by each mobile specialty, mWhatever!

For most new coming users, that can use the phone as his assistant, will be hard to take advantage of isolated applications with different and sometimes complex interfaces. The way how the information will be delivered to the user, should be rethought in an integrated and objective manner for effective usage and adoption.
Practitioner Track
Engineering Education Online: Our Approach, Challenges & Opportunities
(A Case Study of KNUST)

R. K. Okine¹  Y. A. Okine²  A. S. Agbemenu³
bobby@knust.edu.gh  yanny182002@yahoo.com  asagbemenu@knust.edu.gh

¹University Information Technology Services, Kwame Nkrumah University of Science and Technology, Ghana
²Maternal and Child Health Hospital, Kumasi, Ghana
³Dept. of Computer Engineering, Kwame Nkrumah Univ. of Science and Technology, Ghana

Abstract
KNUST is the foremost Science and Technology University in Ghana, and has been in the frontier of transforming access to education with the blend of eLearning and classroom sessions since the implementation of eLearning in the year 2005. Currently, KNUST has established the Institute of Distance Learning mandated to spearhead the transformation of education through technology. The IDL has been able to mitigate internet access which used to be a major bottleneck, and continues to be successful in the development of content for the programmes. KNUST has gradually dealt with these earlier challenges and has taken up the challenge or opportunity in offering quality and respected Engineering Education via E-learning / Distance Learning. This paper shares the experiences of KNUST IDL in offering Engineering Education via E-learning, the challenges it faces, which will help build on literature on the subject whilst recommending an approach to deal with the challenges and opportunities it offers.

Background
Kwame Nkrumah University of Science and Technology through the IDL offers 8 Engineering programmes at the undergraduate level for holders of Higher National Diploma (HND) who on account of their location and work schedule will find it quite impossible to attain a degree programme which is in high demand by the industry. These students are periodically offered a blend of online and face-to-face sessions on weekends (Saturdays and Sundays) at the IDL Centres across the country. The Engineering undergraduate programmes offered through distance learning are BSc. Geomatic Engineering, BSc. Agricultural Engineering, BSc. Mechanical Engineering, BSc. Computer Engineering, BSc. Telecommunication Engineering. However, KNUST has taken the bold step of
offering some of the programmes strictly online, i.e. BSc. Petroleum Engineering and BSc. Chemical Engineering.

**Admissions Requirements**

Applicants into the KNUST IDL programme are expected to have completed a three-year diploma i.e. Higher National Diploma from any of the ten Polytechnics in Ghana, and have a minimum of five years working experience. The HND is a technical higher education programme where more focus is placed on practical skills than theory. It is expected that the applicant must have at least 5 credits in GCE “O” Level, including English Language and Mathematics and at least 6 credits in SSSCE/WASSCE subjects in the relevant areas, including English Language, Mathematics and Integrated Science.

The B.Sc. in their preferred Engineering programme hence becomes a top-up degree to enable them meet the high demand of a Bachelor of Science Degree. Example, an applicant into the B.Sc. in Mechanical Engineering will need an HND or its equivalent diploma certificate in any of the following Mechanical Engineering disciplines i.e. Production Engineering, Plant Engineering, Automobile Engineering, Refrigeration and Air-Conditioning, and Foundry Technology.

One of the graduate engineering programmes offered online is the MSc. in Petroleum Engineering. The one-year MSc. Petroleum Engineering programme is aimed at candidates who wish to gain a well-focused and applied technical background that prepares them for a professional career in geophysics. The programme also enables candidates who are already working in the petroleum industry and wish to enhance their technical skills and qualifications the opportunity to do so. Applicants should have a degree, minimum of second class lower from a recognized university in any of the following fields: Physics, Engineering Physics, Geology, Earth Science, Mathematics/Statistics, Engineering or other related fields.

**Mode of tuition**

The IDL offers a blend of online and classroom sessions for all its Engineering students. Students are given a branded USB internet modem which gives them 7GB of internet access per month to enable them access their online courses, submit assignments and in some instances take quizzes. This internet provision is so important in mitigating or at least managing one of the major bottlenecks in access.

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to technology-enabled education (see Okine et al. in the list of references). This arrangement was entered into by the KNUST IDL with Vodafone as the service provider.

KNUST IDL has 11 centres across the country to facilitate the classroom sessions of the blended learning. The classroom sessions are organized on Saturdays and Sundays in all centres. This is mainly to meet the demand of the students who are already professionals in their field and whose work schedule would make it quite impossible to be in regular campus-based degree programme sessions. However, most of the course work is covered through the online platform which has enough content (i.e. PowerPoint presentations, video tutorials, simulations, etc.) with assignments, quizzes to enable them access all the opportunities that comes with blended learning. In some instances, there are live lecturer's/instructor sessions with the students via the online platform.

Examinations
Examinations are conducted at the IDL centres at the end of the semester with the same supervision like any of the campus-based programmes. Lecturers are incentivized to take up IDL courses which demand their availability on Saturdays and Sundays in the remote IDL centres. The grading is not different from the mainstream campus-based programmes and taken through the scrutiny of the Examinations office and academic board to ensure that quality education and respected degrees are offered albeit via a blend of classroom and online/digital technology. However, in some instances, they are conducted online especially the quizzes and assignments.

Graduation
The Engineering programmes in KNUST IDL running for 8 years now have graduated qualified engineers offering world-class graduates on the subject area. The final certificate presented to students is not labelled as a programme offered through blended learning mainly to mitigate the complexity associated with degrees or access to education through distance learning or digital technologies.

Opportunities
- KNUST IDL has been able, so far to successfully offer various opportunities through its blended learning approach to offer professionals a quality university education without the demand of a campus-based approach.
- The programmes are on-demand and tuition is higher than the mainstream campus-based programmes, hence serves as a sustainable revenue stream for the university.
On the account of students under the Engineering Education Online at KNUST, below are some randomly selected notes:

“I had no time to continue my education. I heard about KNUST’s distance learning programme in Computer Engineering. I decided to put in my application thinking I will just walk through. I was very surprised when I had to go to the laboratory as well. It has really enhanced my career”

“I was sceptical at first. Since there was no other engineering programme which I could do only on weekends and at home, I decided to give it a try. I had no regrets. The dedication of the lecturers is second to none”

“The data dongles I was given was very useful. I was worried about how I was going to submit assignments and watch lecture videos. Mobile data is very expensive here”

**Challenges**

Generally, there are several reasons why a lot of higher educational institutions do not offer undergraduate engineering programs via distance delivery. The main obstacle is the professional accreditation agencies, who require students to have a very high level of laboratory classroom time in a program before accepting a degree for professional accreditation. However, KNUST IDL continues to strive in this demand gradually with selected engineering programmes.

Distance or online courses already have an issue with credibility in our society. KNUST IDL, therefore does not discriminate the degrees or certificates offered and does not label them as online since the course work meets the general standards of the university academic board.

There is also the belief that engineering is very much a hands-on profession and needs personal supervision within a laboratory context. Presence of a laboratory assignment or experiments are lost in the distance learning, hence the likelihood of students actually grasping the concept is very debatable even though video content and simulation applications are blended into the online platform.

Another obstacle is the very high cost of designing laboratory simulations in engineering that might replace physical labs for online students.
References


Integrating SMS to an open source electronic platform to improve retention for HIV/ART patients’ management in Northern Nigeria

Benjamin Akinmoyeje
MSH Nigeria Idealab & National Open University of Nigeria, Abuja, Nigeria,
Contact Information: (Benakin@gmail.com, +2348033249474).

Abstract: This paper discusses the approach of using integrated SMS messaging into an electronic medical record system to improve management of HIV/AIDS patients undergoing ART (Antiretroviral Therapy) with increase retention. HIV/AIDS patients enrolled into care sometimes fail to turn up for their appointment or clinic visits. This can lead to non-adherence to their drug regimen, which can have dire consequences especially for pregnant women. The open source electronic medical record (EMR) system which is piloted to replace the paper documentation will enable caregivers and program managers to quickly identify patients that were not present to receive their drugs or clinic visit for further follow-ups. This system is still in the early stage of development and is supposed to help HIV/AIDS program officers to manage patients that need to support in adhering to their treatment. Finally this will reduce the number of HIV/AIDS patients lost to follow-up in the HIV/AIDS care programs in Northern Nigeria.

The need for electronic medical record system cannot be over emphasized in low resourced settings of a developing country like Nigeria; due to the relative limitations of hard copy paper registers which are oftentimes slow and arduous for HIV/AIDS program managers to gather data for decision making; with an EMR system integrated with Short Message Service the benefit of faster and more accurate data for decision making can be harnessed for the benefit of the patients and the HIV/AIDS clinic.

Background
Various Non-Governmental Organizations have been supporting HIV program in Northern Nigeria with funds from donors like USAID, Global Fund, DFID, etc. A typical NGO is supporting 30 health facilities providing comprehensive HIV/AIDS services and 90 health facilities providing PMTCT services. The mode of reporting from these facilities is still through manual data collection.
method using the Nigeria National Response Information Management System (NNRIMS). The current data collection and reporting method requires that M&E specialists from the states travel to these health facilities and physically collect data from registers monthly. This requires that 6 drivers and 6 specialists stay out in the field for a week or more. This method of data collection and reporting is neither cost effective nor cost beneficial. It is slow, stressful, time consuming and expensive.

Consequently, as the program expands with rationalization, this method of data collection and reporting becomes unrealistic and outdated as we may not be able to achieve data quality of timeliness and completeness. Also one of the major challenges in the program is patients in care or on ART treatment is getting lost to follow up, due to the process involved in the hospital visits and data collection. To this end, we intend to achieve the following objectives with the proposed electronic medical record system with integrated SMS reporting and alert system.

• Accurate, timely and complete information when it is needed in order to manage and operate appointment schedules efficiently.
• To filter adherence – messages to Behavioral Change and motivate patients.
• Improve retention of HIV/AIDS patients in ART&Care program.
• To provide unique needs for individual PLHIV and sub serve general function of the PLHIV
• To improve patient drug refill appointment.

Statement of Problem
With the need to ensure that 100% of patient tested positive to HIV/AIDS must be enrolled in care and placed on ART, it is important that HIV/AIDS clinics are equipped to act in a timely manner to ensure that patients are assisted to be regular on their clinic visits and reminded when necessary with the use of coded SMS messages or physical follow up as it suits the occasion.

The need for a timely cost effective system that allows health workers to identify and reach patients in a good time to help improve their wellbeing is highly needed.

Methodology
The clinic in question has developed and deployed a localized OpenMRS emr system and patient records from the clinic are uploaded from the physical registers including patients’ details such as mobile phones numbers if consent is given. The system has an appointment system that is always updated with the expected number of patients expected to attend a specific clinic day. At the end of each clinic day, the electronic medical record assistant identifies patients who were not present for their clinic appointment, and this trigger two sets of messages one to the patient tracker (a volunteer recruited to give support to
HIV/AIDS patients in the community) and program manager. In this case, it allows for the clinic to identify patients who are to be followed up and subsequently reducing the possibility of losing these patients in the stack of folders. The OpenMRS system allows for integration of SMS module system that allow implementers to use the functionalities of the SMS to respond to a predetermined alert set on the platform. The module responsible to do this presently been modified and tested for functionalities; simultaneously patient interviews are been conducted to in other to ensure that human centered design approach is considered for suitability of the solution.

**Expectations**

We anticipate introducing a system like this will improve the retention drive and also the quality of care given to PLWAs at facilities where the EMR is already been implemented.

**Technical details**

The module will be a web-based application that will allow the focal person use the mini laptop to review patients records pulled from the OpenMRS platform; the following data are expected to be available

- Appointment dates
- PLWAs telephone number
- Regime due dates
- Status of PLWA enrolled in ART care.

**Proposed Flow of SMS Module**

![Proposed Flow of SMS Module](image-url)
The above model shall be implemented using a web SMS module integrated into the OpenMRS EMR platform. This will allow the Retention coordinator pull regular patient data based on set criteria and thereafter send condition specific SMS messages to the patient. We anticipate piloting this in two facilities with a selected or test patients.

**Expected Outcomes**

We expect to see an increase uptake in adherence treatment and retention by PLHIV in the pilot Health facilities.
The Impact of Tech Innovation Hubs on ICT4D

Robert K. Okine  
mFriday (co-founder) / Kwame Nkrumah University of Science and Technology, Ghana

Cathrinerose Barretto  
Kinu Innovation and Co-creation Space (co-founder), Tanzania

Abstract The African continent has experienced a significant rise in co-working spaces providing a range of services for start-ups and entrepreneurs. The session will focus the different perspectives of each space and argue that such spaces are significantly contributing towards the creation of solutions to tackle socio-economic challenges in Africa.

The presentation is directed to a wide spectrum of people: Managers/Founders of Innovations Hubs, Investors, Entrepreneurs, Researchers, Private sector – such as telecoms, Non-Governmental Organisations, government stakeholders, resource organisations which provide funding for start-ups. Presentations are to be followed by questions and interventions from the audience.

Motivation

In recent years the African continent has experienced a significant rise in co-working spaces, innovation hubs and living labs/ community spaces providing a range of services for start-ups and entrepreneurs. While hubs are mushrooming all over the continent, there is still a lack of understanding of the concept of such spaces, how they can drive the entrepreneurship ecosystem and create impact. Products or software being created by startups emerging from these spaces have resulted in solutions solving some of the continent’s most pressing challenges - in education, health, agriculture, and so on.
The hubs, innovation spaces and living labs which nurture these start-ups cannot operate in a silo. Equally important stakeholders include research organisations, government entities, private sector, Non-Governmental Organisations, Academic Institutions, and resource Considering that most of the tenants of these spaces are purely tech, there is a need to link up with researchers in order to leverage their discoveries in the conception and design processes.

Attending the session will provide key stakeholders in the ecosystem an opportunity to know what is taking place within various tech innovation spaces on the continent; models for building hubs in countries that do not have hubs and opportunities to form linkages between stakeholders within the ecosystem.

We currently have a hundred and more tech and innovation spaces on the continent, each with different focuses and models for sustainability. The session will focus the different perspectives of each space and how such spaces are significantly contributing towards the creation of solutions to tackle socio-economic challenges in Africa.

The main purpose of the open session is to hear experiences from others. We will engage with the audience and make sure both those involved in the tech innovation space and those hearing it for the first time contribute to the session. The presenters will lead the conversation which shall be followed by questions and interventions from the audience.

**Objectives**

The African continent has largely relied on an agriculture-based economy. However, recent studies have shown that the use of Information and Communication Technologies (ICTs) has transformed many economies towards a knowledge-based economy, in which the production and dissemination of knowledge leads to economic benefits. For millions of unemployed yet tech-savvy youth across Africa, increased connectivity is bringing tremendous opportunities.

There have been many developments in Africa, including technology developments and this has led to the emergence of innovation hubs and living spaces - “innovation spaces are physical environments that promote community, learning, and making.” These spaces have come out as a response to the emergence of technology communities and growth in local ICT entrepreneurship. Spaces have different focuses, activities and target groups. There are more than Hubs, labs, libraries, hackerspaces, makerspaces,
telecentres, co-working spaces in more than 26 countries just in Africa. According to recent research, African hubs are springing up at the rate of nearly 1 every 2 weeks. They provide a home for those with new and innovative ideas, create an atmosphere where they are encouraged to try new things and, most importantly, are able to meet like-minded individuals they can grow with. You find young people with an average age of 26, developing soft solutions to tackle challenges in all key sectors like health, education, agriculture and so on in their countries.

It has therefore become paramount to harness this new initiative across the continent especially in guiding it in meeting its respective goals.

The goal of the session is to provide a platform in the following way:

1. For representatives from the various tech hubs in Africa to tell their story- activities, business model, challenges and future plans

2. To create a conducive environment for tech hubs to collaborate especially on ICT4D projects which have similar needs for the continent?

3. To look at the future of innovation hubs in Africa- whether it is a bubble or an initiative that can stand the test of time.

The presenters will share with participants the work being done in their respective hubs. In a participatory way, participants will interact with presenters.
Use of tablet PCs to make mobile online education a reality: The case of ISCED’s online programs in Mozambique

Type of Study: Descriptive Case Study

Wisdom Machacha
ICT Director
Instituto Superior de Ciências de Educação à Distância, Mozambique.
wisdom.machacha@gmail.com

Key words: online, mobile learning, distance education, tablet PC, internet, m-learning

Introduction

Mobile devices are now very common among Mozambicans attending higher education, these devices are mainly used for personal communication and access to social media. Few universities have adopted widespread m-learning technologies and in those that have it is not clear that they are being used in pedagogically appropriate ways (this has been noted already several years ago; see Harington et al, 2009) In Mozambique it does not seem to be any different, these powerful devices are hardly used for any meaningful pedagogical purposes in a structured manner. ISCED (Instituto Superior de Ciências de Educação à Distância), or Higher Institute of Science and Distance Education has made the first bold step to integrate mobile devices as a legitimate tool for delivery of online distance education in Mozambique.

ISCED is making tremendous progress in the provision of distance education in Mozambique through its online programs. ISCED provides tablet PCs to all its students. This innovative strategy of making it possible for students to have their university in their pockets wherever they are and at whatever time has made it possible for ISCED to access a student market never explored before by traditional face to face and distance education universities.

Growing Student Numbers

Within a year the student population has grown from 2500 in 2015 to a total of 7000 in 2016. This exponential growth in student numbers can only be attributed to the fact that ISCED offers flexible online courses which does not require the student to be physically present on campus to access knowledge. They learn where ever they are through their mobile and other internet enable computing devices. ISCED offers 6 degree courses 100% online. One would ask how is it possible to implement quality 100% online degree programs in Mozambique considering the well documented problems of electricity, communication, poor road infrastructure and many other ills associated with African countries.
**ISCED’s Pedagogical model**

The Institution’s pedagogical model is online distance education, supported by the Flexible Learning philosophy which is a hybrid of delivery methods. The hybrid model incorporates various methods of content delivery and guided by self-centred student learning, but more importantly is capable of recognizing multiculturalism and diverse student learning needs. It supports contributions from all participants (Petrova 2001). ISCED’s pedagogical model is 100% online and supports mobile learning, contact sessions for initial student orientation and also distributes paper based learning materials. The courses are offered in a modular fashion and each module consists of 3 subjects and runs for a period of 8 weeks and students write an invigilated exam at ISCED exam centres located in all provincial capitals throughout the country.

![Flexible Learning](image)

*Figure 1 The “Subsets of flexible learning” according to Brown (2003)*
Mobile Compatible Systems

ISCED makes sure that all web based learning applications are mobile compatible. The website was developed using the CSS3 web authoring software. The Institution has developed and uploaded learning materials on the open source LMS and is accessible by anyone with access to an internet enabled device. All course materials, academic information and administrative student information can also be accessed on the mobile enabled LMS through an in-house developed application called Secretaria Online. ISCED also uses mobile compatible open source software for the student registry system and e-library, most of the books on the e-library are OER.

ISCED Mobile: ISCED also developed an Android app ISCED Mobile which allows student to have access to academic calendar, online tests, chats, forums, grade book/transcript and administrative information like fees payments statements.

Micro learning system: This is a mobile application which uses SMS as learning tool. Small parts of the learning materials are sent to students and followed up with questions and answers in the form of quizzes.

Student and Staff Support Services

Emerging technologies offer an opportunity for the development, at the institutional level, of quality processes with greater capacity to enhance learning in higher education than available through current quality processes (Simon N. 2016). However the coordination and collaboration of different parties involved in the implementation of distance education programs is often necessary and support for academic staff is recognized as having important effects on the adoption of distance education (Childs et al., 2005; Singh & Hardaker, 2014), especially related to the technological aspects of course implementation (Siemens G. 2015). At ISCED teachers/tutors are offered initial and continuous training on technology supported online delivery methods and tools, eg, interactive white boards and learning management systems. This process ensures that the teachers are capable of effectively supporting the learners.

When student enrol at ISCED they are offered a package containing a SIM card, Tablets PC loaded with video tutorials on how to access learning materials online, time table and University regulations. The first face-to-face contact session with a duration of 3 days is dedicated to help student familiarise with online learning environment and tools. They also meet their tutors and they agree on the ‘rules of the game’.

Students can contact the institution through the help desk system. The help desk is manned by 6 multidisciplinary members of staff; ICT trained, Psychologist, Counsellors and subject experts. The help desk system has a fixed phone, cell phone, online chat forum, webex videoconference system, skype and a professional helpdesk management software. An SMS system is also used for sending SMS to students regarding changes in academic calendar, reminders for fees payment and evaluation activities like tests and forums. These systems allow all student inquiries to be recorded, channelled to the correct destination and also track and quality assure student support.
ISCED is a member of various Academic Alliances in order to have access to software at a discounted educational cost. ISCED uses the proprietary accounting software, however it was customized according to ISCED’s needs and it is integrated to other open source systems.

**Overcoming the Device divide**

Access to devices like computers, laptops and tablets is a challenge to many students. In order to overcome the **Device divide** ISCED gives 10” android tablets and a 3G GSM SIM card with an initial 500MB to all students and the cost of the tablet is included on fees. All tablets are loaded with the basic open office, pdf reader, mobile moodle and a client software to access the video conferencing system. ISCED signed an agreement with the biggest cellular company in the country in order to give Internet access to students at a discounted rate.

In order to mitigate the problems of access to electricity for students in remote areas, ISCED provides portable solar chargers at a cost. A dedicated Tablet PC technician is responsible for fixing hardware and software problems encountered by students on a daily basis. The most common problem brought to the attention of the technician include storage memory problems when student overload tablets with files and photos, flat batteries, broken tablet screens which are replaced at a fee.

ISCED also gives the option to students to buy printed manuals of the learning materials. In spite of most learning activities like homework, tests and forums are done online, all exams are done at designated exam centres and are supervised and invigilated by ISCED staff.

These innovative strategies to integrate the use of mobile learning in administrative, teaching and learning processes in order to access a larger student market at the same time raising the quality of learning has helped ISCED to stand shoulders above the rest as far as provision of online degree courses in Mozambique is concerned.

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Educational Health Information Platform (PENSA)

Valter Cumbi
Source Code, Lda
Bairro da Coop, Aquino de Bragança (antigo Rua G.) N0. 108, Maputo, Mozambique
Contact Information: (vcumbi@sourcecode.solutions, +258 82 000 4444)

Abstract: Despite the extensive health information available in Mozambique, the segment of the population that most needs it is often deprived of it due to the communication channels used. Email / Internet campaigns rarely reach rural areas, and many citizens are still without the means to buy a television / radio, or even have the electricity to power these devices. It is for these reasons that we found a possible solution in our Educational Health Information Platform (PENSA) which relies on USSD (a technology viewable on any mobile phone). Through PENSA, all Mozambican citizens will be able to register and select the health issues which they would like to be kept informed, as well as be able to see symptoms, precautions, and general information for various diseases. All of this information (along with reports) will be viewable and modifiable on the “back-end” web interface, availed to the Ministry of Health.

Context of the Problem

Problem
The vast majority of Mozambican citizens (particularly in rural areas) have little access to pertinent health information. This adversely affects their capacity to:

- Prevent disease acquisition & dissemination;
- Identify symptoms that require further medical attention;
- Adopt healthy lifestyles (to prevent diabetes, heart diseases, etc.);
- Remain abreast of relevant health issues (vaccinations, flu outbreak, Ebola, etc.).
Several logistical factors contribute to this problem, including low physician density (estimated at 25,000 patients per physician) and impractical outreach/awareness campaigns which are:

- Resource-intensive—when staff & materials are required to visit rural areas);
- Expensive—travel & accommodation costs for staff;
- Slow—takes long to visit all pertinent areas;
- Once-off—not done continually or followed-up.

Exacerbating the problem is the inadequacy of conventional communication channels/technologies. TV and radio are expensive as continual communication tools that often don’t reach the key (rural) demographic due to the cost barrier and lack of electricity. Furthermore, these media are not information tailored to the needs of a specific citizen. Internet also does not reach the key demographic as only 10% of the population has access.

**Mobile Phones**

To address this health information problem, organizations have focused on cellphones which reach over 60% of the Mozambican population. While we believe this is the correct approach, the current cellphone technology used also exhibits limitations:

- Mobile applications (apps)—require smartphones, of which only 20% of (the richer) Mozambican cellphone users have;
- SMS—impractical (expensive & slow) to send all citizens SMS about all Mozambican health issues

**Solution: USSD**

Unstructured Supplementary Service Data (USSD) is a technology (similar to SMS) provided by all telecommunications operators. It has several key advantages, of which the most important is its capacity to be displayed and responded through any and all cell phones (from smartphone to the most basic). USSD also allows for interactive/guided menus, and is ideal for use where there is limited Internet speed and limited Internet reach, and where target users has basic cell phones.
Proposed Solution: PENSA – Educational Health Information Platform (Plataforma Educativa de Informação de Saúde)

What is PENSA?
PENSA is a platform that avails educational health information to any citizen with a mobile phone, as well as allowing them to pose health-related questions. It also allows the Ministry of Health (MISAU) staff to submit different types of health information for citizens to view, as well as push (send) information to specific groups (based on citizen preferences, location, health history, etc.).

How does PENSA work?
From the perspective of the citizen, they can use USSD (a familiar technology) to perform the following operations for free:

- Register for information they would like to receive (maternal/infant health, etc.);
- View general information on key health topics (malaria, HIV, stroke, vaccinations, etc.);
- View symptoms & precautions for selected diseases (ebola, cholera, diabetes, etc.);
- View up-to-date contact details for nearby health centres/practitioners;
- Submit questions.

From the perspective of MISAU, they can (via the “back-end” website interface) perform the following operations for free:

- Submit information for citizens to view (general info, symptoms & precautions, etc);
- Update contact details for health centres/practitioners in different districts;
- Push (send) information to relevant groups (e.g. if there is a flu outbreak in Tete, inform all the users of this platform in Tete of the outbreak, along with precautions and vaccination instructions);

Besides the advantages mentioned above, PENSA provides MIASU with several others, including:

- Customizable reports/statistics that are instantaneously updated from user-submitted data;
- Flexible and alterable menus (languages, structure, sub-menus, etc.) that are immediately availed to the citizen;
- Extendible platform that can be adapted into other technologies.

**Ministry of Health and PESS**

The Ministry of Health, in fulfilling its mandate to provide health services to all Mozambicans, prepared the Strategic Plan for the Health Sector (PESS - Plano Estratégico do Sector da Saúde) 2014-2019 in order to “contribute to availing to all Mozambicans, particularly the most vulnerable demographic, with the best health possible at an affordable cost”. In this regard, PENSA fits ideally into PESS. Furthermore, this platform supports the achievement of 3 of the 7 Strategic Objectives (Objectivos Estratégicos - OE), namely:

- OE 1 - increase access and utilization of health services;
- OE 3 - reduce geographical inequalities (and between population groups), in the access and use of health services;
- OE 4 - improve efficiency in service delivery and resource utilization.
Jaguza livestock App: Powering livestock production to strengthen food security

Katamba Ronald
Afrosoft IT Solutions ltd (U), Uganda
katambaronald@gmail.com
Tel: +256703034758

Abstract: This paper discusses the importance of various Information and Communication Technologies (ICTs) innovations in monitoring livestock, detecting diseases and disseminating relevant information on livestock husbandry in Uganda. The paper reports part of a study that investigated the extent of use of ICTs by rural livestock farmers and how access and dissemination of livestock information could be improved through use of ICTs. The methodology used in the study was a questionnaire and pilot whereby qualitative data were gathered. The findings of this study revealed that different types of ICTs were used by rural livestock farmers though some ICTs e.g. mobile apps were used more than other ICTs, e.g. radio and television. It was concluded that ICTs are important tools for promoting livestock husbandry production, but their use is hindered by several factors including lack of ICT innovation such as intelligent systems like apps.

Introduction

Jaguza livestock App is an artificial intelligent and computer version system, mobile and web that aims at improving livestock production in Uganda, Africa as a continent. It has a number of modules of which a farmer can choose a module that suits his/her best need current is working on online and offline platform

Background

There is a difficulty faced by farmers in detecting the early stages of diseases in animals today. This is a problem that has led to the loss of many animals due to delayed treatment and preventive measures. There is also the problem of theft of livestock and domestic or farm reared animals. These lead to losses, disappointing animal sales and products and hostile relationships in communities. Jaguza’s aim is to establish national wide network for detecting animal diseases and handling the dangerous outbreaks of diseases. If animal becomes sick or suffers from any illness, regional and the national monitoring
stations and local veterinary doctors will be alerted as well as farmers are alerted so that they can start early diagnosis. The system uses sensor technology to detect the early viral phase of ECF (East coast fever Disease), FMD (Foot and mouth diseases), Mastitis among other known diseases that can quickly infect herds on an epidemic scale, it is now paramount to have rapid, real-time reporting of large-scale disease outbreaks, as well as a more efficient way to track animal movement and their health condition in real time.

Jaguza livestock App objectives are the following:

- To reduce livestock labor cost
- To catch fever in livestock immediately
- To treat sick livestock earlier for better response to treatment
- To reduce overall treatment cost with earlier treatment
- To increase profit margin with maximum sell weight
- To reduce livestock loss and decrease investment risk
- Tracking and identification information for health information

Modules of Jaguza

Monitoring
This module continuously monitors using of electronic ear tags to track movement of animals and an alert is sent to the farmer in case the animals move out of the mapped area, farm, sub county also region.

Early disease detection
It has a disease center with several animal diseases, their signs, symptoms and preferred or recommended treatment and preventive measures which help the farmer to diagnose animal diseases by the help of a feet electronic tag. It also gives notification /reminder to the farmer for the treatment of the animals.

Analytics and reporting
It also has a live charting feature that displays live graphs that show the animals under observation and those that need attention in real time.
It allows the farmer to remotely monitor their sales and daily produce of products like milk. They are able to analyze and track the sales trends of all their products daily, weekly, monthly or annually.

Animal care
It has a resource center which is a database platform with lots of animal and agricultural information, good farming practices and other agricultural information mainly based on livestock.
It also comes with a module for animal feeds which shows how much feeds the animals consume and helps the farmer plan feeding expenditure for his animals in order to obtain profitable and calculated results.

**SMS**

Jaguza provides an SMS service feature that enables the users of the system to access some system modules using a USSD code like 6868. The system recognizes the user requests by filtering out specific keywords and returning specific data. Like reminder and alerts about the gestation period, Heat and insemination period. It has a feedback module that allows the farmer to give the veterinary doctor some feedback about the state and status of the animal currently undergoing treatment.

**GIS mapping (livestock surveillance and information system)**

This will help farmers, government and other stakeholders to map and monitor farmers animals and number of livestock farmers in particular districts with details of the animals they have. Users, Senior Veterinary and government will be enabled to know how a disease is distributed geographically but also that an animal disease can be viewed against other information for example rainfall maps, vegetation maps, rivers, swamps and so on.

**Marketing place**

This module helps a farmer to market his/her livestock products. Pictures are captured with necessary description such as place, terms of sale, prices, contact person and uploaded to the cloud server, thereafter potential buyers view via the web thus widening market and sales globally (webs expands business more multiple physical stores).

**Methodology**

This section introduces the methodology and techniques that are used in acquiring and analyzing information and to achieve the objectives of the project. It only briefly includes the approaches and procedures used to collect and analyze information.

**Interviews**

An interview is a dialog between two or more people where questions are asked by the interviewer and responded to by the interviewee in order to obtain the information required.

A couple of face-to-face discussions were held with the farmers and extension workers to establish a broad context of what they would like the system to accomplish for them. This type of data collection method was considered due to the following advantages:
They are useful to obtain detailed information about personal feelings, perception and opinion.

Interviews allow for more detailed questions to be asked.

Usually achieve high response rate from interviewees.

Interviews are not influenced by others in a group.

**Questionnaires**

A Questionnaire is set of questions that are prepared for gathering information from individual. Questionnaires can be administered by mail, telephone and handouts. They can be given to farmers to be answered and include both open and closed questions to make sure that all the necessary information is acquired. Questionnaires were deployed because of the following:

- Questionnaires are relatively easy to analyze.
- They are familiar to library staff and management.
- Information is collected in a standardized way.
- They can be used for sensitive topics which users may feel uncomfortable to answer to the interviewer.

**Findings**

The results of the study showed that mobile apps were used more than (90%) other ICTs e.g. radio (7-60%) and television (3%). It was concluded that ICTs are important tools for promoting livestock husbandry production, but their use is hindered by several factors including lack of ICT innovation such as intelligent systems like apps.
Research Track
Abstract
This research aims at exploring the innovative potential of mobile devices in school management. In this perspective the article discusses the allocation of pupils in the next education levels, within public schools of Maputo city. A computerized student’s allocation system that can be accessed using mobile service is proposed, where the model uses age as ranking factor and the first three preferences considering displacement. This system is expected to increase the efficiency of the student’s allocation process by providing the relevant information and decision to the managers and users in real time mode, and thus increasing transparency, accountability and strengthening the trust between all participants in this process.

Keywords: allocation, mobile devices, school, education, management.

* Corresponding author
Introduction
Maputo is the largest city of Mozambique, being the capital of the country. Its population is around 1 300 000 inhabitants over an area of 346 square kilometres. In Mozambique, more than 90% of primary schools are public, of which 101 are located in Maputo city. The national general education system consists of seven years of primary education and five years of secondary education [1]. The public primary education is free and is divided into two levels: primary education of the first degree (EP1, 1st to 5th grades) and primary education of the second degree (EP2, 6th and 7th grades). With the introduction of the new curriculum in 2004 primary education is structured into three learning cycles: the first cycle, correspond to the first and second grades; while the second cycle, goes from the third to fifth grades and the last cycle, comprises the sixth and seventh grades. The official entry age at first grade is six years [1, 2]. Primary schools usually work in two shifts of five hours, one in the morning and another in afternoon. To accommodate the expansion of the system, some primary schools mainly in the major cities, work in three shifts of 3.5 hours. Some schools also teach EP2 in the night shift, but this is decreasing. Less than 5% of students attend primary school in private or community schools. Upon completion of primary education pupils can continue their studies in general secondary education or basic level of Technical and Vocational education.

The secondary education goes from eighth to twelfth level and is subdivided into two cycles [1]. The first cycle comprises eight to tenth grade, while the second is from eleventh to twelfth. This structuring of general education is reflected in turn in the structure of the schools, i.e., a school that teaches primary level does not teach secondary and vice-versa. This provision of educational infrastructure generates a constant need for allocation of students as they complete their second grade moving from primary to secondary education level and within the secondary level after completion of first cycle. In Maputo city, the local government is responsible for providing education through its directorate of education (DECM) to every citizen. The DECM is represented in each administrative district by the district educational department (DDE), where each public school is located, being thus under the jurisdiction of the corresponding DDE [2].
**Students Allocation Systems**

Many countries use allocation systems considering the minimization of displacement, i.e., reducing travelling distances and costs for pupils on the path home to school and vice-versa \[3, 4\]. A deferred-acceptance algorithm \[5\] was one of the first techniques that was used to distribute students within faculties of universities, by creating sets of pairs containing students (S) and targeted universities (U). The Boston school choice mechanism \[6\] is a modification of deferred-acceptance algorithm \[5\] used to allocate children in several schools, combining the residence and school preferences of pupils’ parents or legal guardians. While the Columbus student assignment mechanism used by the Columbus City School District in the United States of America, allocates first the students living within the geographical area of the schools and the remaining places are given by employing a random lottery system \[4\]. Yet another technique for allocation of students \[7\], employs a geographic information system (GIS) connected to the municipality database, to distribute students following their house location and the nearest available school. However, all the systems have their drawback as for instance, some students may be allocated in schools far from their residence or even get a school that is not their preference. Moreover, the use of GIS based allocation systems employs the displacement as the main factor, which in situations like in the Maputo city this may not work well due to the lack cartographic database for most of city suburbs.

**Maputo city Allocation System**

School enrolment is done at any public school and each school deals with its own enrolments at the primary education level. When the number of pupils is greater than the school capacity, the parents have to look for another school including private schools. The problem of allocation arises in the transition of level two of primary education to secondary education and also within the secondary education, when students move from first to second cycle. The allocation algorithm used in Maputo city DDE is an adaption of the Boston school choice \[4\], with the variable age taken as ranking factor.

To carry out the allocation process in Maputo city, following procedures are implemented:

**Step 1:** Each student submits to the school a preference list of four schools in which she/he wishes to study ordered by priority.
Step 2: The DDE allocates a school to the student based on her choice by taking the age as priority, i.e., students are sorted by age and those with lower comparative age are selected first.

Step 3: Using the Boston system of the pairing of student and school preference, following steps are performed:

3.1 Each school considers the students that have chosen it first. At the end there will be two possibilities, or no more vacancies or no more students have selected the school as first preference.

3.2 The school that still have vacancies after the previous stage considers the students that placed it as next preference. After this stage there will also be two possibilities, or no more vacancies or no more students have selected this school.

3.3 Previous step (step 3.2) is repeated until there is no more vacancies or all the students have been allocated.

Figure 1 below, shows the actual system’s entities implementing the described procedures.

The way this process is actually implemented raises a lot of concern mainly at the beginning of every academic year for parents and legal guardians, as well as for the students involved. Students can be allocated to schools that are not their
preference, in schools that are far from their homes and even not being placed in any public school. Adding to this, the process is performed manually raising the perception that the allocation algorithm is not properly implemented. Moreover, the current system is enable to produce results within the established timeframe, to ensuring gender balance between the allocated students and schools, etc. Thus, the digitalization of Maputo city student’s allocation system seems to be a better option which may help education managers of DDE by:

- Bringing about a better organization of the system
- Providing increased data security
- Providing the execution of more secure tasks
- Reducing execution errors
- Increasing processing time
- Increasing the quality and quantity of processed information
- Reducing waiting times (in relation to results publication).

Proposed Digitalized Maputo city Allocation System
In 2014, Mozambique had more than 18 million mobile subscriptions, which represents 70 subscriptions per 100 people [8]. Also, about 60% of Mozambican population has access to mobile phones of which more than 10% use internet [9]. This data is revealing if considering the potential for expansion of technological services. However, the use of mobile technologies in the management of school activities in the country is practical non-existent.
The allocation of students is an issue closely linked to school registration. Currently in Maputo city there is no centralized database of students, and a computer system would first need a set of information of the targeted students. In the allocation process, four steps are identified:

- Constructing the student database
- Submission of student’s preference
- Allocation of students
- Checking the allocation results

Constructing database of students – includes the use of a professional database management system able to register all required student’s information. However, it is not practical for obvious reasons each student to register or parents to enroll their dependents. Therefore, as most of the Maputo city
schools have their basic student data in Excel spreadsheets files, these files are integrated into the system.

Submission of student's preferences – The submission of preferences is made using mobile devices with Internet access. First, the student must access the system using the student and identity card numbers which are unique. Then, she/he must choose schools in a given priority order and submit to the system. However, the first three schools must belong to the same DDE where the school of the student making the choice is located. This simple strategy is implemented in order to reduce the displacements, avoiding the use of GIS due to inexistence of accurate addresses in most city’s suburbs. The preferences can later be edited until the closing date of submissions. Figure 2 below illustrates the submission process.

Allocation of students - This is performed within the DDE interface where basically an automatic allocation of students achieved. The allocation algorithm is implemented using PHP programming language. The function implementing the allocation performs its task in two stages:

- Considering the first three preferences, assuming that schools belong to the same DDE of current school.
- Considers the students that were not taken in the previous stage, looking for places for the fourth student's preference within the available schools in the city.

When the school runs out of vacancy numbers while there are students who meet the requirements, the DDE evaluate the possibility of schools to provide more vacancies. In the case where students do not meet the requirements, they may be allocated to night shift.

Checking the allocation results – To verify the allocation results, one has to introduce the student or identification card number. A screen pops-up listing the information about the allocated school name and address and the study shift, as shown in Figure 2.

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2 students who have not lost more than two years of schooling
Conclusions

A modification of the Boston school choice allocation system is employed within the Mozambican Education System (MES), particular at the Maputo city education directorate where this research was conducted. In comparison to other allocation systems, the current presents a different feature, since the objective pursued by the designers is not only to minimize the travelling distance home-school and vice-versa, and also to preserve the age balance of pupils, thus, implementing the concept of homogeneous schools. In addition, the model ensures that students with lower comparative age attend school during the day this way grouping students with similar profile. Other factors could be adopted in order to ensure the concept of homogeneous school, as distributing students according to their academic performance and gender. However, both factors were not included as they would introduce some level of discrimination and separation.

The use of mobile service in the area of education management in Maputo city, especially regarding school choice, is expected to make a difference when it comes to transparency, accountability and participation of parents and students. This study shows that although it is clear that mobile technology present new ways for parents and students to participate in the management and provision of education services such as student's allocation systems, for this to happen they need to be made aware of these opportunities and their responsibilities.
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Mobile Learning Management Issues in Higher Education: A Retrospective and Prospective Review

B-Abee Toperesu
University of Cape Town, South Africa
Contact Information: b-abee.toperesu@uct.ac.za, +27 21 650 9111

Jean-Paul Van Belle
University of Cape Town, South Africa
Contact Information: Jean-Paul.VanBelle@uct.ac.za, +27 21 650 9111

Abstract: As mobile devices become ubiquitous, they have landed in the classroom fostering a new phenomenon of mobile learning and resulting in a paradigm shift in pedagogical approaches. University IT infrastructure has inevitably been impacted by the influx of mobile devices giving rise to many IS management issues. The target audience for this paper includes IT leaders in higher education institutions who now face new IS management issues as a result of mobile learning. This paper reviewed the top IS issues in higher education institutions as identified by established research organisation Educause. The paper then contextualised the first two key management issues within literature. Main findings suggest that Information Security and Optimising Educational Technology will remain a key focus in the coming few years.

Keywords: Higher Education Institutions (HEI), Security, IS issues

Introduction

Mobile devices have become ubiquitous and thus become a part of our lives. Individuals are using mobile devices to store, process and retrieve information from anywhere at any given time. These devices have also become powerful communication tools in the wake of advanced communication networks such as LTE (Long Term Evolution) and WiFi. Users are able to seamlessly collaborate and share information across divides. Not surprisingly, mobile
devices have crept into the classroom as learners integrate their learning with mobile devices.

Learning institutions have found themselves in an uncomfortable position of being more reactive than proactive to the demands and issues that these devices are bringing. With the domestication of WiFi inherent in most academic institutions, students are now bringing to campus not only one device but in some cases several mobile devices which they connect to the network to support their learning (Abachi & Muhammad, 2014). This influx of devices has brought about new challenges to university management as they seek to monitor, support and secure their network.

The phenomenon of mobile learning also commonly referred to as m-learning, emerged in recent years through the increased integration and adoption of mobile devices in learning. However, there is a lack of consensus on the true meaning of mobile learning as various authors in literature have defined mobile learning in different contexts. This can be attributed to the fact that mobile learning can be viewed from two distinctive vantage points, i.e. technological (Mobile) and educational (Learning).

Geddes as cited in (Hashemi, Azizinezhad, Najafi, & Nesari, 2011) defines m-learning as, “the acquisition of any knowledge or skill through using mobile technology, anywhere, anytime.” (p. 2477). Ozdamli and Cavus (2011) describe mobile learning as a model which allows learners to obtain learning material from anywhere at any time using mobile technologies and the internet. It can be noted that the anywhere and anytime attributes are inherent in both definitions. Kinash, Brand and Mathew (2012 as cited in Marzouki, Idrissi & Bennani, 2013) gave an explicit and elaborate definition of mobile learning. They define mobile learning as simply "the use of mobile devices that can connect to the Internet for educational contexts" (p.567). However although this definition is most appropriate, the authors allude to the fact that questions may still abound and that no clear and precise definition can be obtained. This study will, however, employ this definition as most suitable within the context of this review paper.

As mobile learning becomes more attractive to higher education students, IT/IS management issues have arisen. IT leaders need to be more proactive in addressing these issues to ensure smooth operation of institutional IT infrastructure and ultimately the learning process.
This paper will first analyse the top IT issues identified by reputable industry specific research organisation, Educause and then focus on the ones specifically relating to mobile learning management. The paper then gives possible solutions in addressing the main challenges identified.

**The FRAME Model**

The FRAME model was used as a lens for this research study. “The Framework for the Rational Analysis of Mobile Education (FRAME) model describes mobile learning as a process resulting from the convergence of mobile technologies, human learning capacities, and social interaction” (Koole, 2009 p. 25). The model claims to address some issues that are inherent in traditional learning methods. It proposes to address issues such as information overload and challenges with collaboration. The model is best explained through the diagram in the figure below.

![Figure 1: The FRAME model (Koole, 2009)](image)

The circles depict three aspects of mobile learning which are the Device, Learner and Social aspects and where these circles intersect is where attributes from both aspects are represented. For instance, the device usability is an attribute that belongs to both the device and the learner. Where all three circles meet shows the ideal mobile learning experience. Koole (2009) claims that by assessing the contribution of all the three aspects to this convergence (DLS), stakeholders will be able to design more effective mobile learning experiences.
Various mobile learning studies have used the Frame model in recent information systems research (Butcher, 2016; Elfeky & Yakoub, 2016; Godfrey, 2016; Misra, Srivastava, & Abeles, 2016). Although there is no definitive figure of the model’s use in information systems, initial searches suggests the model has been widely adopted.

**Key IT/IS Management Challenges in Higher Education**

Mobile learning is seen as being imposed by the 21st century learners’ need for mobility (Marzouki, Idrissi, & Bennani, 2013). As the digital natives are increasingly finding their way into higher education, more and more mobile learning ways have been identified. This paper reviews the key challenges faced by IS managers in higher education institutions as they try and keep pace with the fast changing requirements of information technologies in enabling mobile learning.

This review paper looks into the key IS issues relevant to mobile learning using secondary data identified by the organisation Educause. Educause identifies itself as a not for profit association of IT community leaders and professional who are committed to higher education advancement. The association annually releases its top 10 IT issues in higher education. This list is first formed and populated by a panel of IT leaders in the Higher Education sector and other industry experts who include CIOs. The list is then voted by the association’s community to determine the top IT issues (Grajek, 2016).

Table 1 below shows the 2016 IT issues in Higher Education, arranged according to priority compared with previous years. However it should be noted that some 2016 IS issues were not previously studied or did not emerge in previous surveys conducted.

<table>
<thead>
<tr>
<th>IS Issues</th>
<th>2016</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Security</td>
<td>1</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Optimizing Educational Technology</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Student Success Technologies</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>IT Workforce Hiring and Retention</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Institutional Data Management</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT Funding Models</td>
<td>6</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>BI and Analytics</td>
<td>7</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Enterprise Application Integrations</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT Organizational Development</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-Learning and Online Education</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Top 10 IT Issues in Higher Education (Grajek, 2016)
From the list presented in the table above, it can be noted that the number one management issue presented is Information Security. This is not surprising for organisations with BYOD (Bring your own device) approaches like educational institutions. Other researches share a similar conclusion with Information Security topping the list. For instance the Society for Information Management (SIM) also conducted a study to determine the top IS management issues for organisations. Although their findings were not particularly focused on one industry, their findings help to have an understanding on how HEI IS issues compare with general organisations.

The 2016 SIM IT trends study was based on responses from 1218 respondents which included 486 CIOs. The respondents represented a total of 785 different organisations (Kappelman, 2016). In this study, security and privacy also came out on the top of the list in two consecutive years. Also of interest is that, IT Talent featured in both studies and appeared in the top five issues for both studies.

<table>
<thead>
<tr>
<th>Most Important/Worrisome Concerns to the IT Leader</th>
<th>2015</th>
<th>2014</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security/Privacy</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Alignment of IT and/with the Business</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>IT Talent/Skill Shortage</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Speed of IT Delivery/IT Time-to-Market</td>
<td>4</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Agility/Flexibility (IT)</td>
<td>5</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Credibility (IT)</td>
<td>6</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Business Continuity</td>
<td>7</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>IT Value Proposition to Business</td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>CIO Leadership Role</td>
<td>9</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Disaster Recovery (IT)</td>
<td>9</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2: IT Leaders’ Top Ten Personally Most Important IT Management Issues, 2013-15. (Kappelman, 2016)

This research paper however focused on the IT issues faced by higher education IT leaders as identified by Educause.

Security

Information security and privacy has remained a top priority among IT leaders globally as cybercriminals are on the increase and higher education institutions are no exception to the threat. Cybercrime can be described as any criminal activity where a computer or computer network is either a tool, place of crime, source of crime or is a target (Pozar, 2014). According to a leading security firm
Symantec, the education sector is now the third most frequently breached public sector (Symantic, 2015) Different forms of threats do exist targeting institutional data, the network or personal data sitting on an individual’s devices. Some examples of information security threats include, malware & virus infections, cyber fraud and hacking. As mobile devices become prevalent in universities, more and more mobile devices become susceptible to these threats. Mobile smartphone hacking software is also now easily available online. This software is used to steal passwords or any personal information.

Another information security factor is that mobile devices can be lost or stolen. Once these mobile device land into the hands of criminals, if not secured, can lead to more harm done to the institution or the network. Although this can be countered by remote wiping the devices that are stolen or lost, this responsibility lies in the owner in most cases as the device personally belongs to them. In most cases educational institutions have no control over personal mobile devices.

In an attempt to address these security issues, the Higher Education Information Security Council (HEISC) came up with the top 3 information security issues (Grama & Vogel, 2016). These strategies are discussed below.

1. Information Security Awareness.

Awareness campaigns can be done to raise awareness of criminal activities. An increase in the number of phishing attempts shows that the target is now the user and cybercriminals seek to exploit their lack of knowledge. While organisation are increasing and advancing their security technologies, very little is being invested in increasing safety awareness among the general users, causing them to be the weakest link on the organisation’s system (Aloul, 2012). Social awareness campaigns can be run to conscientise people of prevalent security issues. According to Grama and Vogel (2016) many higher education institutions are promoting October as cyber security awareness month each year since 2004.

2. Information Security Strategy. Higher education institutions need to developed effective information security strategies (Grama & Vogel, 2016). An information security strategy needs to relate to an institution’s overall mission and demonstrate how information security supports the mission and its values. Formulating such strategies help elevate information security concerns to HEI leaders.
3. Security Technologies. Ways of insuring information security and privacy using next-generation technologies are available. The most common method is enforcing detection software. Programs that detect and filter infections using algorithms and signature based matching techniques have been developed. These programs identify malware before it reaches the computer system or network (Zolkipli & Jantan, 2010). Further advancements in enterprise systems security include endpoint security. With endpoint security, each mobile device must meet certain standards before it is granted access to the organisation’s network. Examples of endpoint security include personal firewalls and antivirus software which is distributed, monitored and updated from the server (Rouse, 2011).

Based on the dominance and persisting nature of information security and privacy as reflected in previous research studies (Aloul, 2012; Astani, Ready, & Tessema, 2013; Walaza, Loock, & Kritzinger, 2014), information security and privacy will continue to be a pressing issue for the next few years (Garba et al., 2015). IT leaders in higher education therefore need to prioritise and focus on their security as more cyber-attacks are now coming to the education sector.

Optimising Educational Technology

Optimising the technologies supporting learning is one of the identified top issues for IT leaders in education. This is attributed to the fact that more and more mobile devices are now accessing institutional resources. If unattended to, the devices will put strain on the available technologies possibly rendering them unusable. The main issues to be addressed by most universities is the availability and efficiency of the network itself.

As digital natives take on higher education life, bringing along a myriad of mobile devices and using them to access online content, network saturation becomes an issue. HEI did not envisage an influx of mobile devices. According to Nykvist (2012) most university networks were never built to accommodate a heavy load of mobile devices. Technology managers have found themselves in a more reactive position as they reconfigure networks to accommodate as much devices as possible. As a means of addressing this problem, Chitanana and Govender (2015) argue that proper application of policies will reduce the strain on the network.

Bandwidth has also increasingly become a challenge in universities as students are exposed to vast amounts of data consuming online resources. Online learning resources such as YouTube have become popular among students.
These sites allow for creation and sharing of video resources. However, these resources have a big impact on the network in terms of bandwidth utilisation. Chitanana and Govender (2015) state that bandwidth is a valuable resource to the university which therefore needs to be managed properly. They further propose that for a university to effectively manage bandwidth, the following three critical elements need to be looked at carefully, i.e. visibility, monitoring and optimisation as shown in the figure below.

![Figure 2: The Critical Interdependent Components of Bandwidth Management (Chitanana & Govender, 2015)](image)

With visibility, the institutions should be able to identify the wireless devices that are connecting to its network. In other words the devices need to be visible in order for policies to be enforced and network access revoked in cases of abuse. Visibility may also include the applications that run on these devices to enable them to be monitored as well. The visibility of the apps is relatively important as it allows for the implementation and or enforcement of some policies especially those relating to data usage (Chitanana & Govender, 2015).

Control refers to the network access control whereby the institution is able to control the level of access granted to its users or devices. Andrus (2013) as cited in (Chitanana & Govender, 2015) describes network access control (NAC) as allowing for the defining of the policies which control how users gain access to the network resources on the network. This is of particular importance to
university settings with a wide range of users which includes guests and visitors who need to connect to the network.

Optimisation involves the identifying and prioritising of network access to critical applications. In a university setting these can be teaching or research applications. Most universities around the world are making use of learning management systems (LMSs) such as Blackboard, Canvas, Moodle or Sakai to deliver learning materials and students can use their mobile devices to access these materials (Abachi & Muhammad, 2014). The resources may include lecture recordings which students through access to the network can download or stream at any time. Such applications can receive priority over others to have a better experience.

**Conclusion**

The purpose of this review paper was to identify the top IT/IS management issues in higher education that emerged in recent years and provide directions that these may take in the near future. The paper first evaluated the top IT/IS management issues in higher education as identified by industry research firms and then focused on the issues relating to mobile learning. The paper discovered that today's higher education IT leaders face many challenges as they manage institutions in the face of an influx of mobile devices and an increase of cybercrime in the form of malware, phishing scams and identity theft targeted on educational institutions.

Information security came out as the top management issue. Prioritising this issue is particularly important in higher education as these institutions receive a huge number of devices which students bring along and connect to the network. Information security is anticipated to remain on the top of the list or at least the top five for the next few years. As networks and mobile devices get more complex so does the underlying criminal activities.

As students are bringing more than one device, this can put a strain on the network (Chitanana & Govender, 2015). The paper therefore also looked at how institutions can manage and optimise their network as a means of addressing the second top issue which is Optimising Educational Technologies. The paper was limited to do an in-depth review on possible solutions on the top two IT management issues because of limitations in the size of this paper. Future research directions could dig deeper into the other IT issues identified in this research. However it is quite important that today’s IT leaders in higher
education prioritise these issues as they will continue to feature as the top important issues in the coming few years.

References


Complementing backyard-bedroom recording studios with a mobile app

Bhavana Harrilal¹, Alette Schoon², Edwin Blake³

¹,³Department of Computer Science, University of Cape Town, South Africa
²School of Journalism and Media Studies, Rhodes University, South Africa

1. harrilalbhavana@gmail.com, 2. A.Schoon@ru.ac.za, 3. edwin@cs.uct.ac.za

Abstract: Research on township hip-hop musicians in South Africa suggests that media producers in developing countries may increasingly be combining use of mobile phones with other digital technology. This demonstrates the need for M4D designers to conceptualise apps which fit such cross-device digital media ecologies. We describe the co-design methods used to support such hybrid township hip-hop digital media ecologies. These designs emerged from an interdisciplinary collaboration, where the ethnographic work of a media studies student and her access to participants were used as a basis for a computer science student in setting up a participatory design project. Such collaboration has been fostered for some time at the ICT4D lab at our university and may provide a model for postgraduate mobile app design collaboration. The mobile application developed supports hip-hop production. We argue for the importance of such creative digital tools in M4D, as they may facilitate voice and capability in marginalised communities.

Introduction

Several scholars have argued that popular media consumption should be given more attention in the ICT4D and M4D literature, as these build a range of digital and mobile technical skills (Arora and Rangaswamy, 2013; Sey and Ortoleva, 2014). We argue that popular mobile media production needs to be recognised as a key focus for M4D designers. Digital and mobile media production provide marginalised communities in the global South with voice, (Couldry, 2010) and inclusion in global dialogues resisting corporate media power (Jenkins, 2006). This is why the ICT4D centre at the University of Cape Town has for some time now worked in this field of popular media production (Bidwell et al., 2010; Noakes et al., 2014; Walton, 2009; Walton et al., 2012). Recent ethnographic research with township hip-hop artists by the second author, show how hip-hop production is integral in resisting a hegemonic violent consumerist masculinity in the marginalised space of the township (Schoon, 2014). We may therefore consider hip-hop through Sen’s (1999, 1992)
capability approach, as allowing young people some control of their own lives, and making it an important focus for M4D.

What distinguishes several hip-hop artists, from other poor, black and predominantly unemployed young people who also owned mobile phones, was their ownership of second-hand personal computers. Hip-hop artists who mastered the digital media software on their computers and had access to a microphone became known as producers. Their simple corrugated iron, cement and mud backyard bedrooms behind the family house were then acknowledged as recording studios (Figures 1 & 2). In this space a communal ownership of the ‘yard’ computer developed between the rappers and the producer.

The ethnographic research, on which the study is based, approached the hip-hop artists’ music production holistically in terms of ‘digital media ecologies’ (Horst et al., 2010). The term ‘media ecologies’ originates in McLuhan’s (1964) medium-determined approach to technology in society. Various scholars have extended his medium-determined notion of ‘ecology’ to describe more dynamic relationships between people, social environments and technologies, such as ‘information ecologies’ (Nardi and O’Day, 1999) or ‘communicative ecologies’ (Foth and Hearn, 2007). Horst et al’s (2010) practice-focused ‘digital media ecologies’ was used to study the township hip-hop world, since its emphasis on broader meaningful practices within which digital practices should be understood, was considered particularly useful to explain how digital media production fitted into a broader practice of redefining the self. Among hip-hop artists in this study, with the acquisition of computers, new practices emerged where digital media was frequently transferred between the computer, mobile feature phones and the mobile internet. The yard computer became a repository of hip-hop media which was transferred back and forth to mobile phones via USB cable, and then further distributed in the streets via Bluetooth. There has been some research considering how, with increased access to computers, mobile

Figure 1: Backyard-bedroom studios, exterior view

Figure 2: Backyard-bedroom studios, interior view
phone users in the global South are making choices between using different
digital devices (Donner, 2015; Pearce, 2011; Walton and Donner, 2012). Up to
now, however, there has been very little research that examines how marginal-
ised people in the global South transfer media between mobile phones and
other digital devices such as computers.

Actor Network Theory (ANT) emphasises, like digital media ecology, the
interactions between technology objects and people, but ANT differs in that it
argues that interactions of objects and people in the network transform their
characteristics and produce new ‘assemblages’ (Latour, 2005, p. 43). The back-
yard computer coupled with the mobile feature phone here may be conceptual-
ised to produce such a new assemblage for the creation and distribution of dig-
ital media. We argue that digital media ecologies should include a focus on how
various devices are used in tandem, and that focusing on such assemblages may
provide additional insights beyond only considering each device in relation to
the user. This focus will be particularly useful for the M4D designer, who may
through this realisation, be able to design for such a new assemblage: a second-
hand computer with digital media production software, connected to a frugal
feature-phone mobile internet.

Studies have shown that appropriately adapted methods are required in
developing world contexts (Marsden et al., 2008). Community based co-design
aids in navigating complex design spaces where requirements are determined by
the many designers who have varied design skills and technological abilities
(Blake et al., 2011). Solutions found in this way address users’ communicated
wants and support their learning, alleviating a researcher’s short-sightedness and
bias. Our co-designed mobile application (“app”) set out to support the digital
practices of the hip-hop community and their collaborative work practices
without trying to replace all their music production processes.

This paper describes the design of mobile services in situations where they
cannot replace computer based systems but are valuable additions that amplify
the resources and allow enhanced participation in hip-hop music creation.

Limitations of mobile phones in developing contexts

This ubiquity of mobile phones in the developing world has seen them pro-
posed as solutions in many Information and Communications Technology for
Development applications (Rashid and Elder, 2009). However there remain
limits to what is possible on mobiles compared to computer based systems.
Most hip-hop artists had feature phones such as BlackBerry’s, or Nokia’s;
budget phones with smartphone capabilities, a smaller screen and limited processing power.

At the outset an understanding of the capabilities of a smartphone was realised by all co-designers. It meant that limited recording and producing processes could be managed on a low cost smartphone as music production is computationally intensive task. This affected the features of the app could have.

In music production there are many aspects to visualise, including waveforms, channels, compression ratios, equalizers and much more. PC software interfaces are designed to allow users to navigate through multiple functionalities in music editing. This works well on interfaces with split screens or multiple monitors but a smartphone has severe constraints in this regard.

**Interdisciplinary Co-design Method**

Our method is flexible and sensitive to a context that depends on the participant, intermediary and designer perspectives and agendas (Marsden et al., 2008). Design is a creative and proactive activity. The designer’s role includes mediating different interests, and facilitating the ideas and initiatives of participants while maintaining a reflexive stance (Wyche, 2015). Importantly, it includes the designer’s judgement with respect to creativity and design knowledge, to conceive and realise design interactions and their corresponding design devices (Ehn, 2008).

The design of mobile apps for creative expression, have increasingly been the result of collaboration by interdisciplinary teams of post-graduate students at UCT. Such collaboration is based in the notion of an intermediary, who bridges a gap between the community and technologists, and acts as a user champion, allowing different stakeholders participation to become protectors and enablers (Simonsen and Robertson, 2012). In our case the intermediary, second author, was a doctoral media studies student with a long term relationship with the community. This allowed the first author trusted admission into this hip-hop community in Grahamstown, South Africa, and access to observations and insights into their digital and media practices.

We built on such insights to expose the technology gaps in the community without having to do extensive interviews and invasive methods. Through joint co-design sessions and visits to home studios, both technologist and intermediary could gain further insight into the digital and media practices of the community. In the design sessions and in previous interaction with the intermediary, hip-hop artists were made aware of their contribution to potential commercial research for mobile app development. Contrary to expectations,
there was universal enthusiasm for this endeavour, and excitement to associate their individual hip-hop brands with a major mobile phone producer.

The knowledge gained from using prototypes, ethnographic information from the intermediary and user design sessions provided the foundation of the app design (Jones and Marsden, 2006). Co-design meetings occurred at every design intervention step: contextual inquiry, identifying requirements, paper prototyping then finally creating a smartphone prototype.

Contextual Inquiry

For the discussion below, the reader should note that many of the terms are explained in the glossary appended after the list of references.

Altogether, fifteen hip-hop artists participated as co-designers at various times during the research project. Ten were recruited through a workshop that took place at the July 2015 Fingo Festival, a township festival that runs alongside Grahamstown’s National Arts Festival (“Fingo Festival,” n.d.); and other artists who gave permission to visit their home studio in the townships, were recruited through the intermediary’s network.

Backyard studio visits
Observing the artists’ recording, mixing and electronic beat production activities revealed that they could not create music without backyard-bedroom studios. Rappers are dependent on producers to create beats, the underlying music upon which their vocal recording is placed. While rappers had access to yard computers, as these were seen as communal assets, digital beat production involved many hours of learning musical and digital skills, which meant that such skills were concentrated in only a few of the producers who had constant access to computers in their bedrooms. Thirteen of the fifteen participants had a feature phone, but only six had a functional home studio and the other nine did not have any recording facility. This called for the design of an app where such beatmaking skills could be developed on the mobile phone and then transferred to the computer.

Mind maps and musical process
The first co-design session focused on each artist’s music creation process; from the initial steps of ideation, to writing lyrics, beat creation, recording and mastering, to distribution and finally promotion. Ten participants were recruited; they were attendees and performing artists of Fingo Festival 2015 and first set of co-designers for our research project. This session provided insights into the community’s media and technology practices, and commonalities and gaps in such practices.
Artists were asked to map their music creation process and were given materials to help plot this on paper. They were asked to include what media and software they would use at each phase. They were free to illustrate this process (Figure 3). Participants produced music creation mind maps that were similar, mainly differing in ordering of steps. Many used the same recording software and shared their music via Bluetooth on their phones or with flash sticks.

**Dependency of Artists on Producers Artists**

Four of the ten participants were both producers and rappers, while the rest were strictly rappers and relied on their producer for the bulk of the music editing and beat creation. The following quotes were from the first session.

“I’ll write my verses on paper then I’ll message my producer. Once he makes a beat, I’ll go visit him. Then I recite my verses on top of his beat. Sometimes he will have to change the beat and I’ll have to come back another day.” – Rapper1

Rapping involves a technique called ‘flow’ in which the inherent rhythms of the beat are accentuated in the rap vocals through emphasis and punctuation. This meant that if the rapper had not written his rap lyrics to the specific beat, it might be particularly difficult to adjust the flow to match it.

“Guys come in to record and we end up recording lots of takes, it takes time to get his flow and doesn’t know his lyrics and verses” – Producer1

As one of the most respected beatmakers in the hip-hop community, Producer1 was able to charge an hourly fee for his services, encouraging rappers to prepare as much as possible. However, if they were not able to practice rapping to the beat beforehand, this was difficult, leading to wasted time.
Differing interests of Artists and Producer Artists
In this session it was apparent that producers and rappers have different interests in the overall music creation process. Producers prioritised mastering and production of beats, while rappers were interested in being able to record their verses and capture ideas for beats. This was so that they might more easily send these to each other via mobile phone instead of timeous travel to visit each other.

“MC’s don’t practice their verses with the beat, they only get to rehearse when they come to record” – Producer2

“I get my beats from my producer via Bluetooth or on a flash. Sometimes on WhatsApp but then the sound quality is lost” – Rapper2

Sending uncompressed works in progress, from rappers to producers, and finished compositions, from producers to rappers, was thought to be of value to both parties, and better than sending beats via instant messaging where sound quality was lost and it could not be used in desktop recording software since it was the wrong format.

Mobile device complements PC recording
From the first it was clear that any app would not act as a substitute to existing recording and production practices, since this would mean a significant step down in sound quality, which was of utmost importance to the artists. There was a need to shorten the lengthy recording process through a technical solution that could eliminate the back and forth travels to get the right beat and quality; and facilitate rehearsal on the correct beat. A mobile phone could handle subtasks of the recording process like beat creation and vocal recording. These could aid the creative process without diminishing overall sound quality for beats, since they could be saved as high quality audio and edited on PC software without sound loss, but vocal recordings would be for rehearsal only. Using a smartphone for rappers and producers to send each other beats or recordings would promote collaboration, and give rappers more control over the beat-making process.

Paper prototyping
Paper prototyping involved seven participants, two producers and five rappers forming a co-design group. Five participants were from the previous design session. While an app which helps both producers and rappers was agreed upon, its features were still up for debate. In this session it was agreed that a
mobile phone could bridge gaps, since everyone had one. In reflecting on the problems discussed in the previous workshop, of rehearsal and time wasted on finding appropriate beats during recording, it was agreed that collaboration and *ad hoc* beat creation was a priority for an app.

Participants were shown some existing mobile music applications which facilitated a discussion on which production features are possible on a mobile platform. This improved their design understanding and mind-set in the co-design session. Participants were then prompted to describe the look and behaviour of a possible app. The paper prototype was co-designed by firstly agreeing upon functionality and then a meaningful music visualisation.

Figure 4 documents how typical PC music software influenced the visualisation the hip-hop artists suggested for the app. It used a line cursor to indicate the playback point on the music timeline. They also suggested a landscape view interface to emulate familiar PC music software. Figure 4 also shows a tabbed interface to navigate to different features. A list of limited features was agreed upon by participants. Given the limitations of mobile processing they prioritised effects, that is, tempo, instruments, samples; and sharing of beats created with peers via Bluetooth (format compatible with existing PC music production software); and the ability to save beats in progress.

**Implementation**

The app developed was designed to be a tool that complements artists’ music creation process. It is not a substitute for a home recording studio but a resource that accompanies backyard-bedroom recording process. It therefore fits the hip-hop artists’ digital media ecology where mobile phones are ubiquitous, but interchanges of digital files with backyard computers are common. Here we have chosen to highlight the beat maker and sequencer app.
of the project (Figure 5). These reflect the design concepts in Figure 4. The prototype beat maker and sequencer was built on a Windows Phone 8.1 platform and deployed on Nokia Lumia 520s as many participants owned or have had interaction with Nokia budget smartphones (Molapo and Densmore, 2015).

The sequencer builds on previous sessions and the interface adopts what artists were familiar with (Figure 5). Artists may change tempo, add more instruments, change the looping of the beats, save to the device, play back their beats, and send them to peers via Bluetooth or through Wi-Fi connection.

Figure 6 shows how the app allows for more samples and instruments to be added to different channels to make more complex beats. This was a priority requested by participants in the paper prototype session, to allow artists to create varied beats on a portable device.
Evaluation

The beat maker and sequencer app was evaluated by six artists. This evaluation had two components: the first several task completion exercises, the second a qualitative user experience questionnaire. The tasks were composing a beat, editing tempo, editing channels, saving a beat and sending a beat via Bluetooth. After completing these tasks, artists were left to explore the app and create beats as they desired. Afterwards they were asked to complete a questionnaire to rate components of the app, usefulness and ease of use.

All artists were able to create and send beats to one another with minimal assistance. This reflected in task completion tests, with every participant completing the tasks in less than three minutes. The task completion tests soon evolved into a beat jam session, since users were instructed to explore the app and create as many beats as desired. A jam session is where artists play (“jam”) by improvising without extensive preparation or predetermined arrangements. Artists preferred if they could save to more audio formats such as MP3 (MPEG-1 Audio Layer 3) but this was in conflict with the producers’ preferred default of AAC (Advanced Audio Coding) which could be ported to their PC’s with no loss in sound quality. Hence the decision to implement AAC was adhered to.

The app was used by all hip-hop artists who attended the evaluation session and met with universal approval. We also visited an artist at home, in his backyard-bedroom recording studio. This artist evaluated both the interface and usability favourably: “It looks beautiful, I love it. You can learn how to use it in one day, look I’m able to learn it in a few minutes” – Producer2

Emergent properties of mobile app

The analysis resulted in that three types of emergent properties were identified:

**Ad hoc usage** – The ubiquity of mobile phones allows for such tools to be used in many different contexts. This potential of *ad hoc* usage was seen as something useful and empowering: being able to create music whilst still in bed or on a bus ride. Artists appreciated its independence of PCs, which meant that more members of the community were able to participate in composing music. By leveraging available technology it extended the ability of artists to create content for later high-quality recording on PCs. The app thus complemented both their music creation process and their particular digital media ecologies.

**Simplicity of App** – The simpler functionality of the app meant that it was also simpler to learn and easy to quickly convey creative ideas and beats to fellow artists. Hip-hop artists were appreciative of this, and compared it to the
complex learning curve for PC production software. This is a positive consequence of simplification required for developing for mobile phones.

**Practice and collaboration** – Producers and rappers used the app collaboratively while evaluations were taking place: working on beats together both in workshop evaluations and at home interviews. Rappers valued accessibility of the app, being able to capture song ideas at their convenience and practice music making skills. Such practice may help in building both personal confidence and a more constructive recording relationship.

**Conclusion**

This paper has shown how co-designing such an app can result in a tool which supports an artist’s technology practices and responds to the particular township hip-hop digital media ecologies where mobile phones were used in conjunction with backyard computers. We showed that even mobile phones with limited capabilities can play a positive role, not replacing PC functionality, but complementing and amplifying resources already in place.

Central to our approach was the interdisciplinary teamwork between a media studies scholar and technologically skilled designer. This frees the technologist from attempting to master ethnographic skills and focus on co-design of appropriate and productive tools in a resource limited context.

**Acknowledgements**

We would like to recognise the hip-hop artists of Grahamstown, and Fingo Festival in particular, for their contribution to this research. This research project was made possible with funds provided by Microsoft.

**References**


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Glossary

Beat: a hip-hop instrumental is casually referred to as a beat

Channel: path for passing data or digital audio. In sequencing, each channel is assigned to a single instrument in any particular instant of time.

Mastering: form of audio post production, is the process of preparing and transferring recorded audio from a source containing the final mix to a data storage device (the master)

MC: (also referred to as a rapper) is a music artist and/or performer who usually creates and performs vocals for his/her own original material

Mixer: an electronic device that channels incoming audio signals while maintaining control over such effects as volume level, tonality, placement, and other dynamics for music production.

Producer: a composer is casually referred to as a producer. In the studio a hip-hop producer also functions as a traditional record producer who is ultimately responsible for the final sound of a recording.

Samples: portion, or sample, of one sound recording and reusing it as an instrument or a sound recording in a different song or piece.

Sequencer: programmable electronic device for storing sequences of musical notes, chords, or rhythms and transmitting them to an electronic musical instrument.

Synthesizer: an electronic musical instrument that generates electric signals that are converted to sound through instrument amplifiers and loudspeakers or headphones.

Township: suburb or city of predominantly black occupation, formerly officially designated for black occupation by apartheid legislation.
Are mobile phones a viable anti-corruption tool?

A literature review of ten years of mobiles as an anti-corruption tool in East Africa

Cecilia Strand, PhD.
Dept. for Informatics and Media. Uppsala University, Sweden
cecilia.strand@im.uu.se

Abstract
Corruption levels in East Africa have not fallen despite significant donor attention, negative business community reviews, and repeated commitments across the political spectrum to forcefully address corruption wherever it is encountered. The continued high levels of corruption, with the exception of Rwanda, thus call into question earlier suggestions that mobile phones, if prolific enough, could be an effective tool against corruption. Through a literature review of ten years (2006-2016) of open access M4D research on mobiles as a citizens-controlled tool for demanding greater government transparency, increasing awareness around corruption, and instantaneous reporting of corruption in the East African context; i.e. Burundi, Kenya, Rwanda, Tanzania, and Uganda; this study attempts to gauge the status of this research field. The review included the ten highest ranking open access ICT4D journals, as well as six journals from parent disciplines; information system and development studies, and finds that earlier optimism have not resulted in a significant body of research. This paper also explores some plausible reasons for the almost complete silence on this urgent and timely subject matter.

Keywords: Corruption, transparency, accountability, ICT4D, M4D, East Africa.
Introduction

Corruption levels in East Africa have not fallen despite significant donor attention, negative business community reviews, and repeated commitments across the political spectrum to forcefully address corruption wherever it is encountered (TI, 2015). Corrupt behavior can take on different forms, such as bribe-soliciting, where public officials demand payment in return for administrative advantages such as speeding up a process, and/or introducing unofficial fees for basic services that should be free (LeVine, 1975). It can also entail a more passive form, where officials simply skim a portion of development assistance or government funding. The 2015 East Africa Bribery Index (EABI) analysis, covering five sectors (police, judiciary, registry and licensing services as well as tax services), from 2010 to 2014, found that the institutions meant to uphold the rule of law (the police and court system) were the most bribe prone institution across the region. The report also concluded that although there have been some improvements in East Africa, these improvement are marginal and can partly be explained by methodological changes rather than real change on the ground (Transparency International Kenya, 2015). Indeed, 80% of respondents in the region, not including Rwanda, reported that corruption had increased a lot or somewhat over the past 12 months (Transparency International Kenya, 2015). Afrobarometer (2013) with data spanning from 2002, conclude a similar downward trend and thus further corroborates increasing levels of corruption across several countries in the region. Rwanda remains the least bribe prone country in the region and is a stark contrast to Uganda where the likelihood of encountering bribes was 40.7% in 2012 (Transparency International Kenya, 2015). The bribe patterns conveyed in the 2015 report mirror outcomes in similar surveys such as the World Bank’s Ease of Doing Business, the Mo Ibrahim Index on Africa Governance, and the Transparency International’s Africa report (Transparency International, 2015).

Corruption does not affect all citizens equally – the poorest citizens who are the most dependent on basic services are the most likely to pay a bribe (Justesen & Bjørnskov 2012). By using Afrobarometer material from 18 sub-Saharan African countries, including Uganda, Kenya and Tanzania to study self-reported experience rather than perceptions of corruption, Justesen and Bjørnskov (2012) finds that poor citizens are much more prone to pay bribes to street-level public servants to get access to basic public services as they cannot afford alternative service providers. In a region with many of the Millennium Development Goals still unmet (Centre for Global Development 2015), and
half of the population living below the poverty line, corruption thus hits hard. The 2015 East Africa Bribery Index (Transparency International Kenya, 2015) report conclude that corruption in essential services, threatens to dilute any benefits brought to the region as a result of economic growth.

Several countries are signatories to international and regional instruments to combat corruption such as UN Convention against Corruption and the African Union Convention on Preventing and Combating Corruption. But despite progress in the legal field, or perhaps as a result of the region’s governments’ failure to deliver on past pledges to stamp out corruption and proceed with institutional reforms related to anti-corruption, with the exception of Rwanda, citizens hold negative perceptions about their government’s attempts to address corruption (Afrobarometer 2013, Transparency International Kenya 2015; Richmond and Alpin 2013). The 2015 East Africa Bribery Index report concluded that the existence of a legal framework and emergence of rudimentary anti-corruption institutions appear to have had little impact on corruption levels, indicating a lack of genuine political will.

The continued high level of corruption (Afrobarometer 2013; Transparency International Kenya, 2015) would indicate that the past decade’s fast growth of mobile phone access, has not significantly delivered on hopes voiced in the mid 2000s arguing that ICT and mobiles could be effective anti-corruption tools. Information and communication technology would facilitate ordinary citizens’ access to information and thus better enable them to hold their government accountable. Furthermore, mobile would equip the same citizens with better opportunities to mobilize around corruption as well as provide an opportunity to instantaneously and at a minimal cost report absences of services or if the service-provider implicitly or explicitly requested an unlawful fee for a service. The continued high and even increasing levels of corruption affecting the poor primarily does thus call into questions the assumption that mobiles if prolific enough, offer a viable option to fight corruption.

Through a literature review of the past ten years (2006-2016) of M4D research on mobiles as a citizen-controlled tool against corruption, especially for the segments the hardest hit by corruption – the poor – in East African; i.e. Burundi, Kenya, Rwanda, Tanzania, and Uganda; this study attempts to gauge the status of this research field. In addition, as corruption hit the most vulnerable the hardest, this study focuses on corruption in basic services, as opposed to corruption in connection with skimming in development assistance programs, or bribes in connection with international or domestic tender processes and business transactions. A better understanding of this highly
relevant topic could have important implication for future and better targeted M4D research and development initiatives. Furthermore, as the literature review resulted in a surprisingly small number of articles, this paper explores potential reasons for the lack of research, as well as discusses implications for future research.

**Background: A mobile phone (and power-tool) in every citizen’s pocket**

East Africa has seen impressive growth in mobile phone access since 2000 as a result of governments’ policy strategies of offering mobile network licenses to the highest-bidding private investors to establish a backbone infrastructure (Table 1).

<table>
<thead>
<tr>
<th>Country</th>
<th>Mobile-cellular telephone subscriptions</th>
<th>Mobile-cellular telephone subscriptions per 100,000 inhabitants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burundi</td>
<td>16 320</td>
<td>153 000</td>
</tr>
<tr>
<td>Kenya</td>
<td>127 404</td>
<td>4 611 970</td>
</tr>
<tr>
<td>Rwanda</td>
<td>39 000</td>
<td>222 978</td>
</tr>
<tr>
<td>Tanzania</td>
<td>110 518</td>
<td>2 964 000</td>
</tr>
<tr>
<td>Uganda</td>
<td>126 913</td>
<td>1 315 300</td>
</tr>
</tbody>
</table>

Even if the mobile phone market is controlled by commercial entities and operated on commercial grounds, relatively cheap smart phones have allowed for lower income groups to own mobile phones too (Chabossou et al., 2009). Furthermore, even if access remains unequally distributed for the foreseeable future, the proliferation of mobile technology even in lower income brackets shows the importance placed on mobile phone access and usage across income groups. The ResearchICTAfrica household e-access and e-usage survey from 2007-2008 show that low income earners prioritize telecommunication services and are willing to spend approximately half their disposable income on mobile communication as well as are prepared to forsake other consumption to ensure access to a mobile (Chabossou et al 2009).
This significant increase in mobile phone access amongst the poor does, provide the citizens most adversely affected by corruption, in theory, with an affordable tool to gain access to government information and new opportunities to voice their concerns with poor service delivery. The next section will explore some of the propositions related to mobile phones as a viable tool against corruption.

**Mobiles as a viable tool against corruption- the rational**

The concept of first ICTs and later mobiles as a viable tool against corruption appears to have surfaced in late-2000 in research primarily generated by development agencies. The importance placed on transparency around fiscal flows, was clearly articulated through the 2008 launch of the International Aid Transparency Initiative (IATI), an online open access platform created by key bilateral and multilateral development partners to ensure greater transparency and supply partners with the necessary information to hold governments and implementers accountable (Davis 2011).

One report from the Swedish Development Agency argues that there “There is big potential in using mobile phones for “increased participation, holding governments accountable and promoting transparency” (Hellström/ Sida 2010, p 53). U4/Transparency International echoed similar sentiments, “Mobile technologies offer remarkable opportunities for promoting good governance, increasing accountability and fighting corruption allow rapid data collection and access to information and offer innovative avenues for social mobilisation and participation” (U4, Transparency International 2010, p 1). World Bank together with African Development Bank, stated that “The power of ICTs is more than just putting mobile phones in the hands of poor people” and presents a causality between greater access to information and empowerment (World Bank, 2011, Foreword). The two Banks highlight the importance of utilizing new emerging platforms, and calls on African governments to take advantage of “the power of social media and exploit it to their advantage, in particular to reinforce democratic processes, drive efficiency, foster innovation, empower public sector workers and expose corruption.” (World Bank 2011, p 17). Bertot et al. (2010) place similar faith in social media to promote transparency and trigger social mobilization against corruption. The Danish development agency, DANIDA, suggests in one of their reports that although citizen auditing using mobiles and social media is at an early stage of development, mobile phones can provide new opportunities for citizen auditing, by crowd-
sourced budget tracking and scrutiny of services delivery through appropriate mobile based platforms (DANIDA 2012). Parallel to this policy rhetoric, the development industry has made significant investments into developing various free hotlines and text-based reporting platforms, such as World Bank’s Integrity App(2012), Ureport in Uganda, Kenyan ”I paid a bribe” website to mention a few (TI 2015).

Academia has however also suggested a causal link between access to mobiles on one hand and new opportunities to fight corruption, on the other. Departing from ideas that ICT has a potential to increase governmental transparency by addressing traditional information asymmetry (Sturges, 2004; García-Murillo, 2010); mobiles it is argued, facilitate access to government information, which increases transparency around government affairs and together with lower transaction costs of communicating, mobiles provides new ways for demanding accountability. Zanello and Maassen (2011) argues, that although ICTs have not yet reached its full potential in East Africa, based on the predicted growth of mobile phone access, information is more readily available than ever before to those who want it, and thus provide new opportunities for demanding accountability. Access to government-related information is a prerequisite for monitoring the same institutions. Talukdar (2012, p250) appear to argue a similar point. Although he refrains to elaborate on his conceptual framework, he claims that mobiles, “can directly fight corruption through ensuring increased civic participation and promoting systematic transparency in governance and development process, and holding governments increasingly accountable”. Talukdar (2012) thus appears to suggest that mobile phones have a key role to play in supporting civic education to build better corruption awareness and thus facilitate civic overseeing systems.

Gaskin (2013, p137) studied how “specific ICTs affect political development especially in the context of how people monitor and hold their government accountable” in 121 countries and found that access to Internet “had a large and “significant effect on transparency and corruption” and thus supports previous statements of a causality between access to Internet and public access to government information, has a positive impact on the level of transparency. Gaskin (2013) however notes that diffusion of mobiles has a, although statistically significant, weaker impact on foremost transparency. Although mobiles have a weaker impact on transparency, the study found a connection between diffusion of mobiles and a “notable reduction in corruption”. Gaskin (2013, p138) concludes that “the two ICTs are distinctly different in their effects on transparency and corruption”. The study suggest that the lack of
direct impact of mobile access, may be a result of not all mobiles in developing countries provide access to Internet and that mobiles may be used for other purposes than access to government-related information.

Bailard’s (2009) study, which is the most often cited study in the field, suggests a direct and significant correlation between higher mobile phone penetration and lower levels of corruption in Africa. The study showed, by examining 46 African countries, from 1999 to 2006, that there is indeed validity to the claim that mobile phones have reduced corruption levels in Africa, or at least the perception of corruption, which is used as the dependent variable. Proliferation of mobile phones is argued to be causally linked to lower levels of corruption levels as mobile phones effectively decentralize information and thereby diminish the opportunities for public servants to engage in corruption secretly, as well as increasing the potential of detection, i.e., the existence of mobile phones deters the crime from ever taking place. The basic proposition for causality is that mobile phones have challenged the monopoly of information and decentralized it into the hands of many; and “corruption prefers the shadows and abhors transparency” (Bailard, 2009, p.337). A second causality is the fact that mobile phones also facilitate sharing information, in this case the possibility to share information about both bribery and corruption. Bailard (2009) argued (referencing to Azfar et al., 2001; Bardhan & Mookherjee, 2000; Schleifer & Vishny, 1993; Treisman, 2000) that corrupt officials weigh the benefits of the corrupt act against the potential cost, such as being reported. Before the diffusion of mobile phones, there were very few tools in the hands of ordinary citizens that would allow them to report crimes anonymously. In short, the rapid proliferation of mobile phones across Africa has, by decentralizing information and provide the affected with a voice, altered “the cost-benefit calculus” (Bailard, 2009, p.337).

To be fair, this research field also presents some caveats for claims concerning mobile phones as a viable anti-corruption tool. The importance of understanding the overall political context is highlighted (U4/ TI 2010), and where government responsiveness is of particular importance. An Ihub report (2015) states, that even if mobile applications have lessened the fear of reporting bribery and/or corruption, such citizen action is significantly hampered by government officials’ unresponsiveness and unwillingness to investigate and indeed punish corrupt public servants. A Transparency International study (2015) echoed that conclusion, when its researchers found that although almost a third of the respondents (28 %) across East Africa,
identified reporting corruption as “the most effective action” to take to tackle corruption, only 12 per cent admitted having reported paying a bribe (TI 2015, p 22). Fear of the consequences, such as self-incrimination and that lack of visible outcome, i.e. punishment of the culprit, made reporting less likely, even if modes of reporting was known and easy. Hellström and Bocast (2013) also argue for greater emphasis on context complexities, after finding Ugandan students’ holding both ambivalent and contradictory positions on corruption. On one hand, students recognized corruption as a threat against society, albeit on the other hand, appreciated it as a tool to ensure reaching short-term self-interests. The importance of sensitivity to contextual constraints was highlighted by Donner, Verclas and Toyama (2008) who argue that mobile applications needs to be embed into existing initiatives and structures; use existing practices as a point of departure, as oppose to attempting to introduce new behaviors, and finally be built to require minimum basic skills, as opposed to requiring advanced technological knowledge. Initiatives that fail to adhere to these simple rules-of-engagement are unlikely to be successful.

In conclusion, the proposed causalities around mobile phones as a viable tool against corruption, appears to be centered on their ability to a) facilitate citizens’ access to government-related information on what type of services they should expect and at what cost, i.e. increase transparency around government services, b) share information horizontally and mobilize around poor service delivery, and c) facilitate reporting of corruption if it occurs and thus function as a technology for accountability, as well as a deterrent for corrupt officials. Mobile phones’ potential contribution to fighting corruption overlaps with UNDP-identified indicators essential for good governance: access to societal information, monitoring of service delivery, tracking of corruption and finally, a system that enables citizens’ involvement and active participation (UNDP, 2006). With this basic conceptual framework in place, the next question is; how has the M4D research field, continued to explore and expand our understanding of mobile phones as a viable tool against corruption.

Methodology

A literature review is an effective research tool to synthesize prior research and map out a field’s main conceptual frameworks, i.e., what explanations and predictions are frequently enlisted and dominate (Webster & Watson, 2002). Ultimately a literature review attempts to present a situation analysis and support the advancing of knowledge in a particular research domain. Webster
and Watson (2002) suggested three main literature review procedures: leading journals in the field, “go backward” using the citations in seminal work, and finally, “go forward” by using data bases such as Web of science. This paper utilizes the first sample procedure for the literature review, and departs from Richard Heek’s (2010) ranking of open source ICT4D development journals. The list was slightly adjusted to better fit the geographical focus of this study and subsequently one journal covering Asia was replaced by the next journal on the list. The final list comprised ten journals (Table 2).

By applying the following search phrase: corruption OR corrupt OR bribe AND Mobile* OR Cell phone* AND/OR ICT* AND AFRICA, each ICT4D journal were scanned for articles that contained items on mobiles as a tool for anti-corruption between 1st January 2006 to 30th June 2016, in a Sub-Saharan Africa context. The rough search generated 71 articles which were manually examined using a combination of methods, such as reading the abstract, and searching inside the texts for sections containing references to corruption to identify relevant pieces that contained all elements, that is fulfilled both the thematic and geographical criteria. After manual processing, all but one article was discarded as they failed to explore mobiles in relation to corruption in East Africa. A schematic analysis of the disqualified articles showed that most articles contained references to corruption as a general development challenge, but failed to connect this development challenge to mobile phone access, usages and practices in East Africa. In short, the two topics were both textually present in the 71 articles, but failed to meet and merge.

As the initial literature review did not generate enough research articles, the sample was expanded to cover journals which, in the words of Heeks (2010), belong to ICT4D’s “parent” disciplines,” namely Development and Information Systems. By using the Schimago ranking, the three top ranked development journals and information system journals covering international social science aspects of information systems were added to the literature review (Tables 4 and 5). The sample procedure was similar to the previous. Most articles in this second sample in the parent disciplines were multi-country studies, in particular in the parent discipline Development. However, several articles in Development journals turned out to be ineligible as they focused on mobile as mobility of people, goods and services, as opposed to the intended reference to mobile phone(s).
Results

This literature review began with reviewing ten years of research on mobile phones and corruption in the ten highest ranking open access ICT4D journals (Table 2. Heeks 2010). But despite adding six journals from parent disciplines – development and information systems – and thus expanding the review outside the “natural suspects”, i.e. ICT4D journals, and reviewing 143 articles in total, the result in terms of number of articles remained very small (Table 5 and 4).

Table 2. Number of relevant articles in ICT4D journals

<table>
<thead>
<tr>
<th>Journal</th>
<th>2005 score</th>
<th>2008 score</th>
<th>Number of art. matching search terms *</th>
<th>Number of art. on mobiles and anti-corruption **</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Information Technologies and International Development</td>
<td>2.61</td>
<td>2.08</td>
<td>16</td>
<td>0 EA</td>
</tr>
<tr>
<td>2 Electronic Journal of Information Systems in Developing Countries</td>
<td>3.62</td>
<td>1</td>
<td>0</td>
<td>0 EA</td>
</tr>
<tr>
<td>3 Information Technology for Development</td>
<td>2.94</td>
<td>1.35</td>
<td>33</td>
<td>0 EA</td>
</tr>
<tr>
<td>4 African Journal of Information and Communication</td>
<td>1.09</td>
<td>0.4</td>
<td>16</td>
<td>0 EA</td>
</tr>
<tr>
<td>5 Int. Journal of Education and Development Using Information and Communication Technology</td>
<td>1.01</td>
<td>0.4</td>
<td>10</td>
<td>0 EA</td>
</tr>
<tr>
<td>6 (Asian Journal of Communication)</td>
<td>1.16</td>
<td>0.23</td>
<td>10</td>
<td>0 SSA</td>
</tr>
<tr>
<td>7 Journal of Health Informatics in Developing Countries</td>
<td>n/a</td>
<td>0.43</td>
<td>0</td>
<td>0 EA</td>
</tr>
<tr>
<td>8 Information Development</td>
<td>0.35</td>
<td>0.25</td>
<td>5</td>
<td>0 SSA</td>
</tr>
<tr>
<td>9 International Journal on Advances in ICT for Emerging Regions</td>
<td>n/a</td>
<td>0.26</td>
<td>1</td>
<td>0 EA</td>
</tr>
<tr>
<td>10 African Journal of Information &amp; Communication Technology</td>
<td>0.25</td>
<td>0.04</td>
<td>1</td>
<td>0 EA</td>
</tr>
<tr>
<td>11 South African Journal of Information Management</td>
<td>0.28</td>
<td>0</td>
<td>5</td>
<td>0 EA</td>
</tr>
<tr>
<td>Total articles</td>
<td></td>
<td></td>
<td>71</td>
<td></td>
</tr>
</tbody>
</table>

* Search term: corrupt/ion OR graft OR Bribe AND Mobile* AND/OR ICT AND AFRICA. ** Number of art. 2010-2016 fulfilling search criteria of addressing mobile phones as tool for anti-corruption in: a) East Africa or b) Sub-Saharan Africa.

As indicated by the number of hits on search terms only in tables 2, 3, 4 corruption is frequently featured. But corruption is not actively related to mobiles or the ICT initiative that was the article’s main focus, but rather appears as a judiciously covered background factor. It is a systemic ever-present development challenge in a Sub-Saharan context. Furthermore, a third of the articles from the ICT4D journal sample do make general statement around
unspecified ICTs’ potential to combat corruption as ICT does facilitate the flow of information, and subsequently allows citizens to be better informed. But these statements are not elaborated on in the sense that the features of platform or service are divulged, or how the system users, i.e., citizens’ actions are causally linked to anti-corruption. None of the articles in the ICT4D sample engage with the opportunities connected with the last five years rapid diffusion of mobiles as citizen-controlled tool, and how that could both open up for new modes of awareness raising around bribes as well as facilitate instant reporting of corruption with significantly smaller risk for the reporter. The review of the ICT4D sample thus indicates that the topic is neglected, at least within the core ICT4D journals.

Surprisingly, it was the review of the parent disciplines’ six journals that generated the input with two articles (article title in last column Tables 3 and 4). Even if the number is small, and thus arguably unable to provide a substantively deeper understanding of the relationship between mobile phones and greater transparency and their potential to be a viable tool as a deterrent, the two articles do highlight a common theme, namely transparency.

Asongu and Nwachukwuy (2016, p138) argued that after analyzing 49 Sub-Saharan nations using World Bank data for the period 2000–2012, that “there is an unconditional positive effect of mobile phone penetration on good governance” and explains the result with the fact that mobile phones help reduce previous “information asymmetry and monopoly” providing elite actors with conducive conditions for bribe-soliciting and corruption and with minimal risk connected to mismanagement of public funds. In short, mobile phones effectively challenged the elite’s information monopoly, and thus removed important conditions for corruption: namely, secrecy and low risk of detection. The next study explored the relationship between saving and well-being at the base of the pyramid, i.e., the 3 billion people who live on less than US$2.50 per day (Martin & Hill, 2015), echoing the issue of transparency albeit in a scaled down fashion. The study argued that digital financial services, often in the shape of m-banking for the poor, made financial flows visible and traceable and thus should result in “safer and speedier transactions and less corruption and theft” (Martin & Hill, 2015, p.415). Both studies thus appeared to support previous proposition that, a) mobile technology first facilitates access to societal information in general, which in turn makes bribe-soliciting and corruption riskier as the risk of detection increases, b) addresses issues of secrecy, as in the case of m-banking, which also makes transactions traceable and visible. Both features, hit at the core of corrupt practices.
Table 3. Parent discipline: Information systems

<table>
<thead>
<tr>
<th>Journal</th>
<th>Number of art. matching search terms*</th>
<th>Number of art. on mobiles and anti-corruption**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  MIS Quarterly</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>2  Information Systems Research</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3  Journal of Service Research</td>
<td>1</td>
<td>1 (Sub-Saharan Africa multi country study: Saving and Well-Being at the Base of the Pyramid: Implications for Transformative Financial Services Delivery by Kelly D. Martin and Ronald Paul Hill)</td>
</tr>
</tbody>
</table>

*Search term: corrupt/ion OR graft OR Bribe AND Mobile AND/OR ICT AND Africa (SSA and/or Burundi, Kenya, Tanz., Rwanda, Uganda).

** Number of art. 2010-2016 fulfilling search criteria of addressing mobile phones as tool for anti-corruption in: a) East Africa or b) Sub-Saharan Africa.

Note: As Shimago does not have a category dedicated to facilitating selection on Information system in an international and development context, the following journals have been removed manually as their focus was deemed unsuitable for this article: Molecular Systems Biology, Journal of Supply Chain Management, Briefings in Bioinformatics, IEEE Transactions on Systems, Man and Cybernetics Part B: Cybernetics.

Table 4. Parent discipline: Development

<table>
<thead>
<tr>
<th>Journal</th>
<th>Number of art. matching search terms*</th>
<th>Number of art. on mobiles and anti-corruption**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Journal of Development Economics</td>
<td>6/3</td>
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<tr>
<td>2  World Development</td>
<td>57/44**</td>
<td>1 (Multi-country study: The Mobile Phone in the Diffusion of Knowledge for Institutional Quality in Sub-Saharan Africa by Asongu and Nwachukwu)</td>
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<tr>
<td>3  Economic Development and Cultural Change</td>
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</tbody>
</table>

*Search term: corrupt/ion OR graft OR Bribe AND Mobile AND/OR ICT AND AFRICA

** Number of art. 2010-2016 fulfilling search criteria of addressing mobile phones as tool for anti-corruption in: a) East Africa or b) Sub-Saharan Africa.

Note: As Shimago does not have a category dedicated to development, the following journals were removed as their focus was deemed unsuitable for the research on global reach as opposed to focusing on developing country contexts: Annals of Tourism Research; Tourism Management; Journal of Regional Science; International Journal of Urban and Regional Research; Social Neuroscience; Corporate Social Responsibility and Environmental Management; Transportation; Population and Development Review.

Before exploring the potential reasons behind the small academic research output on mobile phones as a citizen-controlled tool against corruption, a few words on the methodology is warranted. A typical literature review preferably contains, after a purposeful sampling, a large and diverse sample of academic
output in a particular field. Consequently, in the instance where a purposeful sampling generates a less than adequate sample of academic output to review, it could be argued that a literature review is no longer a possible methodology. An alternative position, which is adopted here, is to argue that the lack of academic output in a particular field or fields, is a result in its own right and could be used as an indicator of the status of the field. The following section will discuss potential explanations for lack of research in the urgent topic – mobiles as a citizen-controlled tool for fighting corruption.

**Discussion**

Assuming for now, that this study’s result is indicative of the current status of the research field, does not provide any insights as to why the topic of mobiles as an anti-corruption tool has not spurred more research and empirical testing of earlier proposed conceptual frameworks. Although, definitive answers can only be found through critical engagement with the ICT4D research community, this paper would like to presents some tentative hypothesizes. Firstly, the result can be an indication that the previous hopes of mobiles’ functioning as a facilitator for citizens’ becoming better informed of public services, and empowered to mobilize around corruption, as well as providing them with a cost-effective and risk-freer tool to report corruption; have gone largely unfulfilled. That is, various pilot projects targeting to increase the availability to government and development partners’ information, have not generated interest amongst service users, or produced new patterns of citizens’ mobilization around corruption. Similarly, investments in hotlines and text-based reporting platforms to provide citizens with affordable and easy ways to report corruption have failed to get users to trust and use the platforms. In short, digital platforms have not deliver the expected results, and the lack of research is a result of initiatives failing to get fully adopted by the intended users. Non-adoption is simply less exciting to study than users’ full appropriation and active engagement with a digital tool and/or service.

Another potential explanation for the almost complete silence, may lay in difficulties of accessing empirical data in this particular field. Researchers attempting to fully explore the proposed causalities–proliferation of mobiles leads to greater transparency and challenge earlier information monopoly, as well as provide citizens with new opportunities to mobilize and report, which increases risk of detection, making corruption a less attractive activity– in an empirical setting are all dependent on a minimum level of cooperation from governments and community members. Access to data in this particular
empirical field is fraught with challenges, as it is dependent on the subjects’ willingness to engage in some level of self-incrimination.

Finally, a literature review resulting in a smaller than expected set of articles or even thoroughly inadequate sample size needs to critically engage with its methodological approach. To more confidently be able to claim that a research field is indeed neglected, future researchers need to cast an even wider net. Reviewing an inter-disciplinary field always presents challenges in terms of how to delineate the search and identify the boundaries of the field. In an emerging field with low level of maturity, this process is further complicated, as a topic may stretch over several disciplines and rather avail itself as a sub-topic rather than a primary topic. As this review departed from a standard literature review technique, i.e. top ranked journals, it could be argued that a less formalistic review design may have resulted in a larger body of research to analyze. In order to explore if the research field exists, but does so elsewhere and has yet to emerge in the traditional academic channels; future analysis should thus be open to other approaches to locate relevant research across a variety of publication platforms, such as database searches, influential reports from the development community, conference papers and especially papers generated by specialized M4D conferences, sector-relevant edited books and chapters.

It is only with more research that we can hope to gain a better understanding of under which conditions does a mobile with its portability, simplicity, and affordability become a viable tool to fight corruption. A mobile phone, just like a Swiss army knife can theoretically be used for many different things, but it may also never be used for any of these. This study reminds us all of the dangers in prematurely assuming that a technological potential in itself will produce a particular change.

References


Use of information and communication technology to disseminate human milk educational resources to lactating mothers. Case study Cape Town

Christine Mburu

ICTD researcher, Kenya

crissyshiru@gmail.com, +254787868701

Abstract

Lactating mothers do experience challenges that prevent them from breastfeeding their infants. Research shows that most of these women report that there are no milk banks in their regions. They opt to use social media to get human milk from willing milk donors. Direct human milk sharing is a prevalent activity that may expose infants to many risks due to contaminated milk. In this research we want to find out the main problem that lactating mothers experience and there after design appropriate Information and Communication Technology intervention that can be used to disseminate educational information to ensure that recipient mothers have access to pasteurized milk.

Key words: ICT, human milk, lactating mothers.

1. Introduction

Human milk provides infants with both nutrients and immunity. Intake of human milk is endorsed as the optimal infant feeding strategy by organizations such as World Health Organization (WHO) and United Nations Children’s Emergency Fund (UNICEF) [7, 8]. In 2009, it was estimated that 3.3 million neonatal deaths occur within the first month of life and, overall 7.3 million children under the age of five die each year [4]. According to the Lancet Child Survival Series [2003], up to 13% of deaths of children under the age of five could be prevented by breastfeeding alone [12]. South Africa has very low breastfeeding rates at just 7.4%, partly as a result of prevalent poverty and effective marketing by baby formula companies [15]. Soon after having their babies, many poor mothers need to get working again. In addition, some families do not have access to breast milk due to lactating issues such as adoption, maternal illness, lactation problems or death [17].

In South Africa, the importance of breast milk for infants’ growth, development and overall health is widely recognized and recommended [16]. Moreover, breast
milk is of special importance for preterm, low birthweight and other vulnerable infants [8, 9]. WHO recommends that, for infants who cannot receive breast milk from their own mothers, the next preferred option is donated breast milk (donor milk) [7]. Families with lactating problems may receive human milk from local milk banks that screen donors, pasteurize milk, and supply it via physician’s prescription to those with medical need [10]. Available statistics indicate that, International Breast Milk Project (www.breastmilkproject.org) has distributed more than 280,000 ounces of donor milk to infants in South Africa since its’ founding in 2006, but such distributions represent only a fraction of the potential demand [18].

According to the study by Becquet [2009], exclusive breastfeeding has been reported to carry a lower postnatal Human Immune-deficiency Virus (HIV) transmission risk than breastfeeding while concurrently feeding on other milks, non-milk fluids, and solid foods [2]. The breast milk transmission is mainly associated with both mother’s viral load and subclinical mastitis [6]. Human milk sharing is a practice that has been happening for centuries in the form of wet nursing [17]. In South Africa, human milk sharing is responding positively to HIV crisis, where an estimated 5 million people are HIV-positive [9]. The milk provides infants with the important, immune-boosting power of mother’s milk and prevents the transmission of HIV and other blood-borne diseases.

The introduction of home refrigeration, has enabled lactating mothers to easily share expressed human milk directly with one another outside of any organization or system [8]. Initially, such peer-to-peer milk sharing required that human milk recipients be personally acquainted with human milk donors [8]. For this reason, peer-to-peer milk sharing rarely occurred. Currently, social media is being used to connect human milk recipients to the donors. The use of social networks makes it possible for milk sharing to occur between individuals previously unknown to one another and on a large scale [8]. However, this method of milk sharing can be risky due to pathogen transmission. Furthermore, contamination of the milk is unacceptably high [17]. Health authorities have been alarmed by the phenomenon of direct milk sharing and have warned parents to avoid peer-to-peer milk sharing. Instead, parents in need of milk are advised to seek human milk only from a milk bank.

However, developing countries are faced with the challenge of lowering their neonate and child mortality rates due to lack of available human milk for vulnerable infants [5]. In addition, lactating mothers are not aware of the existing local milk banks and the importance of acquiring screened human milk from human milk bank. Human milk banks are a great way to help infants whose mothers are not able to breast-feed. However, the growth of human milk banks has been very slow due to; lack of awareness, leadership gap, fewer
neonatal setups, infrastructural and maintenance costs [3]. In South Africa, most milk banks are in major cities like Cape Town, thus leaving rural clinics with no access to pasteurized human milk [5].

Chaudri et al. [2013] developed and implemented an affordable system to monitor breast milk pasteurization in remote areas [5]. The study was carried out by Program for Appropriate Technology in Health (PATH) in collaboration with HMBASA, with the aim of solving human milk bank shortage in rural South Africa. The system consisted of a mobile application (running on an android phone), connected to a temperature probe that monitored milk temperatures during pasteurization [5]. It provided audiovisual feedback to guide users performing the procedure. The mobile application also printed bar code labels for each donation, so nurses could trace every donation. After analyzing the research findings, they found that the system was a simple and cheap pasteurization-monitoring device that can be appropriate for community-level milk banks that are not affiliated with hospitals.

Researchers have studied and developed system to solve the shortage of human milk in South Africa but the communities are not yet educated on the importance of using pasteurized milk rather than acquiring human milk shared via social media. The purpose of this research is to study how Information and Communication Technologies (ICTs) can be used to disseminate educational resources about the risks of formula and direct milk sharing to lactating mothers. With this information, we will be able to sensitize human milk donors to donate to the local milk bank. By sharing this vital information with the human milk donors and recipients, we expect an increase in human milk donation in the local milk bank thus ensuring availability of milk for vulnerable children.

2. Research Questions

1. What are the main challenges that mothers with lactating problems face as they try to look for safe human milk for their infants and how can ICT be used to solve these challenges?

2. Which user centered design methods will be appropriate for us to collect user requirements that will result in developing the appropriate information dissemination system?

3. What new knowledge will we learn after completing this research that will add knowledge in the area of ICT which will be useful to other researchers?

3. Literature Review and Research Methods

According to the study carried out by Perrin [2014], human milk sharing is a
prevailing activity in the world [17]. The observational study suggests that these milk sharing communities are active, with thousands of individuals participating in the direct exchange of human milk. Gribble [2013], discovered that most milk banks experience milk shortage due to numerous peer-to-peer milk sharing networks [8]. Milk donors are not always able to give to a milk bank because there are no local milk banks or because they do not meet the milk bank criteria. Human milk recipients may seek peer-to-peer donor milk in order to avoid the risks inherent to formula feeding such as nutrients and antibodies deficiency, lack of enzymes and hormone, slow to digest etc [1]. This study shows that, as long as there is shortage of pasteurized donor milk, it is likely that a large number of families will continue to seek human milk via online milk sharing communities. Direct milk sharing should be viewed as complementary to donor-milk banking and not as its competitor. Moreover, the expanding network of mother-to-mother milk sharing might well spur human-milk banking by increasing awareness of the significance and availability of breast milk, persuading more lactating mothers to donate, and thereby increasing both the number of banks and the available milk volume.

Kumar and Anderson [2015] deployed Projecting Health initiative, that targeted the dissemination of health information for pregnant women, lactating mothers, and their newborns using locally crafted short films in rural India [13]. The main goal of the project was to address local maternal and infant mortality rates that are among the highest in the country [13]. The information dissemination took place via group screenings of locally produced short films. In this study, they focused on women’s technology practices and the role that mobile phones played in disseminating information. In their findings, the percentage of women using their mobiles for consuming media was larger than what they expected. In addition, the percentage of Accredited Social Health Activists (ASHAs) showing videos on their mobile phones also increased. A third of these ASHAs said that they found it easier to explain health information using the mobile phone. Some ASHAs said that they and their work were taken more seriously by their communities after Projecting Health was introduced [14].

Jennings et. al [2013] conducted a formative research in Nyanza province, Kenya to examine pre-intervention community and community health workers (CHWs) perceptions on use of mobile phone to improve prevention of mother to child transmission (PMTCT) related communication [11]. They worked with the HIV positive women, their couples and facility nurses to come up with gender tailored Short Message Services (SMS). From the focus groups conducted with the participants, they identified that most of them had access to mobile phone and prior experience in sending and receiving SMS. Mobile phone technology was used to disseminate PMTCT information to both HIV positive women
and their partners. SMS tailored towards women encouraged them to take initiative to request for specific services (such as receipt of extra drugs, early infant testing, emergency preparedness etc) at the health facility. SMS tailored toward men provided information of child prophylaxis and benefits of communicating directly with health providers. As a result, couples perceived the gender tailored messages motivational to improve couples communication regarding PMTCT and defining men's role in PMTCT. Their confidentiality was protected and the phone linked them with the health workers. This study found mobile technology as an efficient tool to improve on the PMTCT cascade on large scale in an area with poor health infrastructure and personnel shortage.

In our proposed research, we want to study how ICTs can be used to disseminate educational information to human milk donors and recipients to educate them on the risk of formula and direct milk sharing and also encourage them to donate milk in local milk banks. This will be an ethnographic study with a focus on Cape Town as our case study city. We will work in collaboration with Milk Matters Cape Town, a community based milk bank [16].

User centered design (UCD) methods will be used in this research to understand the underlying problem statement by collecting information and finding a suitable solution that will be used to solve the mentioned problem. Approvals to conduct this study will be obtained at different levels. First, the study proposal will be submitted to the institutional review board of University of Cape Town for ethical review. Permission to conduct the research will also be sought from the management of Milk Matters, the organization under which this research will conducted. After receiving authorization, we will conduct a face to face interview with Milk Matters’ staff to understand their day to day task, and their main clients to understand how they sensitize mothers to donate human milk. We will also find out how milk recipients get information of human milk availability in the milk bank. We will use observation method to learn how the organization screens the human milk donors and the milk pasteurization process. Focus group sessions method will be used to gather information from lactating mothers who visit the milk bank with an aim of understanding the lactating problems they face, whether they have been involved in direct milk sharing, what led them into it, and the educational resources that would help them when they encounter lactating problems. We will work closely with lactating mothers and Milk Matters staff to formulate educational resources. Through literature review, we will learn of existing ICTs used to disseminate educational information and some of their setbacks that need to be addressed.

After interacting with our participants and learning the participants’ needs and the environment where we will be conducting our research, we will co-design the appropriate ICT artefact that will be used to disseminate educational resources
to lactating mothers. The system design ideas will be implemented on an incremental basis. The system will be developed, tested and deployed at Milk Matters organization. The staff will monitor the performance of the system and help respond to lactating mothers questions sent via the system. The system will be used for at least six months. The system will collect the participant profile data and store a log of all the participants it interacted with.

Thereafter, we will evaluate the performance of the system. An open ended guide will be used to elicit information from lactating mothers and the organization staff. This will help us learn the benefits and some of the challenges that the participants encountered while interacting with the system. We will use the system log to analyze participants’ details in these categories: participants’ age, the list of lactating problems they encounter, system interaction frequency and the system feedback they shared after the research period.

4. Anticipated Outcome
At the end of our study, we expect to have answered all our research questions. Our research will prove that ICTs can be appropriate and ideal media in educating lactating mothers on the importance of human milk to their infants and the reasons why they should avoid direct milk sharing. We also expect that the intervention will increase the amount of human milk being donated at Milk Matters milk bank. Academically, the outcome will include contribution of knowledge in the area of Information Communication Technology for Development (ICT4D). We expect to publish academic papers and eventually come up with a detailed thesis.

References


Abstract: This paper shows detailed skills audit and skills gap analysis from 122 small and medium sized companies in Kenya. The detailed skills audit and skills gap analysis show that most SMEs’ employees’ ICT abilities were consistent with the needs of their jobs in most areas of basic software use (word processing, internet and intra-networking, using computers, mobile phones applications and e-mail). However, significant skill gaps were noted in ICT skills related to spreadsheet, website authorship, presentation and graphics, and ability to select appropriate software for new tasks, browser skills, and ability to use security management systems, VoIP, knowledge of computing networks and operating systems management skills, were noted to be significant skills gaps.

These skill gaps should form the focus for the topics for significant staff development in ICT training in SMEs. It should be noted that more often than not, management and website authorship skills levels were low but few firms considered that these skills were necessary for them to operate effectively. Therefore the results are discussed in the context of lifelong learning and skills development as key to the competitiveness and sustainable growth of SMEs in Kenya.

Keywords: ICT, Small and medium sized companies, Skill gap, Staff development
1.0 Introduction

Interest in the role of small and medium-sized enterprises (SMEs) in the development process continues to be in the forefront of policy debates in developing countries (Kinyua, 2014). The role of ICT has been viewed as a critical element for the performance of small and medium-sized enterprises. The small and micro enterprises (SMEs) play an important role in the Kenyan Economy. Data from the Economic Survey (2006) indicate that SMEs contributed over 50 percent of new jobs created in the year 2005. As a sector, SMEs have an important role to play in the economic development; poverty reduction and employment creation in developing economies (Hallberg, 2000). Stern (2000) says that the SME sector is the sector in which most of the world’s poor people are working. According to OECD (2014), despite the potential benefits of ICT, there is a debate about whether and how its adoption improves firm performance.

SMEs have gradually recognised the positive impact that ICTs such as computer terminals, e-mail and the Internet and their applications can have on their business (OECD, 2004). As is the case with all technologies, small businesses are slower than large ones to adopt new ICTs. SMEs also face generic barriers to ICT adoption including trust and transaction security and IPR concerns, and challenges in areas of management skills, technological capabilities, productivity and competitiveness (OECD, 2004). Lack of ICT skills and business skills are widespread impediments to effective ICT uptake once adoption decisions are made. Small firms may lack objective information regarding the benefits and costs of adoption of ICT (OECD, 2004)

Information and communication technology (ICT) and e-business applications provide many benefits across a wide range of intra-and inter-firm business processes and transactions (Calice et al, 2014). Other barriers have been seen to be the availability of ICT competencies within the firm, and availability and cost of appropriate interoperable small-firm systems, network infrastructure and Internet-related support services. According to OECD report (2014), in advanced OECD countries, most SMEs, have at least one computer terminal, usually with Internet access. The report further says that adaptation of many types of business software can improve
information and knowledge management within SMEs, leading to more efficient business processes and better firm performance (Calice et al, 2014).

ICT skills needs and skills shortages in Kenya are well documented in various government policy documents for instance ICT is identified as one of the key pillars in the vision 2030 (Republic of Kenya, 2010). The growth of the modern economy has been attributed in a large part to the advancement of technology especially ICT (Tuma, 1987). Furthermore, there is evidence to show that developing skills in information and communications technology (ICT) has led to economic development in Kenya (Wanuri, 2011). Wanuri further says that the use of mobile phones has had a positive impact on the Kenyan economy in terms of taxation.

Even though the ICT sector is growing rapidly, the use of ICT in Small and Middle enterprises in Kenya has not grown at the same rate and yet it is critical for economic prosperity. Tuma (1987) says that from economic history, technical advancement is initially an invention and then later an innovation. ICT has followed this pattern in its adoption; however SMEs are yet to reap maximum benefits in Kenya. Tuma further says that recent history has suggested that economic development and growth have been closely associated with technological revolutions.

Kenya like many developing countries has a limited research in terms of scholarly studies about the SMEs. The National Baseline Survey conducted by Central Bureau of Statistics, ICEG and K-Rep Holdings in 1999 provides the most recent comprehensive picture of SMEs in Kenya. Mead (1998) observes that the health of the economy as a whole has a strong relationship with the health and nature of micro and small enterprise sector. This paper adds to that body of work that documents skills gaps in ICT in Kenyan SMEs. In particular it makes a contribution by reporting on the different levels of ICT usage by SMEs. It makes a contribution by reporting on the differences between self-assessments of ability and the needs of existing job roles among individual employees.
2.0 Skill gap analysis
According to the Economic Modelling Specialists International (2013) defines skill gap as the perceived mismatch between the needs of employers for skilled talent and the skills possessed by the available workforce (EMSI, 2013). A skills gap measures the difference between the skills needed for a job versus those skills possessed by a prospective worker. The importance of having a more precise measure of skill and resulting skills gaps cannot be understated (ACT, 2011). Antonucci and Domenico (2012) opine that the skill gap analysis is used to identify the skills that an individual needs, but he sometime hasn’t, to carry out his or her job or to perform certain tasks effectively.

2.1 Objectives
This research was conducted to gain a better understanding of the ICT skill gaps among SMEs in Kenya. The objectives of the research were:

i. To identify the current ICT skill gaps among SMEs in Kenya
ii. To identify which ICT skills have large gaps among SMEs in Kenya

Data for this study was collected using a mobile phone survey between August and Sept 2016, a total of 100 employees working in 122 SMEs who had been sent by their firms to attend training under the Enterprise Development Programme training at Strathmore University were interviewed. The data was analysed and tabulated.

2.2 Methods
SME definitions vary from country to country and are ideally defined specifically according to sector. The African Development Bank defines SMEs as those firms that have less than 50 employees (Calice et al, 2012). The target sample for the study was 122 SMEs. The SMEs were sampled based on those who have attended the Enterprise Development Program training at Strathmore University. The contacts of the respondents were obtained from a list compiled by the enterprise development. The consent of the respondents was sought by sending them an email and explaining the intended research.

The respondents applied online to participate in the training, 41 indicated that they are localised in Nairobi, 5 from Machakos, 4 from Kiambu, 3 from Nakuru, 1each from Eldoret, Narok, Kajiado, Homa
Bay, Kisumu and Malindi, 41 others did not indicate their country of origin. The SMEs selected are representative of SMEs across the country as they come from all parts of the country. Purposive sampling technique was used to select them. The questionnaire was sent to the respondents by a mobile phone technique called Msurvey. They answered the questionnaires on their phones and the data collected was analysed.

2.3 The Skills Assessment Frameworks
ICT skills assessment frameworks have been developed by various institutions for instance the University of Surrey came up with one framework in 1998 to help a variety of small and medium sized enterprises assess the skills and skills development needs of their staff (Hay, 2003). Hay says that topics of interest to UK businesses were identified over a period of consultation and testing lasting for more than a year. ICT topics were illustrated by a series of ‘level statements’ designed to describe different competencies within each area of work. They were then tested and developed by interactive use (Hay, 2003), the Skills Analysis Tool (SAT) was developed for use on-line and configured to allow users to score both their own self-assessment of their ability and their perceptions of the levels of skill actually required by their job (Hay, 2003). This research used a mobile phone survey to get data for analysis. The survey was modelled on the University of Surrey framework. Whereby certain ICT skills were identified and a questionnaire designed ranking the usage of the identified ICT skills from basic to expert user.

3.1 Data Collection
The respondents who took part in the ICT skills survey were identified from a register kept at Strathmore University’s institute of continuing education Enterprise Development Training programme. A total of 122 SMEs were identified from a list of SMEs that had sent their staff for training at the institute. They were sent a questionnaire via their mobile phones to score their ICT skills competencies, 100 were selected out of the 114 employees who responded, the scores were collected and analysed in terms of percentages and numbers at each level of competence. The results were tabulated and presented in tables.
3.2 Skills Profiles

Table 1 shows the 11 self-assessment scores for all participants in the ICT skills usage survey from 122 SMEs in Kenya.

Level 1 - basic user
Level 2 – understanding basic functions Level 3 – experienced user
Level 4 – advanced user

Table 1. Frequency of competency level scores (at levels one to four) among a total of 100 individuals from 122 different small and medium sized firms in Kenya.

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<th>level 1</th>
<th>level 2</th>
<th>level 3</th>
<th>level 4</th>
<th>No response</th>
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<td>1. Using a computer(s)</td>
<td>14%</td>
<td>14%</td>
<td>50%</td>
<td>21%</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>14</td>
<td>50</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>2. Software applications</td>
<td>17%</td>
<td>50%</td>
<td>25%</td>
<td>8%</td>
<td>0</td>
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<tr>
<td></td>
<td>17</td>
<td>50</td>
<td>25</td>
<td>8</td>
<td>0</td>
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<td>3. Internet and intra-net working</td>
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<td>17%</td>
<td>33%</td>
<td>42%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>17</td>
<td>33</td>
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<td>4. E-mail</td>
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<td></td>
<td>8</td>
<td>17</td>
<td>33</td>
<td>42</td>
<td>0</td>
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<td>5. Website authorship and management</td>
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<td>25%</td>
<td>17%</td>
<td>8%</td>
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<tr>
<td></td>
<td>50</td>
<td>25</td>
<td>17</td>
<td>8</td>
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<td>6. Security systems management</td>
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<td>7. Word processing</td>
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<td>8. Spreadsheets</td>
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<td>9. Presentation and graphics</td>
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<td>10. Mobile phone applications</td>
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<td>36%</td>
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<td>11. VoIP</td>
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<td></td>
<td>55</td>
<td>27</td>
<td>18</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
From the data analyzed, most Kenyan SMEs have ICT skills at the basic level (level 1 and 2), meaning that most of their employees have only basic ICT skills. The adoption of ICT usage in SMEs seems to be slow in this time of advanced ICT skills. The study also established that out of 122 SMEs, only 36 had websites underscoring the gap in ICT skills among SMEs.

On the other hand, very few of the employees had ICT skills at level 3 and 4. From the data, the SMEs are limited in business skills like marketing their products and services by advertising on their websites by intergrating online platforms to reach more customers. There is need for further training for full adoption of ICT by Kenyan SMEs in their operations so that they have potential to grow vertically rather than horizontally. Without websites, the SMEs seem to be localised in their geographical areas of operation, and adoption of ICT will make them to be more competitive.

Most of the SMEs that were sampled for this study have less than 50 employees. Table 2 shows in percentage the number of the 122 SMEs with less than 50 employees.

<table>
<thead>
<tr>
<th>No. Of Employees</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>46%</td>
</tr>
<tr>
<td>6-10</td>
<td>27%</td>
</tr>
<tr>
<td>11-20</td>
<td>9%</td>
</tr>
<tr>
<td>Above 20</td>
<td>18%</td>
</tr>
</tbody>
</table>

4.0 Discussion

There is an overall good correspondence between the levels of skill necessary for individuals’ employment based on their self-assessment of their own abilities. Four skills topics for which average levels of ability were reported consistently higher than the perceived needs of the job were: basic computer use, word processing, using spreadsheets and database use. All other skill areas: general software applications, networking, website authorship, presentation and graphics software skills, operational systems management, and browser use indicated lower levels of ability. These skills therefore represent significant net skill gaps.
The most noticeable aspect of the skills gap results is the clear division between basic software applications skills and peripheral ICT skills such as networking, browser use and software applications. With the exception of presentation and graphics skills, all basic software applications (e.g., e-mail, using computers, and word processing and mobile phone applications) showed average levels of ability that exceed the common needs of the job. This reflects the long-standing availability of training that supports the majority of office-based software applications, e.g., Microsoft training and the International Driving Licence (ICDL) programmes which are particular examples. It is clear that significant skills gaps exist in those areas that are rarely taught in office support training programmes. This shows that many employees are ill-equipped to scrutinise available software applications and to select software for particular uses. At the same time, browser skills, knowledge of operating systems management and networking skills are poor. This reflects the consequence of their general neglect in specific training. There is a clear ‘gap in the market’ among training providers: this gap should be addressed to improve skills in the SMEs in Kenya.

Some of the comments on ICT skills SMEs are looking for are: graphic design & web design, basic comprehension of how a computer works, excel, word, Erp's, Social marketing, competence in using accounting software and manufacturing software's. Internet knowledge, database and cloud applications, and security applications, in-depth system analysis, knowledge in excel sheet and QuickBooks, security, mine is a textiles firm no ict skills needed.

5.0 Conclusion

The data presented by this research confirm that many SMEs in Kenya lack significant skills in ICT. This lack of ICT skills is likely to impede their potential for sustainable growth and competitiveness. Furthermore, these skills gaps are readily identified by the employees themselves, and generally, more than 50% of the individual respondents in the survey indicated that they lacked skills necessary for their job in at least one area. This significant finding; not only suggest that commitment to training and development is necessary for competitive advantage, but also that this need is very clearly recognised by a significant proportion of staff in SMEs. Detailed
audits of individuals’ skills in ICT and development needs are an important first step in the upskilling process. This should be done to provide evidence of need and detailed information about the precise training priorities of individuals. Further research needs to be done on how ICT helps SMEs in business development especially in record keeping and marketing.

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From Community Multimedia Centers to Multipurpose Centers
Salomao David, Lorenzo Cantoni
Universita della Svizzera italiana, Via GBuffi 13, Switzerland, cumbulas@usi.ch.

Abstract: The digital divide has brought forward the deployment of public access venues in rural Mozambique. These sites struggle to attain social and financial sustainability when in most cases such centers are the single source of information for communities. In this paper we argue that Mozambican Community Multimedia Centers can become sustainable mobile spaces of development and technology trials given adequate ground to co-design, analyze, experiment new technologies to become multipurpose centers. Initiating agencies must create small grant projects seasonally aimed at improving the capability of CMCs to create services that have intrinsic value to communities.

Introduction

The existence of a significant divide between the urban and rural Mozambique public access to information and Communication Technologies (ICT) pushed forward in the 90s the appearance of Public Access Venues (PAVs)(Rega et al., 2011). The PAVs were created to reduce the digital divide as researchers acknowledge that wider digital gap, greater the gap between wealthy and poor (Therien, 1999). In Mozambique, the most deployed type of PAVs are telecentres, community radios, and Community Multimedia Centers (CMCs). The PAVs were embraced as general ICT and development (ICTD) euphoria, with more than one hundred donors funding ICTD projects with billions of U.S dollars' worth of investment poured in developing nations (Bailur, 2006).
Nevertheless, the access to ICT does not seem to serve the majority of the rural Mozambican population, although a significant investment in PAVs has been made since the 90s. In Mozambique, the divide is wide, and no tangible evidence has been provided to the utility of this venues. The sites are facing a diverse range of problems, such as social, financial sustainability, and capacity to address community access to ICT.

There is limited conclusive evidence on the impact of PAVs, suggesting that these venues are not living up to the expectations placed on them. Therefore, this article argues that existing PAVs can become working spaces of
development and technology research given adequate ground to co-design, analyze, experiment new technologies. This paper engages issues of locality and design practices, addressing PAVs as multipurpose centers of constructivism, research, use, and adoption of ICT. The paper presents a community design initiative performed in Xinavane, a town located in the Maputo Province a southern province of Mozambique. This case is part of RE-ACT (Social Representations of community multimedia centers and ACTions for Improvement). RE-ACT addresses a particular type of PAVs, the CMCs, and their concerns – in involving both local communities and researchers to co-design appropriate services for the communities CMCs serve.

Public access venues in Mozambique: Chronological review

Many leading research and development agencies such as UNESCO, the World Bank, the International Communications Union rolled out PAV projects in developing countries such as Benin, Bhutan, India, Mali, Mozambique and Vietnam (Bailur, 2006). PAVs are defined as “institutional site with the mission to offer public access to information tools and resources with services that are available to all and not directed to one social group in the community to the exclusion of others” (Sey & Fellows, 2009).

In the 90s, Mozambique witnessed the first deployment of PAVs, two telecentres were established by the Centro de Informatica da Universidade Eduardo Mondlane (CIUEM) in the villages of Namaacha and Manhiça (Groenendijk et al., 2008; Vannini, 2014). These PAVs were supposed to be critical access points for digital inclusion, so they were run by non-profit agents, who work as intermediaries in supporting community on the usage of ICT. The agents should be politically neutral, and technically proficient; trusted by the community and attempt to provide equitable access to the services available. The following years the country observed a public establishment of Telecenters by Initiating agents (UNESCO and CIUEM) and the Community Radios by the Government (Instituto de Comunicação Social). The radio stations are portable and operate on Frequency Modulation (FM) bands; they contained a mixer, a cassette player, microphones and equipment needed to establish a radio station in rural villages.

In the year 2000 due to social and financially sustainability issues CMCs were created by aggregating telecentre and community radios (Rega et al., 2011). The CMCs in Mozambique were built with the premises that connectivity and direct access to information will lead to empowerment and capacity building and with
it “development” (Roman & Colle, 2002). Most of the CMCs in Mozambique were established in the rural areas where the lack of broadband telecommunication infrastructure to connect to the internet is the greatest challenge. Those CMC developed in the urban areas although broadband connectivity doesn’t present a challenge, they face other problems such as operating cost, and capable staff to maintain the technological infrastructure.

The CIUEM in 2006 created a task force denominated Centro de Apoio a Informação e Comunicação Comunitária (CAICC) to support telecentres in training, interchange of information and helpdesk. The Forum Nacional das Rádios Comunitárias de Moçambique (FORCOM) was also created in 2004 to support financially and upgrade community radios.

In 2003 the UNESCO and the Mozambican Ministers of Science and Technology (MTC) joined on a scale up the project that resulted in additional 17 CMCs being established in rural Mozambique. In 2010 the CMC project was entrusted to the MTC with the financial support from the World Bank. This cooperation project aimed at deploying additional 40 CMCs until 2015. In 2016 the Universal Access Fund of Mozambique started supporting the MTC on the deployment of additional CMC in the provinces of Zambezia, Tete, and Sofala. Figure 1 demonstrates the existing CMCs in Mozambique; the CMCs in red are part of the RE-Act Project.

**Objectives**

The paper has two aims: the first to contribute both to practitioners, NGOs and government entities with a theoretical approach for community co-design. Second is to demonstrate that communities can be entrusted the responsibility to create and run improvement actions for 12 months, using community design practices to adopt new technologies. Improvement actions in this context are small budget projects worth 2000 USD (two thousand United States Dollars) financed by the RE-Act project.

**Problem framing**

Since the 90s up to date, while other implementers of PAVs (Uganda, Benin, South Africa) have conducted impact assessment studies that evaluate and access the social implications of CMC (Dralega, 2009; Gumede et al., 2009; Gurumurthy, 2010), in Mozambique there has not been any evaluation study performed that focuses on the social impact of the PAVs.
Within RE-ACT an impact assessment study was carried which covers the social impact of the CMCs and financial sustainability issues. Within this paper, focus is placed on an improvement action performed in the Xinavane CMC.

**Methodology**

In the first phase of our study in the Xinavane CMC, we have used a combination of qualitative and photo elicitation techniques for our study. It was
conducted as a comprehensive analysis of the community leaving the premises of the CMC and collected data on their demographics, social, and education status. The qualitative data was run using semi-structured and open-ended interviews to initiating agencies (UNESCO, CIUEM, and MTC), CMC staff and local communities (users and non-users). In the second phase of the study, focus group sessions were held to co-design improvement actions.

The Xinavane CMC

The Xinavane CMC is located in the Maputo province, is a rural town known also as Sugar town. The town is located approximately 130 Km north of the capital city of Maputo; it hosts the biggest Mozambican sugar company the Tongaat Hulett Sugar. The Xinavane CMC is established at the Escola Secundaria de Xinavane; it has four computers, two multi-functional printers and a community radio station that provides services such as necrology, advertisement, announcements. The CMC also provides ICT training and access to television channels for news and special sports events. The CMC has 15 volunteers who work on the telecentre and radio station on shifts. The CMC has as the leading financial partner the Tongaat Hullets Sugar company who donates access to satellite TV channels.

Data analysis

To analyze the data gathered a meta-ethnography approach was used to translate the concepts and perceptions of individuals to understand how each individual member of a cluster group conceptualizes and perceives the CMC of Xinavane. Two philosophies can be outlined while listening interviews of stakeholders (initiating agencies, CMC staff, and local communities) about how they perceive the PAVs; the first philosophy we outline is a dynamic approach which addresses PAVs as a technology for development by itself, using critical internal dynamics to provide universal access to ICT. The second is a deterministic approach which we have subdivided into utopian and dystopian (Davison, 2001). The utopian regards technology as a mean of salvation that will lead humanity to progress (Coenen, 2007), while dystopian contradicts utopian by considering technology as a disruptive, alienating, harmful and noxious agent for people.

From the analyses of the actual situation of the CMC and the perception that derives from stakeholders, we see the dynamic approach fitting the discourse of the initiating agencies, the utopian and dystopian discourses matching the CMC staff and local community respectively. The initiating agencies such as
UNESCO and MTC use a dynamic approach towards the CMC. They perceive the CMC to be a source of information and service providers with the ability on their own to generate income and make the CMC financially sustainable. Initiating agencies when established the CMC created conditions for the technological infrastructure of each CMC to be comprised of at least four computers, one multi-functional printer, and a radio station capable of covering on approximately 100 km ray. The agencies provided training for the CMC staff on journalism, computers, and management of the technical infrastructure. The staff was trained to be able to teach local communities ICT training (basic windows, word, excel, PowerPoint, and the Internet). The communities leaving on the premises of the PAVs have presented these venues by initiating agencies as locations where they could obtain knowledge and information paying a small fee. The CMC staff uses a utopian approach when using and adopting the CMC on a context where access to knowledge and information is a privilege, not a right. The team is comprised of locals who are not in most cases employed; they gain their living working for the community on the CMC. Furthermore, the CMC electricity, water, repair of the technological infrastructure, access to the Internet is not free. The paradox occurs on how each social group perceives the PAV, as initiating agencies are looking at sustainability with small fees for access to ICT, communities look for information and knowledge, the staff looks for a way of leaving.

The paradox generates discontent feeling between stakeholders. Initiating agencies reframe their investment priorities or experiment different approaches to mitigate the design gaps. The CMC in a context where knowledge and access to information is a valuable asset to avoid becoming insolvent increases the cost of knowledge and information. The community carries on their activities with the gap between the haves and has not, becoming a noxious agent in the community. The misaligned or paradox perceptions create unfavourable conditions for the CMC to be effective in serving a broader set of the community.

Co-design

Participatory action research (PAR) is a rapidly growing approach in ICT4D research; it takes many forms depending on the particular context and issues involved (McNiff, 2013). One of the PAR many forms is co-design, a research approach by, with, and for people affected by a particular problem, which takes places in collaboration with academic researchers (Sanders, 2002).
Co-design seeks to affect desired change as the path to generating democratize knowledge production and foster opportunities for empowering stakeholders by re-interpreting existing tools and techniques (Sabiescu et al., 2014). The process of co-design enables engagement with both productive and adverse effects of power through attention to language, representation, and subjectivity. When working with rural Mozambican communities, consensus establishes the social cohesion on understanding, rites, and practices amongst the participants of the activity. The approach here adopted means to solve the problem framing by adopting an equalitarian design approach that puts all stakeholders in the same position and addresses the issue from a common point of view where all people involved in the process have the right to have an opinion nevertheless of their social status or position.

To co-design this improvement action one focus group session was held at the University Eduardo Mondlane (UEM) and five other meetings took place at the CMC. The first focus group session held at the UEM had as participants the initiating agencies, the CMC directors, the RE-ACT team, and academic practitioners. This session provided space to discuss the shared understanding stakeholders had on CMCs, address the lack of dynamic interaction between interested parties and methods each actor could proactively pursue. The remaining sessions were held at the CMC of Xinavane and had as participants sixteen people, six who were from the CMC, two ICT4D researchers from the RE-ACT team and eight from the local community. The local community was represented by individuals who are parents, homemakers, teachers, government employees, and business entrepreneurs.

**Co-design in Xinavane**

The first working sessions in the CMC had as main objective present the constraints the CMC has. The limitations presented were:

1. The cost of electricity;
2. Cost of Internet broadband;
3. The price of computers (purchase, repair);
4. The virus; and
5. Community support.

The cost of electricity generates constraints for the Radio station as the station must be turned off for four hours during the day while ICT courses are being
held. The cost also affects the ICT courses, which became less attractive to the academic community; the cost reduces the wish to attend the sessions given.

Access to the Internet is expensive, and the community uses the internet on mobile phones instead of using computers without internet access. The computer that is used to print documents frequently gets a virus, and the community does not feel safe to use the CMC computers to print documents.

The community does not contribute or support the CMC even when the radio station is broken. Furthermore, the CMC director reported that most of the donated computers if they have a problem, they need to be fixed in Maputo, the cost of repair is higher than the amount of money they generate from them. The community requested after the demonstration of the problems to create groups to reflect on the problems and create practical solutions. Under the RE-ACT team guidance, four groups were formed. The groups had to address four issues, services to be provided, who are the users to be provided, which technological infrastructure is to be used to provide the service and which additional training the staff will require providing the service. During the second session of co-design, discussions were held regarding the technological infrastructure, and training given to the CMC staff. The focus placed the RE-ACT team to act as designers instead of mediators and observers of the co-design sessions.

Devices such as Intel Next Unit of Computing (NUC) a small-form-factor personal computer designed by Intel that costs 330 USD were showcased to participants. Another device, the Raspberry Pi 2.0 a low cost, credit-card sized computer that costs 49 USD, which can be plugged into a computer monitor or TV and uses standard keyboard and mouse was brought to demonstrate possible technological infrastructure. These devices were selected because they best fit the problems the CMC has, they are low cost and processing equipment. The remaining sessions were led by the community selecting services to be provided such as electronic newspaper, cinema, Wi-Fi internet, sim card registration, open office training, and postal office. On the last co-design session, responsibilities were provided to each group of participants. The community requested the CMC to create a management committee composed of influential people from the Xinavane town. The committee had the mandate to work on an incentive policy for the CMC staff and create a network for the promotion of the CMC. It was entrusted to the RE-ACT team the responsibility to order the Raspberry Pi's and prepare a training program for the CMC staff in the usage of Raspberry Pi and Ubuntu Mate OS. The CMC staff
had to create conditions to attend the training programs, provide access to courses, services, and information. The staff also had the responsibility to keep the committee informed about the deployment of the infrastructure on the CMC.

Results

The results of the co-design approach implemented on the Xinavane CMC suggest that with Raspberry Pi’s 2.0 and Ubuntu Mate OS the CMC could low consumption of electricity drastically. Furthermore, the technology lectured and the operating system is relatively new, and this tends to bring more people to attend the CMC courses. As a result of the co-design was created a newspaper which is sent to eight private companies, and 64 individuals who pay a monthly subscription that covers the cost of the Internet. The CMC provides access to Wi-Fi charging approximately 1 USD a month if the user is using his device (laptop or smartphone), the speed provided is not higher than 1012 Kb (shared) and the download limit is 250 Mb per user. The CMC has also added services such as postal office and sim card registration, although they do not have the official mandate to do so, they handle such services as they best know the district and the community. We have addressed the paradoxical perceptions of CMCs by creating conditions for stakeholders to interact and work for the CMC for the benefit of the community.

Conclusion and Recommendations

The results of the co-design approach implemented on the Xinavane CMC suggest that with low cost and low processing devices the CMC can low consumption of electricity drastically with it the cost of courses and services reduces. The services provided are not mainly for those who have a comparatively higher socio-economic status, but it does reach the majority of the population. Mobile devices became a wider source for media digest, either by accessing the local newspapers online or receiving information using social media and networks. Digital and interpersonal communication promoted adoption and diffusion of services provided by the CMC. Furthermore, the technology lectured and the operating system is relatively new, and this tends to bring more people to attend the CMC courses. We have addressed the paradoxical perceptions of CMCs by creating conditions for stakeholders to interact about social issues and the CMC sustainability in a constructive and seasonal basis. The idea of making the Xinavane CMC a multipurpose community space with a management model overseen by the community created a link between both entities who are responsible for the sustainability of
the CMC. We think that a full self-sustainability CMC in the Mozambican socio-cultural context is inviable, the initiating agencies such as FSAU and MTC must strive to create a model to provide small grants aiming to ensure that CMCs deliver services with up to date and low-cost technologies.

The community though it financial contribution exerts a positive impact; the impact is limited to the financial capacity of the context, this is where the initiating agencies crucial role in promoting and creating grants to maintain this centers operationally. These CMCs can act in a country deprived of infrastructure as public service centers that serve government public companies which can bring forward e-government, and e-health services. There is no reason to believe that yesterday's computers will continue to be the standard piece of equipment, investment has to be made on inexpensive small appliances that can connect to the internet and allow web browsing. Mobile phones proved to be the most used piece of technology used by the local community to access the internet, during the improvement action. One of the success factors of this design approach is the ability to bring different people and perspectives into a layout setting and allow them to participate in the production of services for their domain actively.

References


Adoption of Telemedicine for Healthcare in Remote Settings: A Context based Test of the Technology Acceptance Model

Gilbert Maiga  
Makerere University,  
Department of Information Technology  
Kampala, Uganda  
Tel: +256 772316918; Email: gilmaiga@gmail.com

Irene Arinaitwe  
Makerere University,  
Department of Information Systems  
Kampala, Uganda  
Tel: +256 782732236; Email: iarinaitwe@cis.mak.ac.ug

Elizabeth Asianzu  
Makerere University Business School  
Department of Business Computing  
Kampala, Uganda  
Tel: +256 782717541; Email: easianzu@mubs.ac.ug

Abstract  
Telemedicine in Africa is potentially a useful conduit of health-care given that the continents health sector remains resource constrained. However, Affordable telemedicine services face challenges of slow adoption and due partly to a lack of models to support its acceptance and use. Inspite of the challenges, interest in telemedicine for health care has elevated the importance of technologies that predict its acceptance and use. This study examined the applicability of TAM in predicting healthcare workers intention to adopt telemedicine in remote settings. A field survey of Health care workers was done to reveal factors for telemedicine adoption and subsequently proposed a model for predicting telemedicine adoption in Uganda. Regression analysis results show that independent variables of User training, sensitizing health workers and patients, guidelines and procedures for telemedicine use have a significance influence on PU while ability to use ICTs has a significant influence on PEOU.

Keywords: Telemedicine Adoption, Telemedicine, Healthcare, Remote Settings, Technology Acceptance Model

1. Introduction  
The key challenges facing healthcare in both developed and economically less developed countries include access and cost-effectiveness (WHO 2010), leaving thousands of people worldwide to die every year, victims of curable diseases, for lack of healthcare services within their reach. These challenges of contemporary
healthcare contribute to telemedicine’s economic, social, and political appeal (Istepanian, 1999). Telemedicine is the exchange of medical information from one site to another via electronically, so as to improve patients’ health (Elotu, 2000; Isabalija, Kituyi, Rwashana and Mbarika, 2011). It includes services for patients from different providers and consumers like specialist referral services, patient consultations for disease diagnosis, treatment plans, remote patient monitoring, and medical education seminars for targeted groups in remote locations. Telemedicine in Africa is potentially a useful conduit of health-care given the fact that the continent is human resource limited especially, in the health sector (Dan and Kaddu, 2013). Telemedicine faces the challenges of Money, Regulations, Hype, Adoption, Technology, evidence and Success (Linkous, 2012). Weisgrau (1995) admits that rural communities have long struggled to maintain access to quality healthcare services. Standing & Standing (2008) agree that in East Africa, where up to 80 percent of the population lives in the countryside, healthcare service delivery faces challenges associated with constraints of remote settings. These are characterized by poor road infrastructure, inadequate healthcare facilities and few professionals, long distances to the health facility and the fragmented nature of healthcare systems. In such remote settings, telemedicine services offer the promise of overcoming these constraints leading to seamless and secure access to improved, efficient and quality healthcare services at low cost (Kotz, 2009).

Telemedicine services help overcome the shortages in healthcare services due to the disproportionate urban-rural distribution of doctors and nurses in the developing countries. The benefits of telemedicine include improved access to healthcare services, cost efficiencies (through better management of chronic diseases, shared health professional staffing, reduced travel time and fewer or shorter hospital stays), improved quality with telemedicine delivering superior products with greater outcomes and patient satisfaction, patient demand as the greatest impact of telemedicine is on the patient, their family and their community, (Elotu, 2000).

2. The Challenge to the Successful Adoption of Telemedicine
Despite the numerous benefits, telemedicine is faced with a number of challenges. In sub-Saharan Africa, Telemedicine services are also challenged by a lack of both modern ICT infrastructure and computer skills for health care personnel, and limited Government’s commitment to such services (Bolognesi, 2006). McLain (2014) also admits that the top three obstacles facing clinicians today include complex telemedicine equipment and use the system features, system downtime and security and privacy. Therefore, though the potential of telemedicine in healthcare is recognized, its widespread adoption and use for health care in remote environments remains limited (Standing & Standing, 2008).
Its success also requires that adopting communities address both technological and managerial challenges, such as user acceptance of technology (Perednia and Allen, 1995). In addition, research in telemedicine has largely focused on technology developments and clinical applications essential to its success (Chau and Hu, 2002). Few studies have investigated factors essential to its acceptance by different categories of healthcare workers operating in differing contexts. Previous studies on physician’s acceptance of telemedicine have been of limited scope and scale, testing hypotheses that lacked adequate theoretical basis with none examining its adoption for remote healthcare settings (Allen et al., 1995).

The widespread adoption and use of Telemedicine for communities in the context of remote rural based healthcare settings remains low. A cause of such poor outcomes is the lack of models to predict and explain the technology adoption for telemedicine and healthcare (Zhang et al., 2010). Several technology adoption models have been proposed to explain and predict user behaviors and intentions (Ajzen & Fishbein, 1980; Davis, 1989; Venkatesh et al., 2003). These models have been tested, validated and proven to be reliable when used to predict user acceptance of technology for business organizations, corporations and students. The most widely used of these models to date is TAM. However, there is less research evaluating technology adoption using TAM within the healthcare context (Holden and Karsh, 2010). This is more so in remote rural based health settings characterized by poor physical infrastructure and electricity, inadequate healthcare facilities and few healthcare workers. Thus, determining whether TAM is a fitting theory for predicting telemedicine adoption in remote healthcare settings remains an empirical question requiring critical examination. This question was supported by the following sub questions: a) what proportion of Uganda’s healthcare workers use telemedicine for improved service delivery? b) What factors affect telemedicine adoption for the different categories of healthcare workers in remote settings of Uganda? c) How well does the technology acceptance model (TAM) help to explain the adoption of telemedicine by healthcare workers in a remote health settings?

3. The Technology Acceptance Model and Healthcare

The technology acceptance model (Davis, 1985) is based on the theory of reasoned action (TRA) proposed by Fishbein and Ajzen (1975). TRA posits that individual behavior is driven by behavioral intentions (BI). BIs are a function of an individual's attitude toward the behavior and subjective norms (SN) surrounding the performance of the behavior. SN is an individual's perception of whether people important to the individual think the behavior should be performed. Davis (1985) developed TAM (Figure 1) as an adaptation of TRA to information systems.
The logic is that the key to increasing use was to first increase acceptance of IT, assessed by asking individuals about their future intentions to use the IT (BI). Knowing the factors that shaped one’s intentions would allow organizations to manipulate them to promote acceptance, and thus increase IT use. TAM’s main dependent constructs are the Behavioral Intention to Use (BI) and actual System Usage. Its major independent constructs are the Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) as shown in figure 1.

TAM posits that PU and PEOU determine an individual’s intention to use a system, with intention to use serving as a mediator of actual system use. PU is also seen as being directly impacted by PEOU. Researchers have simplified TAM by removing the attitude construct found in TRA from the current specification (Venkatesh et. al., 2003). Actual system use is difficult to measure and BI has generally been used to represent it. TAM has undergone a number of changes and updates to TAM 2, with a variable to measure the subjective norm (SN). The unified theory of acceptance and use of technology (UTUAT) is another extension of TAM.

3.0 Research Method and Design
A descriptive survey design was used to collect data required to test the constructs of perceived usefulness (PU) and perceived ease of use (PEOU). The model developed was evaluated using regression analysis. Multiple regression analysis was used to explain the relationship between perceived usefulness and perceived ease of use (dependent variables) and sensitizing staff, training users, staff remuneration, establish policies and guidelines for telemedicine use, need for laws to protect telemedicine practitioners, access and ability to use ICTs, Affordable telemedicine services (independent variables).

3.1 Questionnaire Reliability Pre-Testing
Reliability is the extent to which the study provides consistent results when studying similar populations (Sasha, 2008). Consistency of results from administered questionnaire show reliability. To ascertain the reliability of the collected data, Cronbach’s Alpha Coefficient was calculated. An alpha value of 0.60 and 0.70 or above is considered to be the criteria for considering internal consistency of the
new scales and the established scales respectively (Nunnally, 1988). The following table 1 shows a Summary of Reliability of Scales Measures.

<table>
<thead>
<tr>
<th>CONSTRUCT</th>
<th>CRONBACHS ALPHA VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage /usage of Telemedicine tools</td>
<td>0.780</td>
</tr>
<tr>
<td>Factors for Telemedicine adoption</td>
<td>0.790</td>
</tr>
</tbody>
</table>

Results in table 1, show that most of the alpha values of the constructs are above 0.7 which is the acceptable range, except the value for training (0.579). This means the questionnaire is capable of yielding consistent result.

### 3.2 Sample size

What size of the sample was required to make precise generalizations about Telemedicine adoption with confidence? The sample size needed is a function of the confidence interval of (+/- 5%), a confidence level of 95%) and the population size. Sample size was determined using the following formula (Bartlet et al., 2001; Krejie and Morgan, 1970).

\[ S = \frac{Z^2(X)(1-X)}{C^2} \]  

Where: \( S = \) Sample Size; \( Z = \) Z Value (e.g. 1.96 for 95% confidence interval); \( X = \) Percentage picking a choice, expressed as decimal (0.5 used for sample size needed); \( C = \) Confidence interval, expressed as decimal (0.05) +/- 5 used for sample size needed). According to Uganda Medical and Dental Practitioners Council (2016), the registered medical personnel in Uganda are 5,152 including licensed dental and medical practitioners (1,265). With a population of about 5,000, the \( S \) for this study according to Krejie and Morgan’s 1970 Sampling table becomes 357 respondents.

### 3.3 Study Administration

The study targeted healthcare workers with differing subspecialties, practicing in public and private hospitals in Uganda. Choice of the target physicians was made based on their present or probable future involvement in telemedicine technology. The particular medical specialty areas included was based on their frequent inclusion by prior telemedicine research and documented clinical application results. These were mainly in internal medicine, pediatrics, obstetrics and gynecology, surgery, emergency care, intensive care, psychiatry, pathology, and radiology.

### 3.4 Results Validity Analysis

Factor analysis was done to examine measurement of convergent and discriminant validity. Factor analysis is a method of data reduction that seeks to underline latent variables that are reflected in the manifest variables (IDRE, 2013). Validity refers
to how well the research method investigates what it intends to (Carcary, 2008). It is the extent to which a questionnaire measures what it is supposed to measure. The study estimated the construct validity basing on its two subcategories of convergent and discriminant validity (Trochim, 2008). Convergent validity and divergent validity requires demonstrating that multiple measures of a construct are (a) related and (b) more related to each other than to measures of other constructs, even when the two measurement methods are similar (Lehmann, 1988).

### 3.5 Validity on the Usage of Telemedicine Tools

Convergent and discriminant validities were statistically computed on the factor of usage of telemedicine tools using STATA. In factor analysis, convergent validity is considered satisfactory when items load high on their respective factors as per the rule that is a loading higher than 0.50 and an Eigen value above one (> 1.0). Discriminant validity was assessed by examining whether each item loaded higher on the construct it measured than on any other constructs. Results for convergent and discriminant validity are presented in Table 2.

**Table 2 Component Factor Loading on Usage of Telemedicine Tools**

<table>
<thead>
<tr>
<th>variable</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use computer and Internet</td>
<td>0.6154</td>
<td></td>
</tr>
<tr>
<td>Use Mobile phones</td>
<td>0.5412</td>
<td></td>
</tr>
<tr>
<td>Use Video conferencing</td>
<td>0.5622</td>
<td></td>
</tr>
<tr>
<td>Use Television</td>
<td>0.7950</td>
<td></td>
</tr>
<tr>
<td>Use Radios</td>
<td>0.7898</td>
<td></td>
</tr>
<tr>
<td>Use Personal digital assistants</td>
<td>0.3284</td>
<td>0.879</td>
</tr>
<tr>
<td>Use Digital cameras</td>
<td>0.7037</td>
<td></td>
</tr>
<tr>
<td>Use Radio calls</td>
<td>0.5957</td>
<td></td>
</tr>
</tbody>
</table>

Loadings below 0.3 were suppressed.

Table 2 results show that most of the items had a higher loading on their factors than other factors. Factor six (use of personal digital assistants) had cross loading value but the difference between the loadings was 0.2 and above, which is valid as per cross loadings rule. Thus both convergent and discriminant validity were achieved.

### 3.6 Validity on Essential Factors for Telemedicine Adoption

Convergent validity on the training to use telemedicine tools was achieved as most of the items had an Eigen value >1.0 and a loading higher than 0.5 on their particular factors. Table 3 results show that all the items extracted had a loading higher than 0.5 on their factors, thus a desired measurement of convergent validity was achieved. Discriminant validity was evaluated by examining whether
the extracted items loaded higher on the construct it measured than others. The following table 3 shows the results for both convergent and discriminant validity.

**Table 3** Summary Component Loading Factors for Essential Factor for Telemedicine Adoption

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor 1</th>
<th>Uniqueness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training and sensitization of staff</td>
<td>0.5670</td>
<td>0.6785</td>
</tr>
<tr>
<td>Affordable telemedicine services</td>
<td>0.7788</td>
<td>0.3935</td>
</tr>
<tr>
<td>Internet availability</td>
<td>0.7380</td>
<td>0.4554</td>
</tr>
<tr>
<td>Supportive government policies</td>
<td>0.7075</td>
<td>0.4995</td>
</tr>
<tr>
<td>Organizational change management</td>
<td>0.6878</td>
<td>0.5269</td>
</tr>
<tr>
<td>Laws protecting telemedicine user</td>
<td>0.6728</td>
<td>0.5473</td>
</tr>
</tbody>
</table>

Rotated factor loadings and unique variances. Rotation: oblique promax Kaiser off

Table 3 results show that most items had higher loading on their factors than other factors and the cross-loading factors had a difference of 0.2 and above. Therefore basing on the results of both convergent and divergent validities were achieved.

### 4. The Descriptive Statistics

The results in this section are from the analysis of the data collected through questionnaires administered to health workers in government, private and not for profit based clinics, health centers and hospitals in Uganda’s districts of Mbale, Iganga, Mbarara, kabale, Ntungamo and Ibanda. Out of 600 questionnaires administered, 340 valid questionnaires were returned hence a response rate of 95.2% (340/600*100). Data was categorized, quantified, coded, arranged in themes according to research objectives and cleaned to avoid errors. Analyzed data is therefore presented the following sub sections.

#### 4.1 On Usage of Telemedicine Tools

Data was collected on the usage of telemedicine tools by Physicians and Nurses. The tools considered in this study were Computers, Mobile phones, Video Conferencing TVs, Radios, PDAs, Digital cameras, Walkie-talkies. Usage of telemedicine tools is one of the indicators of telemedicine usage for improved health care delivery. The following figure 2 shows the percentage of Nurses and Physicians that have used telemedicine tools in health care delivery.
The study findings show that 62.53% physicians and 43.67% Nurses have used computers, 53.45% physicians and 49.14% have used Mobile phones, 10% physicians and 9.23% have used Video Conferencing, 50% Nurses and 3.26% have used TVs, 57.39% Nurses and 2.61% Physicians have used Radios, 33.33% Nurses and 5.56% Physicians have used PDAs, 40% physicians and 36% nurses have used Digital cameras and 5.83% Nurses and 1.89% Physicians have used Walkie-talkies.

4.2 Factors for Adoption of Telemedicine Technology
Data was collected on the challenges for adoption and usage of telemedicine services. Figure 3 show the challenges that need to be overcome for successful adoption of telemedicine as a tool for improved health care delivery in Uganda.

5. A Model for Telemedicine Adoption
This section presents a description of a model for predicting telemedicine adoption. It uses requirements obtained from the results of the field study especially the essential factors for telemedicine adoption suggested in literature and confirmed by the health professionals in rural areas of Uganda. The model extends the TAM – TPB integrated model (Chau and Hu, 2001). The model was evaluated using regression analysis to confirm the existence of the relationship between the independent variables (sensitizing staff, training users, staff remuneration, establish policies and guidelines for
telemedicine use, need for laws to protect telemedicine practitioners) and the dependent variable (PU).

The following relationships were suggested in figure 4 above:
H1: Sensitizing staff has a direct positive influence on Perceived Usefulness.
H2: Procedures and guidelines have a direct positive influence on Perceived Usefulness. H3: Staff remuneration has a direct positive influence on Perceived Usefulness.
H4: User training has a direct positive influence on Perceived Usefulness. H5: Trust in telemedicine services has a direct positive influence on Perceived Usefulness.
H6: Affordability has a direct positive influence on perceived ease of use.
H7: Accessibility to tools has a direct positive influence on perceived ease of use.

5.2 Regression Analysis
In this study multiple Regression analysis was used to explain the relationship between perceived usefulness (dependent variable) and User training, trust in telemedicine services, staff remuneration, sensitizing health workers and patients and establishing guidelines and procedures for telemedicine use (Independent variables) in one set; Perceived Ease of Use (dependent variable) and affordable telemedicine services and access and ability to use ICTs (independent variables) in another set. To explain
perceived usefulness and perceived ease of use, multiple regression analysis was performed between the dependent variables and independent variables and the results are presented in the following tables 4 and 5

Table 4 Summary of Multiple Regression Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t values</th>
<th>p&gt;t (significance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>-5.2805</td>
<td>0.478</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Sensitizing health workers</td>
<td>.4427083</td>
<td>.1703436</td>
<td>2.60</td>
<td>0.010</td>
</tr>
<tr>
<td>Training health workers</td>
<td>.994709</td>
<td>.00504225</td>
<td>19.73</td>
<td>0.000</td>
</tr>
<tr>
<td>Trust in telemedicine</td>
<td>.4586466</td>
<td>.4798705</td>
<td>0.96</td>
<td>0.340</td>
</tr>
<tr>
<td>Procedures and guidelines</td>
<td>.9659864</td>
<td>.1071428</td>
<td>9.02</td>
<td>0.000</td>
</tr>
<tr>
<td>Staff Remuneration</td>
<td>.994709</td>
<td>.00504235</td>
<td>19.78</td>
<td>0.01</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Perceived usefulness

In table 4 Coefficients (the plus or minus sign) help to interpret the direction of the relationship between variables. If the Coefficient is positive, then the relationship of this variable with the dependent variable is positive and if the Coefficient is negative then the relationship is negative, if the Coefficient is equal to 0 then there is no relationship between the variables. From the results in table 4 the independent variables that have a relationship with Perceived Usefulness are; Sensitizing health workers, Training health workers, Trust in telemedicine services and establishing procedures and guidelines for telemedicine use and staff remuneration.

The Beta value (b coefficient) measures how strongly an independent variable influences the dependent variable. It is measured in units of standard deviation. The Beta value assesses the strength of the relationship between each independent variable to the dependent variable and the higher the beta value the greater the impact of the independent variable on the dependent variable. The independent variables with higher beta values in table 4 are Training health workers (b=.995) and Procedures and guidelines (b=.966). The independent variable in the following table 5 with a higher beta value is Access and ability to use ICT tools (b=.747). The significance value (P value) gives the impact of each independent variable on the dependent variable. A smaller P value suggests that the independent variable is having a significant impact on the dependent variable. The p Value rule is that its value should never exceed 0.05 if the relationship between a dependent and an independent variable is to be significant. In table 4 it is establishing procedures and guidelines, Training health workers, staff remuneration and sensitizing health workers independent variables
that had a significant impact on Perceived Usefulness the independent variable. Therefore holding other factors constant, Perceived usefulness depends on the four independent variables. Trust in telemedicine services independent variable had no significant impact on Perceived Usefulness the dependent variable as its p value was less than 0.05 as in table 4.

Table 5. Summary of Multiple Regression Analysis.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t values</th>
<th>p&gt;t(significance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>-0.3794118</td>
<td>0.0263547</td>
<td>14.40</td>
<td>0.000</td>
</tr>
<tr>
<td>Affordable telemedicine services</td>
<td>0.0706076</td>
<td>0.1382271</td>
<td>0.051</td>
<td>0.611</td>
</tr>
<tr>
<td>Access and ability to use ICT tools</td>
<td>-0.7473118</td>
<td>0.178337</td>
<td>-4.17</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 5 results show that Access and ability to use telemedicine tools has a relationship with perceived ease of use (PEOU) as it has a positive coefficient. The relationship between them significant because the p value is less than 0.05. Holding other factors constant, Perceived ease of use depends on one independent variable.

![Figure 5: Results of the regression analysis (significant relationships at p<0.05)](image-url)
Results of regression analysis in tables 4 and 5 are mapped on the telemedicine adoption model in figure 5 above highlighting the factors that have significant impact on perceived usefulness and PEOU. The results with respect to staff sensitization show that sensitizing health workers had a significant influence on perceived usefulness supporting the suggested relationship in (H1) though with a low positive coefficient of 0.442. The suggested relationship was supported with a positive coefficient of 0.994 and was significant with a p value of 0.010. Therefore, for telemedicine to be successfully adopted, it is important that these stakeholders are aware of the effects of a new technology (telemedicine) otherwise they will resist it. Establishing procedures and guidelines had a significant influence on perceived usefulness with a high positive coefficient of 0.965 and p=0.000, supporting the suggested relationship (H2). Therefore health workers need guidelines and procedures on how to make use telemedicine as a tool for improved health care delivery.

Staff remuneration had a significant influence on perceived usefulness with a high positive coefficient of 0.994 and p=0.000, supporting the suggested relationship (H3). This implies that with better remuneration, health workers will make use of telemedicine as a tool for improved health care delivery. With respect to training, the results showed that user training had significant influence on perceived usefulness with a high positive coefficient of 0.994 and p value of 0.000 implying that in practice, training of the health workers in telemedicine would make them perceive telemedicine as useful leading to adoption of telemedicine in Uganda, supporting the suggested relationship (H4). The suggested positive relationship between Trust in telemedicine services and PU (H5) was supported with a low positive coefficient of 0.45 despite, being insignificant with a p value of 0.340 which is above the recommended value 0.5.

Although, the relationship between access and ability to use ICT tools and Perceived Ease of Use was significant with a p value below 0.05, the positive relationship as suggested (H7) was not supported as indicated by a high negative coefficient of -0.7473. However, the results show a significant relationship between access and ability to use ICT tools and perceived ease of use meaning there is need for hospitals to be equipped with computers, telephones, internet connectivity and equip these health workers with skills in order to realize the potentials of telemedicine. The suggested positive relationship between affordable telemedicine services and PEOU (H6) is supported by a very low positive coefficient of 0.0706 despite, being insignificant with a p value of 0.611 which is above the recommended value 0.5.

The model explained up to 36.2% of the variance in perceived usefulness and up to
8.72% of the variance in perceived ease of use. This means that 63.8% of the variance in perceived usefulness and 91.28% of variance in perceived ease of use is explained by other factors not in this study as presented in figure 5 above.

6. Discussion of the Results and Conclusions
This study examined the need for a model to predict telemedicine technology adoption by determining the factors that would explain why Physicians and Nurses are likely to perceive a technology as useful and easy to use. The factors identified for telemedicine adoption are sensitizing health workers, training of health workers, trust in telemedicine, procedures and guidelines, staff remuneration, affordable telemedicine services and access and ability to use ICT tools.

Regression results show that user training and sensitization of staff are critical for telemedicine adoption. These results are in agreement with Isabalija et al (2011), whose findings show that lack of training support for staff using telemedicine services is one of the challenges to telemedicine adoption in Uganda. Staff remuneration is equally important for successful telemedicine adoption as the results are in agreement with (Kim and Chang, 2007) who note the need for improved staff remuneration as it can facilitate telemedicine adoption and if not attended to can be a barrier to its adoption.

With respect to establishing procedures and guidelines, Isabalija et al (2011), support the need to establish procedures and guidelines to be followed by telemedicine practitioners to have telemedicine uniformly practiced and health workers acknowledging it. Access and ability to use ICT tools are critical for successful adoption of telemedicine as Bertot et al., (2006) and Mbarika et al (2007), support accessibility of ICT tools and skills as important aspect of user centered services which has a correlation with quick adoption new technologies like Telemedicine. The model outlines the critical requirements for telemedicine adoption by healthcare workers in Uganda.

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Are mAgriculture applications living up to expectations?
A critical review of empirical evidence and methodologies

Heike Baumüller
Center for Development Research (ZEF), University of Bonn
hbaumueller@uni-bonn.de

Abstract: Mobile technologies are often seen to hold great potential to improve service delivery to farmers in developing countries. This paper takes a critical look at the empirical evidence to test this potential. Specifically, it reviews research into the role of mobile phone-enabled services in helping farmers adopt agricultural innovations. The analysis is structured around four types of services that are relevant in this regard: information and learning, financial services, access to inputs and access to output markets. The review highlights a dearth of empirical evidence in the existing literature. It also points to several methodological shortcomings and challenges in research on agricultural m-services and mobile phones in general.

1 Introduction

The rapid evolution and uptake of digital technologies has been hailed as the ‘fourth industrial revolution’ which is characterised by “a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres” (Schwab, 2016). Many believe that these changes hold great promise for developing country agriculture (Annan et al., 2016; Gates, 2016; Warshauer, 2016). In particular the utility of mobile phones to deliver services (referred to as m-services here) has received much attention due to the explosive growth and extensive reach of the technology. In practice, however, agricultural m-services are still far from fulfilling their assumed potential. According to a review by the GSM Association, they make up only a very small share of development-related m-services (8%) (Metcalf, 2015). Many struggle to reach scale and financial sustainability (FAO, 2015).

What is missing in current debates around the utility of agricultural m-services is a systematic review of the empirical evidence on the performance of such services. The most comprehensive review on the use of mobile phones for agricultural and rural development was prepared by Duncombe (2012).
However, most of the studies reviewed relate to mobile phone use in general rather than m-services. The latter are only touched upon and the bibliography is incomplete. Other reports on this subject (Aker, 2011; Donner, 2009; FAO, 2015; Gakuru et al., 2008; Qiang et al., 2011; Vodafone Group and Accenture, 2011; World Bank, 2011) tend to rely on a narrow selection of the literature, case studies and anecdotes. Other literature reviews related to mobile phones and m-services have focused on micro- and small enterprises (Donner and Escobari, 2010), financial services (Duncombe and Boateng, 2009; Shaikh and Karjaluoto, 2015) and m-commerce (Ngai and Gunasekaran, 2007), but do not offer insights related to farmers.

This paper presents such a review with a focus on the role of agricultural m-services in helping farmers to adopt agricultural innovations and thereby increase their productivity and income. Relevant m-services can be grouped into four categories: information and learning, financial services, access to agricultural inputs and access to output markets. The remaining paper is organised as follows: Section 2 reviews empirical evidence on the impact of m-services, structured around the four categories. Section 3 identifies overarching research gaps. Section 4 highlights methodological weaknesses in the existing literature and challenges in mobile phone-related research in general. The final section offers conclusions and summarises the research gaps.

2 A Review of empirical evidence

The following literature review summarises key findings from empirical research on the impact of agricultural m-services on farmers’ ability adopt agricultural innovations. The papers were identified using academic databases (e.g. Science Direct, IDEAS, AgEcon) and internet search engines (e.g. Google Scholar) with combinations of keywords such as mobile phone, agriculture, technology adoption, poverty etc. In addition, the snowball method was applied to identify relevant literature from reviewed articles. Only studies were selected that were published (or use data) after 2000 when mobile penetration rates started to expand significantly in developing countries. Where services are offered through several dissemination channel (in addition to mobile phones), studies were only included if the data are disaggregated by channel since the studies otherwise do not offer any insights specifically on the use of m-services. In addition to empirical studies published in refereed journals, the literature review also includes grey literature provided that the publications include information about the data and methods used. Overall 18 studies were identified and reviewed.
2.1 Information and learning

The Potential

M-services can be used to transmit information from and to farmers. Mobile phone-based surveys can be employed to gather data on farmers' needs and to monitor formal field trials or informal experimentation. M-services can also be used to share different types of information with farmers. Advice on farming practices is one of the most widely available information m-service in agriculture. In addition, m-services offering information related to the production environment (e.g. on weather or crop diseases) can assist farmers in better understanding and managing risks. M-services providing information on market prices and buyers can help them to assess and realise the economic potential of new innovations (see also below). M-services are also employed in educational initiatives and to facilitated social learning by offering platforms to exchange information and experiences.

The Evidence

Several studies have looked at the use of m-services to disseminate farming information in general. Three studies assessing the impact of voice-based information services highlight certain benefits. A study of LifeLines, a telephone-based advisory service for Indian farmers, finds that the majority of farmers reported that the service had improved their productivity, increased savings and earnings and decreased the need for loans (Haider Rizvi, 2011). Also in India, the use of the m-service Avaaj Otalo, which employs recorded voice messages to deliver and exchange information, led to reported changes in management practices, including increased use of effective pesticides and more extensive adoption of the lucrative but risky crop cumin (Cole and Fernando, 2012). The authors do not differentiate between the different functions of the service (automated voice messages, a helpline and a social media platform) when assessing impacts.

Conclusions differ on the impact of m-services on improving agricultural knowledge in general. In the case of Avaaj Otalo, most farmers appear to accept the advice on face value, but did not show improved agricultural knowledge overall (Cole and Fernando, 2012). In contrast, a study of the Knowledge Help Extension Technology Initiative (KHETI) in India concludes that farmers had a higher awareness and knowledge of agricultural techniques (Fu and Akter, 2011). The m-service employs special phones operated by so-called munnas who record short dialogue strips (images and voice) to exchange questions and solutions on local agricultural problems. Interestingly, illiterate,
poorer and landless farmers seem to have gained most, which the authors speculate may be because they had previously thought that modern ICTs only benefitted the rich and educated.

A study of M-Solution in India, which disseminates weather and farming-related information via SMS and audio messages, compares impacts between male and female farmers (Mittal, 2015). The majority of users felt that they had improved their knowledge of farming practices, increased yields and reduced costs. Weather information was generally judged most relevant followed by information about nutrient management and seeds. However, the prioritised information does not necessarily relate to the topics listened to or the actions taken. Thus, while respondents rank some topics as less important, the listening rates (i.e. average time of listening to a message) were nevertheless similar compared to priority issues. Also, while men and women had similar listening rates, women said that they had acted on less of the advice, including on weather information which only a majority of men said they had used to plan irrigation and input use. The author attributes this difference to women’s limited direct involvement in related decision making.

Two studies of the m-service Reuters Market Light (RML) in India, which provides farmers with information on weather, prices and farming practices, come to different conclusions about the role of the service in changing agricultural practices. In both studies, a share of the farmers reported that they had changed their practices as a result of using RML. In the survey carried out by IMaCS (2011), almost two thirds of the farmers reported that the information had ‘slightly’ helped them adopt better practices and 19% stated that it had helped ‘a lot’. In the second study, almost a third of farmers had changed crops between the two survey years (Fafchamps and Minten, 2012). Treated farmers were 14-20% more likely to cite RML as a source of inspiration for the change than control farmers. However, the positive perception is not born out by the analysis of the entire data set which shows that “treatment is found to have no effect on the propensity to change variety or on the reason for changing variety” (p. 28).

Other studies have examined the provision of specific agricultural information. Three studies looked at the impact of weather information sent by SMS to farmers. One study in Colombia concludes that farmers who received weekly weather information reported 4-7% less weather-related crop losses compared to the farmers in the control group who did not receive this information (Camacho and Conover, 2011). The survey of Indian farmers who were sent regular weather updates through RML shows that most (85%) judged the information as useful. In contrast, Fafchamps and Minten (2012) do not find that the RML users were able to reduce crop losses after storms compared to control farmers.
A service disseminating information on the correct use of soil nutrients via SMS and voice alerts in India had led to a perceived 15% increase in incomes among intervention farmers compared to the control group, mainly through cost reductions due to the application of appropriate (i.e. lower) amounts of seeds and nutrients (Raj et al., 2011). Farmers were given individualised instructions for nutrient management and other crop cultivation practices via SMS and voice alerts which they were then required to implement. The observed benefits might thus say more about the utility of the instructions than the mobile phone as a dissemination tool.

The use of m-services to facilitate education and learning has hardly been assessed empirically. One study examines the impact of the Lifelong Learning for Farmers initiative in India where training modules are recorded and disseminated to female livestock producers via mobile phones (Balasubramanian et al., 2010). The study concludes that the participants regard mobile phone-based training as useful and more convenient than face-to-face contacts because they could access the recordings at a time and place that suited them.

Only one study has examined an m-service to facilitate social learning and exchange although much of the focus rests on usage rather than impacts. Patel et al. (2010) assess the performance of the social media aspect of Avaaj Otalo in India which offers farmers a platform to ask questions via recorded audio messages which are then answered by service provider staff or other farmers. The users valued in particular the possibility to listen to other farmers’ questions and the recorded answers. Interestingly, the majority (65%) preferred to receive the information only from staff members. None of the farmers was interested in receiving answers only from other farmers and 35% only if they were combined with staff advice.

2.2 Financial services

The Potential

M-payments allow farmers to pay for innovations and to sell their produce. Access and repayment of loans through the mobile phone can provide farmers with the necessary financial resources to purchase technologies and associated inputs, to cover for production losses if they set aside part of their land for experimentation and to increase their willingness to bear the financial risk in case the technology does not perform well. M-banking facilities can also help farmers manage and earn interest on their savings, thereby enabling them to better deal with the seasonality of agricultural income and increase the choice of
when and where to purchase which inputs. Finally, mobile phone-enabled insurance services can make insurance for smallholders viable by reducing the need for visits to insurance claimants, for instance by monitoring weather events through weather stations or disbursing payouts via mobile money.

The Evidence

Very little research has looked at the use of mobile phone-enabled financial services in the agriculture sector (including m-banking, loans and insurance). The one empirical study in this area examines the use of mobile payments by Kenyan farmers (Kirui et al., 2010). The study finds that around half of the farmers made and received transfers via their mobile phones, primarily through M-Pesa. The use of m-payment services was more widespread in areas with higher agricultural commercialisation. Further distance to banks, higher education levels and higher capital endowments also increase the likelihood of farmers using m-payments. However, only a small share of payments was used to pay for farming-related items, including inputs (7%) or farmworkers (6%). Most of the money went towards non-agricultural uses, such as paying school fees, meeting regular non-food household needs or repaying debt.

2.3 Agricultural inputs

The Potential

M-services can also facilitate access to agricultural inputs although they are not yet widely used for this purpose. For instance, m-services could disseminate information on input suppliers or input prices, or provide trading platforms for inputs. Some services are also supporting access to water, e.g. by allowing farmers to use their phone to switch water pumps on and off. Mobile phones also facilitate access to electricity, although somewhat indirectly, where mobile network operators have been providing excess power from their base stations to local communities. Some virtual labour markets have also been set up, although their use in the agriculture sector is still limited. Moreover, mobile phone-enabled financial services outlined above can facilitate the procurement of inputs.
The Evidence

The use of m-services to facilitate access to agricultural inputs has hardly been assessed. One study looks at the performance of the Berendina Employment Resources Centre in Sri Lanka which uses a computerised database and mobile phones to match demand and supply for labour in rural areas. It finds that hardly any users took up the job offers provided through the Centre because they did not trust offers received over the phone (Balasuriya and de Silva, 2011).

2.4 Output markets

The Potential

Various m-services provide information on market prices for crops and livestock which could help farmers to evaluate the likely profitability of new technologies or by enabling them to obtain higher prices for the crops (e.g. through bargaining or access to buyers with better offers). In addition, the ability to profitably sell surplus produce for income generation will also depend on good access to markets. Mobile phone-enabled 'virtual' markets for agricultural products can help farmers link up to alternative buyers or markets while m-payments can facilitate transactions between farmers and buyers. Another expanding m-service includes supply chain management systems which use mobile devices to manage produce sales, thereby simplifying sourcing from large numbers of smallholder farmers

The Evidence

Several studies have looked at the use of m-service to facilitate participation in markets, including the impacts of price information and market linkages on production planning, income and producer-buyer relationships. Three studies conclude that m-services providing price information have helped farmers improve their planning. TradeNet users in Sri Lanka said that the information enabled them to make more informed decisions about the best harvest and selling times (Lokanathan et al., 2011). The assessments of Esoko in Ghana (CTED, 2013) and M-Farm in Kenya (Baumüller, 2015) show that the price information was most important at the sales stage, but was also used earlier in the production cycle when deciding what to plant, albeit to a lesser extent. All
of the studies used surveys to assess impacts and did not quantify actual changes in technology adoption, productivity or income.

Research findings on the impact of price information on the prices that farmers receive are mixed. Two studies conclude that farmers using m-services were able to obtain higher prices for their crops. In Bangladesh, all farmers who regularly received price updates through PalliNet felt that their income had improved as a result of using the service (Islam and Grönlund, 2010). Just over a third of farmers said that their income had increased by 10-20% and 8% of farmers by 20-25% while the remainder did not quantify the increase. Similarly, users of TradeNet in Sri Lanka said that they had earned more for their produce (Lokanathan et al., 2011). While they did not seem to use the information for bargaining, they nevertheless felt that the traders offered them better prices because they knew that farmers were aware of prices in other markets.

An experimental study in Colombia comes to different conclusions, however. The research shows that many farmers who received daily price information via SMS were more knowledgeable of prices in different markets, but did not receive higher sales prices than those who did not use the service (Camacho and Conover, 2011). The study compared prices recorded by farmers with average daily prices collected by the Corporación Colombiana Internacional. The authors do not offer an explanation for this finding.

The two studies of RML also show limited impacts on prices. IMaCS (2011) finds that 58% of the farmers did not feel that the price information had helped them increase the market value of their products. Just over a third (36%) reported increases of 1-5% and the remainder 5-6%. The authors explain the limited impact by the fact that the surveyed farmers mainly sold at local markets for which no price information was available. Fafchamps and Minten (2012) conclude that farmers with a free one-year RML subscription did not receive significantly higher average prices. They also note that the RML subscription did not impact transaction costs nor did it induce farmers to economise on the cost of searching for price information. The authors explain that most farmers sell at the nearest wholesale market, thus limiting their opportunities for arbitrage. Supply-side factors and technical problems with the service can also not be ruled out.

Two studies of Esoko also highlight the challenges in drawing clear-cut conclusions about price impacts. One study finds that users obtained higher prices for yam (11%), but not for maize, cassava, and gari (processed cassava) (CTED, 2013). The authors suggest that the difference may be due to the fact that bargaining is more common in the case of yam marketing than other crops. This hypothesis is supported by the fact that around two thirds of farmers said that they had used the price information to bargain with traders. In contrast, another study of Esoko concludes that farmers with access to the m-service
received 10% higher farmgate prices for maize and 7% for groundnuts than the control group (Courtois and Subervie, 2014).

Three studies that have looked at the impact of m-services on trading patterns do not observe significant changes. A study of PalliNet in Bangladesh finds that around a third of farmers with access to price information had switched markets at least once, but most preferred to stay in the same market because they were not familiar with the business mechanisms in other markets (Islam and Grönlund, 2010). Similarly, the TradeNet study notes that users with access to information about and interaction with different traders (through the TradeNet marketing platform) largely continued to sell to the same traders because they depended on them as a source of loans and information (Lokanathan et al., 2011). An assessment of the price information service M-Farm in Kenya also finds little evidence of changes in sales patterns (Baumüller, 2015).

None of the studies has assessed the effectiveness of mobile phone-enabled agricultural markets. Anecdotal evidence suggests that 'virtual' market places may need additional support measures if they are to reach smallholder farmers. Reviewing past experiences with Cellbazaar, the founder Kamal Quadir and his colleague Naeem Mohaiemen reflect that uptake had been faster in urban than rural areas (Quadir and Mohaiemen, 2009). Reaching farmers was found to take some additional effort in the form of "human translation or help" (p. 71), including training through public and private institutions.

Empirical research into the effectiveness of mobile phone-enabled supply chain management systems is still limited. An internal review by the Kenyan company Virtual City of its Agrimanagr service, which uses mobile technologies to track produce deliveries from small farmers to processors and sellers, shows improvements in efficiency (Virtual City, 2009). Specifically, the review finds that the system had reduced the delay in payments to farmers from 120 to 31 days due to a faster consolidation of report, cut purchasing times from 3 minutes to 22 seconds, and increased the average produce weight per transaction by 9-13% with the use of electronic weighing technologies.

3 Cross-cutting issues and research gaps

Hardly any studies have looked into behavioural factors that influence farmers’ willingness and ability to use m-services. Attitudes to risk, for instance, play an important role in agricultural technology adoption. While none of the studies looked at the role of risk attitudes in m-services adoption, several studies on mobile phone use in general note the importance of trust as a prerequisite for people to use their phone in business transactions (Galperin and Mariscal, 2007; Jagun et al., 2007; Mascarenhas, 2010; Molony, 2006). Research into the
usability of m-services needs to involve comparisons between different designs of m-services, e.g. how the service is delivered (e.g. voice, SMS, internet), how it can be accessed (e.g. push or pull) or how much should be charged. Only one study compared delivery mechanisms within an m-service by offering farmers market information either automatically (the 'push' group) or on demand (the 'pull' group) (Islam and Grönlund, 2010). The information was considerably more effective for farmers in the push than in the pull group.

The utility of mobile phones vis-à-vis other channels to deliver a service and the complementarity between different channels has received little attention. Some evidence has emerged from research into information m-services. Two studies look at changes in preferred information sources prior to and after the introduction of the m-service. In India, SMS from RML became by far the main source of information for weather information (previously TV), market prices (previously traders), crop advice (previously ‘other’) and government schemes (previously local newspapers) (IMaCS, 2011). Similarly, the introduction of M-Farm in Kenya led to a decline in the importance of traders and market buyers as a source of price information (Baumüller, 2015). While some farmers continued to obtain information from middlemen, the quality of information was generally seen as worse than M-Farm. The study of KHETI also finds that the large majority of treated farmers regard the m-service as faster and better quality than traditional extension services (Fu and Akter, 2011).

Veeraraghavan et al. (2009) assess the Warana Unwired project which involved switching from a PC-based to an SMS-based system to transmit information to and from members of a sugarcane cooperative in India. Farmers could request information through their mobile phone or by using a phone in the village kiosks that also housed the PCs. Kiosk owners collected information on fertilizer and water use. The SMS-based system was generally well received. Advantages over the PCs include the battery power, mobility, fast access anytime and democratisation of access. However, PCs where still preferred for entering longer text, e.g. on fertilizer use.

Two studies comparing different dissemination channels for price information find the radio to be a popular channel. The study of M-Farm shows that the radio is regarded as a viable alternative to the m-service, in particular in the early stages of production. M-Farm gains in importance at the sales stage, possibly because of the time-sensitivity of the information and the ability to store price information on the mobile phone (Baumüller, 2015). Comparing market information provided through radio and mobile phone, Ferris et al. (2008) find that farmers preferred to receive the information through the local radio stations even though almost all of them had access to a mobile phone. Many farmers were not aware of the price information service available through SMS and were not used to using their mobile phone to access business information. However, the authors predict that SMS will become more
desirable in the longer term because they are cheaper and can be accessed and updated more easily.

Impact studies rarely distinguish between user groups who may differ, for instance, by gender, income, social standing or religion. Usage and impacts, however, can vary considerably between these groups. For instance, the study of farmers’ use of m-payments in Kenya suggests that the main users are farmers in commercial agriculture areas with higher levels of income and education (Kirui et al., 2010). Gender-related factors can also play an important role, but rarely feature in existing research on m-services. The study of M-Farm in Kenya finds that women felt empowered by their participation in the training in how to use the m-service because it had familiarised them with the use of the mobile phone which they were then able to use for other purposes. Also, as elaborated above, Mittal (2015) shows that women are equally interested in the information, but appear less able to act on it due to other constraints.

Further research is also needed on how usage of m-services differs between those who own a phone and those who share someone else’s. One study comparing mobile phone owners, non-owning users and non-users in Tanzania observes that owners used phones for a greater variety of purposes while non-owning users mainly used phones to contact family members or for business reasons (Goodman, 2005). A study of Ugandan farmers also shows that households that did not own a mobile phone could still benefit from the availability of mobile phones in the community, for instance when someone in the village arranged the collection of produce with a trader (Muto and Yamano, 2009). Understanding these differences is particularly important when studying m-service usage and impact among low income groups where phone sharing is more common (de Silva and Zainudeen, 2007).

Finally, not enough attention is paid to the context in which the m-service is provided to understand how other factors may influence the utility of the service. Some of the studies of marketing-related m-services have sought to explain limited impacts by referring to other constraints that prevent farmers from taking advantage of price information or marketing choices (Fafchamps and Minten, 2012; IMaCS, 2011; Islam and Grönlund, 2010; Lokanathan et al., 2011). Only one study systematically assesses the relative importance of different factors. The study concludes that lack of information about prices and buyers is far less important to farmers than other constraints, such as lack of finance or risk of crop losses (Baumüller, 2015). Various studies into the use of mobile phones in marketing more generally also find that other factors such as established business relationships, the perishable nature of the produce, limited storage facilities or trust are more influential in making sales decisions than price information or market linkages (Burrell and Oreglia, 2015; Frempong et al., 2007; Galperin and Mariscal, 2007; Jagun et al., 2007; Kameswari et al., 2011; Mittal et al., 2010; Molony, 2006; Tadesse and Bahiigwa, 2015).
4 Methodological shortcomings and challenges

The review of the literature points to certain methodological shortcomings in the research on agricultural m-services. Such shortcomings are not only found in this sector. A review of assessments of m-health applications in low and middle income countries finds a lack of rigor in the design and methodology of most studies (mHealth Alliance, 2012).

Much of the reviewed research relies on farmers' perceptions obtained through surveys rather than time series data gathered by data collectors or by analysing actual usage patterns. Two studies indicate that m-service users may at times be overly enthusiastic when reporting impacts. In the case of RML, a large proportion of farmers in the treatment group mentioned the m-service as the inspiration for changing agricultural practices. Thus, it could be expected that more farmers in the treatment group had changed their practices. However, as noted above, the researchers did not find supporting evidence in this regard (Fafchamps and Minten, 2012). In the case of M-Farm, farmers reported that they usually received equally good or better prices than those quoted by M-Farm. However, when comparing M-Farm prices for sweet potatoes with actual prices received, the study finds that actual prices were almost always lower (Baumüller, 2015).

An important shortcoming of the existing research is that studies often do no assess impact in relation to usage. Rather, research tends to distinguish between users (or those with access to the m-service) and a control group, and then compares impacts for the entire groups irrespective of usage patterns. Haider Rizvi (2011), for instance, observes that the usage frequency of LifeLines was generally low and varied widely between weekly and twice a year, but does not differentiate by usage in the impact analysis. Similarly, Fafchamps and Minten (2012) note that only 59% of farmers who had been offered a free RML subscription to receive price and farming information actually used it, but does not differentiate by usage in the impact analysis. Similarly, Fafchamps and Minten (2012) note that only 59% of farmers who had been offered a free RML subscription to receive price and farming information actually used it, but carry out much of the analysis using intent-to-treat estimates for farmers who were offered a free RML subscription irrespective of whether they used it. A similar approach is taken by Cole and Fernando (2012) in the case of Avaaj Otalo although only 58% of treated farmers had called the helpline and 65% had listened to push content. In the absence of usage data, establishing causalities between the m-service and observed changes is difficult.

At the same time, it is important to note that impact studies of m-services are subject to several methodological challenges. The impact of the m-service can be difficult to isolate from the use of the phone in general. If farmers are introduced to an m-service, it may induce them to use their phone more readily for other purposes. The study of M-Farm shows that women farmers who had participated in M-Farm training, started using the phone for other business transactions as well (Baumüller, 2015). The study of KHETI also finds that
treated farmers were generally more open to using new agricultural and mobile technologies after they started using the m-service (Fu and Akter, 2011). One study tried to deal with this challenge by preventing participants from using the mobile phone they were given to access the service to make or receive other calls (Mitra et al., 2013). However, the researchers would not be able to prevent participants from using their own phones.

Isolating impacts becomes even more complex where an m-service offers several functions (e.g. different types of information, delivery channels or types of services) or is part of a larger support programme. Indeed, many researchers do not attempt to distinguish between the different functions (Cole and Fernando, 2012; Fafchamps and Minten, 2012; Kiiiza and Pederson, 2012; Mitra et al., 2013). One study that separately assesses impact of the price information and the selling services finds that M-Farm users were often not able to differentiate between the impacts. The farmers also attributed impacts to the m-service although they were in fact a result of the umbrella project implemented by the local partner (Baumüller, 2015).

Randomised control trials may be most suitable for the study of m-services since providers are able to control and measure usage of the service. However, such research nevertheless risks contamination since the conditions under which the interventions are implemented are often difficult to control (Barahona, 2010). For instance, in the case of publicly available m-services, anyone is free to subscribe. Lokanathan et al. (2011) find that although Tradenet was only mentioned to the treatment group, farmers in the control group had also heard of the service through word-of-mouth and advertising. Avoiding contamination is particularly challenging in the case of information services given that information spreads easily (including through mobile phones). Several studies find that many farmers share the information they receive through the m-service with other farmers (Baumüller, 2015; Courtois and Subervie, 2014; Mittal, 2015).

5 Conclusions

The literature review points to a dearth of empirical evidence that could substantiate or contradict the pathways by which m-services could help farmers adopt innovations. Even studies assessing the same m-service often come to different conclusions. Some preliminary insights can nevertheless be summarised with regard to information and marketing m-services which have been the focus of the majority of the research. Farmers often report to have benefitted from information m-services. Actual benefits are most likely to arise from improved production planning and better management of weather-related risks while perceived price gains are not necessarily borne out by other evidence. With regard to output markets, most studies concur that m-services...
have had limited impacts on trading patterns which remain largely unchanged due to other constraints. Supply chain management may be among the most promising m-services because of improvements in efficiency. With regard to m-services offering payment services, education and social networks, research findings are too limited to draw any meaningful conclusions. To the author's knowledge, no study has looked into the utility of mobile phone-enabled surveys, loans, savings, insurance, and input and output markets for farmers.

In addition to research gaps related to specific types of m-services, several overarching gaps are also found in the literature. Hardly any research has compared the utility of different delivery channels both within the m-service (e.g. voice versus SMS) and between different types of channels (e.g. mobile phones, radio, TV or face-to-face contact). Also, most studies do not differentiate between different user groups although the propensity and ability to use an m-service may differ considerably. Further research is also needed on difference in usage and impacts between those owning and sharing phones. Finally m-services are rarely assessed within the context in which they are provided. While some studies have looked at the farming context to explain their findings, most do not systematically assess the influence of contextual factors as part of the research question.

The literature review has also shown that existing research suffers from several methodological limitations. The vast majority relies on farmers’ perceptions rather than time series data which provide only weak evidence when assessing actual impacts. Indeed, some studies show that farmers are often overly enthusiastic about the benefits of the m-service and struggle to recollect prices or income. In future research, baseline studies prior to launching the service, including both surveys and other numerical measurements gathered by independent data collectors, would be needed to better understand changes over time. Impacts should also be assessed in relation to actual usage patterns rather than only users versus non-users. At the same time, some methodological challenges may be difficult to address, such as spill-over effects of mobile phone use, leakage of information or isolating impacts where m-services offer multiple functions. Carefully designed experimental studies may help to address these challenges at least to some extent.

This paper offers a review of the literature with regard to the potential role of mAgri applications in the development and adoption of agricultural innovation among farmers. Similar reviews could also be carried out to assess impacts on other policy objectives, such as food security or smallholder livelihoods. Similar to the review presented here, such studies could set out a conceptual framework on potential impact pathways, assess available evidence and highlight research gaps. Such analyses will also be useful for the design and evaluation of mAgri services more generally by allowing service providers or researchers to develop success indicators to achieve the stated objective and assess the services against these indicators.
Note: A longer version of this paper has been submitted to the Journal of International Development.

6 References


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A Review of Research on Mobile Phones and Development Published in Three Top ICTD Journals (ITID, EJISDC and ITD) 2011-2015

Jean-Paul Van Belle & Selina L. Mudavanhu
Department of Information Systems, University of Cape Town
Private Bag, Rondebosch, 7701, South Africa
Jean-Paul.VanBelle@uct.ac.za

Abstract: Mobile technologies have been touted as a game-changer in the ICT- for-Development (ICTD) arena. This study set out to research if, in fact, this is reflected in the top ICT4D research publications. Surprisingly, only a relatively small proportion of the last 5 years’ publications in the top three ICT4D journals feature mobile phones: 68 out of 476. This paper presents a descriptive analysis of these papers, a reflection on how they conceptualized mobile technologies and the dominant domains of research.

Keywords
M4D research; Critical literature survey; Mobile technology conceptualization; empirical M4D studies

Introduction
The last decade has witnessed a phenomenal increase in subscriptions and innovative uses of mobile phones by individuals and organisations particularly in the global south (Niang and Scharff, 2014). With this, several researchers have invested time and resources trying to understand the link between mobile phones and development. In 2011, for example, the Information Technologies & International Development journal published a special issue on mobile telephony.

In addition to empirical studies, there is a growing body of work that reflects on the ideas that have been published in the Information-and-Communication-Technologies-for-Development (ICTD) field in general and the subgroup of Mobile(-Technologies)-for-Development (M4D) in particular. Examples of researchers who have reflected on the ICTD field include Chepken, Mugwanya, Blake and Marsden (2012) who provide an overview of ICTD technology interventions developed over a 15 year period (1995 – 2010). Dodson, Revi and Bennett (2012) examined 40 articles published in the Information Technologies &
International Development journal between 2003 and 2010. Their research identifies common patterns in projects that failed to meet their objectives for development. Gitau, Plantinga and Diga (2010) discuss the role that African scholars have played in the field of ICTD. They contended that in comparison to scholars from the West, there were very few scholars from Africa whose work has been published in academic publications. Raiti (2006) looks at the challenges of the ICTD field such as the lack of a spread of scholars across disciplines in a field that is typically multidisciplinary. Gomez (2013) conducted a content analysis of 948 articles that were published in peer reviewed journals and conference proceedings published between 2000 and 2010.

While the group of studies reviewing past ICTD research is small (Gosh et al, 2015), the studies that have reflected on mobile phones in relation to development are even fewer. Wamala Larsson and Svensson (2015) are among the few authors who have reflected on M4D research. Wamala Larsson and Svensson (2015) reviewed the M4D conference proceedings, focusing on the manner in which mobile communication platforms are used as tools for development. They also discuss the sectors that these mobile communication platforms have been used. Focusing specifically on research on mobile phones, Donner and Escobari, (2009) conducted a systematic review of studies on the use of mobile phones by micro and small enterprises (MSEs) in the global south. In a different study, Donner (2008) reviewed 200 peer reviewed articles whose focus was mobile phone use in developing countries.

This paper contributes to current reviews of research in the ICTD field in general and on mobile phones and development in particular by looking at articles on mobile phones that were published between 2011 and 2015 in three top ICTD journals (according to Heeks, 2010), Information Technologies and International Development - ITID, Electronic Journal of Information Systems in Developing Countries - EJISDC and Information Technology for Development – ITD. In that regard, this paper endeavours to respond to the following questions:

- What are the dominant characteristics of research on mobile phones published in the top three ICTD journals ITID, EJISDC and ITD?
- What routes could future M4D research potentially take?

The section that follows provides information about the journals that were included in this study.
About the ITID, EJISDC and ITD journals

Articles that were included in this review were published in the ITID journal, the EJISDC and the ITD journal between 2011 and 2015. These journals are listed as the top three ICTD journals on the Heeks (2010) list. Heeks contends that the ITID journal has an impact factor of 2.35 while the EJISDC has an impact factor of 2.31 and the ITD, 2.15.

The ITID journal started publishing in 2003 and produces an average of four issues per year while the EJISDC began publishing in 2000 and publishes an average of five issues per year. The ITD journal is the oldest of the three journals; it started publishing in 1986 and generally publishes four issues per year.

Regarding the sample used in this study, it is important to note that Heeks’ ranking was largely based on open source journals. This means that the authors of this paper did not analyse content published in subscription-based journals. Inclusion of these subscription-based publications had the potential of giving a much more comprehensive picture. It is also important to mention that Heeks’ ranking only focuses on ICT4D journals. This means that other interesting and important research on technologies and development published in non-ICT4D journals or in journals that are not techno-oriented are left out. In view of the above points, the authors of this paper recommend that future studies focus on the journals that were left in this research.

Research Design

In the first phase (paper selection), papers were included on the basis of having any of the following terms in their titles and/or lists of keywords (when available): ‘mobiles, mobile phones/cell phones, mobile phone technology and m(domain of development).

In the second phase, coding took place. The following information was recorded: title of paper, name of author(s), disciplinary affiliation of authors, keywords, type of paper (empirical research or reflection on concepts), research approach (for empirical papers), domain of development work, and conceptualisations of mobile phones.

Out of a total of 476 articles published in the three journals over the specified period of time, only 68 (14.3%) of them had the abovementioned terms in their titles and lists of keywords (see Table 1). Given the general optimism regarding the potential of mobile phones in bridging the digital divide in the global south, 68 articles across three journals over a five year period is very little. Although the authors of this paper acknowledge that these findings might not reflect the general trends in the field, based
on the results, there is need for more research that focuses on mobile phones.

**Table 1: Total number of articles studied**

<table>
<thead>
<tr>
<th>Journal</th>
<th>Total number of articles</th>
<th>“Mobil” Article*</th>
<th>Mobile/Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Technologies &amp; International Development journal (ITID)</td>
<td>150</td>
<td>27</td>
<td>18.0%</td>
</tr>
<tr>
<td>Electronic Journal of Information Systems in Developing Countries (EJISDC)</td>
<td>198</td>
<td>24</td>
<td>12.1%</td>
</tr>
<tr>
<td>Information Technology for Development journal (ITD)</td>
<td>128</td>
<td>17</td>
<td>13.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>476</strong></td>
<td><strong>68</strong></td>
<td><strong>14.3%</strong></td>
</tr>
</tbody>
</table>

*Have ‘mobile phones’/‘cellular phones’in titles and/or lists of keywords

**Findings**

**Empirical Studies**

The bulk of the articles that were published in the *ITD*, *ITID* and *EJISDC* journals were empirical papers. Common research foci included issues of adoption, expenditure, uses and impacts of mobile phones by individuals and organisations (Chew, Ilavarasan and Levy, 2015; Mwangi and Brown, 2015; Sam, 2015; Shaffril, Omar, D'Silva and Bolong, 2015; Dissanayeke and Wanigasundera, 2014; Ezenwa and Brooks, 2014; Wamuyu, 2014; Chib, Wilkin, Hua, 2013; Laguerre, 2013; Porter et al, 2012; Nchisc, Boateng, Shu and Mbarika, 2012; Schaub, 2012; Agüero, de Silva and Kang, 2011; Bankole, Bankole and Brown, 2011; de Silva, Ratnadiwakara and Zainudeen, 2011; Furuholt and Matotay, 2011; Islam and Gronlund, 2011; Salia, Nsowah-Nuamah and Steel, 2011; Zainudeen and Ratnadiwakara, 2011).

Writing in the Sri Lankan context, Dissanayeke and Wanigasundera (2014) discussed the ways in which mobile phones were used in a farming community in the North-Central province. In a different study, Schaub (2012) argued that mobile phones were central to the trans-Saharan migration process. Schaub (2012:126) wrote: “Phones are also shown to be used by migrants’ ‘helpers’ for the purpose of internal coordination.” Also writing about migration, Blumenstock (2012) focused on how internal migration patterns in Rwanda can be inferred using mobile phone call records. Porter et al (2012) were interested in understanding young people’s mobile phone usage and mobility in Ghana, Malawi and South Africa. Martin and Abbott (2011) analysed the ways in which farmers in rural Uganda engaged with
mobile phones.

Of the empirical papers published in the three journals, almost all the studies were conducted in the global south. Most studies were carried out in India, Kenya, Bangladesh and South Africa.

Table 2: Countries in which studies were conducted

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>10</td>
</tr>
<tr>
<td>Kenya</td>
<td>8</td>
</tr>
<tr>
<td>Bangladesh, South Africa</td>
<td>5 (each)</td>
</tr>
<tr>
<td>Sri Lanka, Uganda</td>
<td>4 (each)</td>
</tr>
<tr>
<td>Ghana, Nigeria, Pakistan, Philippines, Thailand</td>
<td>3 (each)</td>
</tr>
<tr>
<td>Indonesia, Malawi, Morocco, Rwanda, Singapore, Tanzania</td>
<td>2 (each)</td>
</tr>
<tr>
<td>China, Egypt, El Salvador, Haiti, Jamaica, Lesotho, Malaysia, Mexico, Niger, Palestine, Peru, Saudi Arabia, Sierra Leon, Zimbabwe</td>
<td>1 (each)</td>
</tr>
</tbody>
</table>

While a huge number of papers are empirical, conspicuous by their absence are papers that reflect on key concepts in the M4D field such as the meanings of development and the impact of mobile phones to the overall development goal. In the conclusion of their study, Martin and Abbott (2011) recommended that there is a need to have more studies to measure the actual impact of mobile phones. Beyond measuring, the authors of this paper propose that researchers should also consider other ways of reflecting and theorising impacts that are not necessarily quantitative in nature.

Research Approaches

Research on mobile phones published in the three journals has drawn on both quantitative and qualitative methodologies. Examples of quantitative studies include: Jain, Kumar and Singla, 2015; Shaffril, Omar, D'Silva and Bolong, 2015; Chib, Wilkin, Hua, 2013; Blumenstock, 2012; Blumenstock and Eagle, 2012; Bankole, Bankole and Brown, 2011. The following studies deployed qualitative methodologies: Aricat, 2015; Anwar and Johanson, 2015; Sam, 2015; Alqahtani, Al-Badi and Mayhew, 2014; Ezenwa and Brooks, 2014; Baro and Endouware, 2013; Rangaswamy
and Cutrell, 2013; Cáceres and Agüero, 2012; Schaub, 2012; Chigona, Lekwane, Westcott and Chigona, 2011; Furuhol and Matotay, 2011. Other studies have drawn on both approaches Muhanguzi and Kyobe, 2014; Jamison, Karlan and Raffer, 2013; Cáceres and Fernández-Ardévol, 2012; Porter et al, 2012; Martin and Abbott, 2011; de Silva, Ratnadiwakara and Zainudeen, 2011; Islam and Gronlund, 2011; Zainudeen and Ratnadiwakara, 2011. Similar to findings by Gomez (2013), there was a greater number of qualitative and mixed methods studies than quantitative researches. Despite this observation, it is encouraging that researchers approached questions of mobile telephony and development in a variety of ways.

**Disciplinary affiliation of authors**

It is important to mention that a large number of the authors did not include the departments to which they were affiliated to. This somehow limited the discussion around the disciplines that appear dominant in M4D research published in the three journals.

Of the authors that specified their disciplinary affiliations, the bulk were affiliated to Information Systems departments (also see Ghosh et al, 2015). Although it is not completely surprising that most authors of papers are located in Information Systems departments, it is, however, concerning given that the field of M4D is multidisciplinary (also see Ghosh et al, 2015).

**Conceptualisations of mobile phones**

An interesting observation about articles published in the *ITD, ITID* and *EJISDC* journals is that mobile phones were generally framed as having positive actual or perceived effects (see Martin and Abbott, 2011) on the lives of the users (Aricat, 2015; Baro and Endouware, 2013; Laguerre, 2013; Blumenstock, 2012; Schaub, 2012; Furuhol and Matotay, 2011; Salia, Nsowah-Nuamah and Steel, 2011; Islam and Gronlund, 2011; Martin and Abbott, 2011). The researchers, however, sometimes alluded to a few of the challenges that people have encountered in using mobile phones. Interestingly, these shortcomings do not necessarily detract from the perceived positive effects of using mobile phones.

In a study with fishermen in Malaysia, Shaffril, Omar, D'Silva and Bolong (2015) noted that mobile phones played a critical role in the fishermen’s personal lives as well as in their businesses. Working with blind masseurs in Indonesia, Anwar and Johanson (2015:1) found that “mobile phones play significant roles in micro-entrepreneurs’ perceived well-being.” The results of a study by Ochara and Mawela (2015) also painted an optimistic picture; mobile phones were regarded as having the potential to enable sustainability in e-participation. In a study focusing on the impacts of mobile
phones on the productivity of micro- and small enterprises in the carpentry and cabinet-making sector in Villa El Salvador, Cáceres and Agüero (2012:88) concluded that, “This study provides evidence of the positive, incremental effects of mobile telephone use on wood transformation microenterprises.” Baro and Endouware (2013) focused on the effects of mobile phones on the lives of rural communities in the Niger Delta region of Nigeria. They argued that mobile phones allowed the research participants to do a range of things which include communicating with family members in urban areas and facilitated a decrease in rural-urban migration by jobless youth. In a different study, Laguerre (2013) pointed to the progressive contributions that the internet and mobile phones had on the growth of the Haitian economy. Islam and Gronlund (2011) discussed the factors that affected mobile phone ownership and use by farmers in rural Bangladesh. Islam and Gronlund concluded that the farmers in their study had a positive attitude towards mobile phones and using them to access ‘professional’ information services. The only limitation that they highlighted is the need for the adaptation of useful services to the usage patterns in the local context.

Whereas most authors wrote glowingly about the results of the use of mobile phones on the lives of research participants, Carmody (2012) critiques the current discourse on the effects of mobile phones. Carmody contends that most of the literature falls into the modernisation paradigm which views development as moving from rich to poor parts of the world. Carmody (2012:1) explained, “While mobile phones are meant to help “flatten” the world and allow for economic development through facilitating connection between places, they often serve to reinforce the dynamics of uneven development.” Carmody (2012:12) continued, “Mobile phones have then been absorbed into, but have not transformed, economic structures in Africa. In fact, these inequitable structures produce poverty, as do mobile phones for many less powerful, if not quite powerless, people, when mobiles are inserted into the structures.”

In view of the observations by Carmody, the authors of this paper recommend that M4D researchers reflect critically on the effects of mobile phones on communities and businesses beyond the immediate and obvious successes.

Dominant domains of development work

Similar to the findings of the study by Gomez (2013), it appears as though most researchers were interested in the business and finance domains, particularly micro- and small enterprises and entrepreneurship (Anwar and Johanson, 2015; Chew, Ilavarasan and Levy, 2015; Johnson and Thakur, 2015; Kabanda and Brown, 2015; Mwangi and Brown, 2015; Muhanguzi and Kyobe, 2014; Cáceres and Agüero, 2012;
Ilahiane and Sherry, 2012; Rabayah and Qalalwi, 2011). Other researchers focused purely on finance (Kusimba, Yang and Chawla, 2015; Renteria, 2015; Alqahtani, Al-Badi and Mayhew, 2014; Harry, Sewchurran and Brown, 2014; Wamuyu, 2014; Bankole, Bankole and Brown, 2011). Ranking of domains are given in Table 3.

**Table 3: Top domains that researchers focused on across the three journals**

<table>
<thead>
<tr>
<th>Domain name</th>
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<tr>
<td>1. Micro- and- small enterprises and entrepreneurship</td>
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<td>2. Finance</td>
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<tr>
<td>3. Agriculture/farming</td>
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<td>4. Migration</td>
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<td>5. Health</td>
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<tr>
<td>6. Fishing</td>
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<tr>
<td>7. Education</td>
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Other domains that were dominant in this study include agriculture/farming (Baumüller, 2015; Jain, Kumar and Singla, 2015; Dissanayeke and Wanigasundera, 2014; Muthiah, Prashant, Umadikar and Karthikeyan, 2013; Vincent and Cull, 2013; Furuholtt and Matotay, 2011; Islam and Gronlund, 2011; Martin and Abbott, 2011) and migration (Aricat, 2015; Yin, 2014; Chib, Wilkin, Hua, 2013; Blumenstock, 2012; Schaub, 2012). Similar to findings by Wamala Larsson and Svensson (2015), health also featured in this study as a domain that researchers focused on (Kumar, 2015; Ezenwa and Brooks, 2014; Matavire and Manda, 2014; Jamison, Karlan and Raffer, 2013; Nchise, Boateng, Shu and Mbarika, 2012).

To a lesser extent, the fishing industry (Shaffril, Omar, D'Silva and Bolong, 2015; Srinivasan and Burrell, 2015; Salia, Nsowah-Nuamah and Steel, 2011) and education (Jobe and Hansson, 2014) appeared on the list of domains that researchers focused on. While the above domains are crucial to focus on, there is a need for researchers to add other domains in order to get a much more comprehensive picture of the impact of mobile phones.

**Conclusion**
Looking at research published in the three journals focusing specifically on mobile phones, it is encouraging that researchers draw on a variety of research approaches. This should be commended as it allows for a much more holistic understanding of the topic.
Beyond identifying dominant trends in research published in the *ITID, EJISDC* and the *ITD* journals, the aim of this paper was to suggest potential routes future M4D research could take. One of the key findings of this paper is that current research on mobile phones and development tends to be empirical. In addition to the empirical papers, the authors recommend that researchers also write reflective theoretical papers on topics such as the meanings of mobile development as well as the different kinds of impacts.

The dominance of researchers from Information Systems departments in ICTD and M4D research needs to be addressed. While there is an acknowledgement of the importance of working across disciplines, there is need for ICTD scholars to deliberate practical ways of how this could be done. Conferences could be spaces in which this can be concretely discussed.

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Shrinking towards the people: tailoring electronic communication media solutions to community needs.

Jude Mukundane
Email: jude.mukundane@m-iti.org
Tel: +351 964 236 527

Christopher Csikszentmihalyi
Email: csik@m-iti.org

Madeira Interactive Technologies Institute
Polo Científico e Tecnológico da Madeira, floor -2
Caminho da Penteada, 9020-105 Funchal, Portugal

Abstract: Advances in communication technology have connected much of the African continent. Fiber cable and radio waves facilitate communication between entities that are very far apart geographically. Yet while ICTs facilitate communications between the farthest ends of the earth, a significant portion of the planet’s citizens find themselves economically excluded from these technologies. Many of these communities depend on FM radio and basic GSM services (voice and SMS) to communicate, but while these technologies increase access to information, their affordances do not serve the important role of public intra-community dialog outside of urban centers. This paper examines attempts at tailoring GSM and FM radio technologies to the needs of small rural communities, based on early results from RootIO, a project conducted in Uganda by the authors to enable grassroots agricultural communities to setup and operate their own low-power FM radio stations, and drawing parallels with projects that have attempted similar tailoring with GSM telephone networks.

Introduction
The Internet, in its contemporary form, is estimated to have touched at least 40 percent of the world’s population [11], a tremendous number given its relatively short history, infrastructure requirements, and the fact that it was preceded by widespread electronic communication media. But usage of the
Internet is largely skewed - the 40 percent average comprises of some communities that boast of more than 80 percent usage, while others have much lower rates of penetration. The biggest correlations to low Internet adoption are reduced literacy levels, lack of infrastructure, and economic need [13], so it is no surprise that the least penetration of the Internet is registered in regions that are generally categorized as developing.

There are however media that thrive in these regions despite these obstacles -- FM radio receiver ownership and use in many communities in the developing region is upwards of 80% [1]. But this is reception of broadcast media, which while valuable, is only one stratum in the possible topography of information exchange. The Internet has demonstrated the power of new form of interaction like fora and bulletin boards, online markets, online systems to facilitate peer production, and many others to benefit individuals and communities. These participatory media are extremely useful for communities, but broadcast does not facilitate them well. How might we enable the lowest-placed communities on the socio-economic scale more access to participatory electronic media, beyond broadcast? First, we will describe why peer-oriented participatory media might be important for rural communities. Next we will describe the advantages and shortcomings of traditional FM broadcast and GSM. After that we will introduce our project, RootIO, which aims to reduce the size and cost of FM to the point where it is affordable enough to rural communities that it “shrinks” from top-down broadcast to a more intra-community participatory platform.

The need for intra-community information supplementing top-down information

Communities need information from the outside, like national or international news, market reports, or information from organizations like the government, the WHO, or UNICEF. For many rural communities on the African continent, this often comes through radio, but possibly also through personal communications with community health workers (CHW) or agricultural extension officers. Doors, walls, notice boards, and trees in rural areas in Uganda spot all sorts of hand-written or cheaply printed posters with all manner of information. These posters are strategically placed in areas that attract considerable human presence, such as churches, hospitals, local government
offices, or by the sides of busy roads. These are augmented by mobile electronic-enhanced media in the form of community announcers on foot or bicycles armed with megaphones announcing messages sourced from within these communities.

But top-down communication has its limits, and various groups have developed ways of augmenting, contextualizing, and internalizing it. Still others recognize the need for horizontal communication: in Apac district in northern Uganda, Kubere Information Center, a community based organization (CBO), records tales from successful farmers and replays these recordings to other communities in group listening and dialog sessions [12] in an effort to transplant local knowledge from one community to another. This type of inter-community communication is far less facilitated throughout the continent than top-down, but it allows the spread of relevant local innovations. In rural Uganda, discussion groups convened by community-based health workers, microfinance institutions, religious organizations and NGOs -- to mention just a few common actors -- are a common scene. Worth noting here is that a lot of the information exchanged in the aforementioned programs is information generated by global research and practice, then delivered into these communities by predominantly top-down broadcast media, but enriched, interpreted, and localized by community-specific participatory practices. Similar “radio listening” groups meet around the world to discuss and interpret programs. Strong communities both receive new knowledge but may also reject or reinterpret it as appropriate, using tools and resources available within those communities. To use an agricultural analogy, it can be said that top-down information is like rain to the resilience of these communities, while lateral intra-community dialog is like soil -- the absence of any of the two stunts community resilience.

The evolution of electronic communication media has ping-ponged throughout its history from broadcast models to horizontal ones, unicast models, and more recently, to the multicast models that are very prominent in social media platforms [14]. These new models however have been largely supported by the Internet, whose access has proven challenging. In more than two thirds of the sub-saharan African countries for which data was available in 2014, Internet access costs ranged from 19% to more than 100% of the GDP per capita[10]. This same region as of 2015 had an estimated 35% of its population living below the poverty line[20]. Broadband penetration in Africa averaged at 17.4% in
2015[1], making the Internet an expensive and rare commodity to many users in Africa. Given the aforementioned hindrances to the use of the Internet by poor and rural communities, and the comparative ubiquity of FM radio and GSM Telephony, can these latter media be repurposed beyond their current broadcast and unicast uses to facilitate other topographies more suitable for inter- and intra-community dialog and exchange?

**FM radio and GSM as a complete but inefficient electronic media ecosystem**

Keeping the focus on low-income rural communities, we note the abundance of two forms of media whose use and availability almost entirely make up the picture of the electronic communication media ecosystem at this level. Beginning with FM radio, surveys in Kenya, Nigeria, Senegal and Tanzania estimate FM radio access in 2016 at 90 percent, with usage ranging from 76 to 86 percent [1]. Typical FM radio stations in these countries, licensed as commercial stations, are usually large -- covering millions of users -- and do not delve into the specific language, lifestyle, and economic peculiarities of communities that constitute their listenership. Lobbying from international organizations led to establishment of community FM radio stations to spur community inclusion and dialog, but In Uganda for example, two of the stations categorized as community each have a reach of more than five million listeners. Participation on FM radio is very low in Uganda - surveys conducted prior to the installation of our four RootIO stations in rural areas revealed that fewer than 1 percent of the listeners had ever called into FM radio stations for any sort of participation. It is also worth noting that none of the listeners surveyed had used the radio stations to procure or advertise a good or service. The bulk of the advertisement and information on typical FM radio stations in Uganda is from entities operating at a national or regional level, with whatever space left being dominated by district level entities. Commercial and regional FM radio has very little time for -- or interest in -- those at the bottom of the social, political and economic scales.

Mobile telephony, on the other hand, is present in many of these communities in the form of GSM, which allows for basic voice calls and SMS [7]. With very little penetration of smartphones, [1] voice calls and SMS -- supported by all feature
phones -- are still major sources of income for telecommunication companies. But access doesn’t necessarily mean use, and connectivity does not always increase. The use of mobile phones to exchange information is very low compared to their access and availability of GSM network. Nigeria, a leading African GSM market in Africa reported average usage of less than five minutes per week by mobile phone subscribers in 2012 [6]. Reduced average revenues per user have resulted in telecom companies rolling back network coverage in some areas, and in some extreme cases, totally exiting markets [3]. There is a desire to use telecommunication services in these communities - it is estimated that the real number of active subscribers in African markets for example is half of all registered subscribers, given that many subscribers possess SIM cards from more than one telecommunication provider in order to enjoy price reduction benefit [8]. This trend also shows that the prices of communication are inhibitive, to the extent that subscribers are willing to invest in extra communication hardware to circumvent these costs. Attempts to reduce these prices resulted in telecom price wars in Uganda [3] for example, contributed significantly to the aforementioned exit of telecommunication companies from markets. As a result, the use of GSM telephony is very low - much lower than coverage permits, due to cost constraints for the plurality of users in poor and rural areas.

It can therefore be seen that communities at the bottom of the social economic scale have electronic media that allows them to both receive broadcast information and send unicast information. However, FM radio and GSM networks in rural settings are exposed to relatively weak revenue bases, unreliable power supply and shortage of skilled labor -- all of which leave their sustainability, let alone profitability, wanting. These media are supplemented by community specific initiatives that attempt to give some sort of multicast communication channel to members of these communities.

**Attempts to shrink FM radio: RootIO**

The RootIO project at its core seeks to enable rural farmers to use FM radio for multicast exchange of information within their communities. Communities that depend on FM radio the most for their information needs are also the ones that have the least access to the input channels of FM radio. RootIO
seeks to make coverage of radio stations smaller, cheaper to set up, and less labor intensive to run - on a scale considered micro even when compared to stations licensed as community broadcasters in Uganda. The idea was that small stations put less financial demand on the communities hosting them, but are also appropriately sized for most of the information being exchanged in these communities [5] through the aforementioned improvised solutions. RootIO stations were also designed to have input channels that are easily accessible, more likely to be inclusive, and be inexpensive to use. Although still ongoing, the pilot phase of RootIO -- four low-power radio stations in different communities in northern Uganda running for over a year -- has yielded results that look promising. Below are some achievements and challenges experienced by the RootIO project in scaling down FM radio to a size that is both appropriate for and sustainable by socio-economically low-lying communities.

**Methodology**

*Research design*

As implementers of the RootIO project, we have used qualitative and quantitative approaches to assess the impacts that RootIO stations have had in the communities where they are deployed in Northern Uganda. Our main concern is improvement of the system, but also to learn more about how ICTs that focus on peer-oriented communication might work in rural communities that typically receive top-down information. This paper is an attempt to share some of our observations and results. It aggregates three primary sources of information on the impacts of the stations and network. First, we conducted focus group discussions in two of four communities to assay their experiences managing, using, and listening to RootIO stations, and to identify novel usage trends and challenges in the operation and role of these stations. Second, field workers constantly engaged with community members to probe for information of interest and listen to issues originating from individual communities, which issues were then investigated in other communities. Third, the RootIO system itself constantly generates and logs quantitative data, as well as mixed data like audio files of programs produced within the community. We leverage all three types of data throughout this paper.

*Participant selection and composition*

Participants for focus group discussions were selected to equally represent
gender, age groups and occupations. For the initial survey, between 20 and 24 key informants were selected from each community and held guided discussions. In order to encourage unfettered speech, the focus groups were separated into men, women and youth. For technical and statistical information regarding key community statistics, local government administrators were consulted, being the custodians of this information at the community level.

**Data Collection and Analysis**

Data from the focus group discussions was formulated into community perspectives, respecting any differences that were expressed by particular groups. These were further compiled into community specific reports. Subsequent key informant interviews were conducted with the management entities and corpora of volunteers performing different activities for these stations. The qualitative information from these discussions was used to infer the level of appreciation of RootIO stations in communities of deployments. Quantitative data for performance of the stations was taken from logs obtained from the central server that controls the scheduling and telephony systems for RootIO stations. This data was tabulated and used to calculate quantities that reflect the technical performance of RootIO stations.

**Limitations**

Owing to the scale of the RootIO project, differences between individual stations that would typically be considered subtle took on a larger scale. For example going from a district to sub-county or lower meant that surveyed communities could be entirely engaged in one kind of economic activity, due to geographic situation. The results of studies in individual communities could therefore not be aggregated given their community specificity.

**Achievements of the RootIO project**

Taking the case of a RootIO station deployed at Gwokke-Keni, a community based organization in Patongo town, in Agago district of Northern Uganda; the following successes were registered along the different dimensions considered:

*Economic*: Gwokke-Keni used to spend close to 300 dollars to run a one-hour
talk show on a regional FM radio station in northern Uganda. After accepting to host and manage a RootIO station, Gwokke-Keni has free airtime that they can use to disseminate knowledge in the interest of the community. The station is administered by a volunteer group of youth who help diverse categories of people to host and participate in talk shows. At one point, the station had approximately 170 US dollars in savings from community adverts and announcements.

**Inclusion:** The RootIO station in Patongo has opened up space for content that before could not contend for regional airwaves. Hyper-local sports events (high school football matches) are now covered, unlike before, and the most frequent callers are market women. The FM radio stations that were available in the community before RootIO were at least four hours away by bus, and receive their feedback from SMS and social media, dominated by the youth. Gwoke-Keni is itself an organization that was stigmatized due to its alliance with persons living with HIV. The station however has transformed Gwokke-Keni from a stigmatized organization to a meeting point for the community.

**Human resource:** Currently the RootIO station in Patongo is run entirely by volunteers. The station only covers their costs in case they need to travel to cover events far from station premises. The station relies on pre-produced shows from various media houses to add regional, national and international information to the mix of the station’s programming. All these stations have to do is “subscribe” to these media houses and add their programming to the schedule. This greatly reduces the number of people necessary to run the station.

**Technological:** RootIO demonstrated that scaling down FM radio technology does not destroy its utility. RootIO stations, though comprised of cheaper infrastructure and covering smaller areas compared to typical FM radio stations, offer services that are better tailored to the communities they serve. RootIO builds on a Civic Media platform model [4] availing sharable components in a shared online platform that allows for any community based practitioners to set up a RootIO station, upon obtention of a license from their communications regulator, using readily available off-the-shelf equipment.

**Social:** RootIO stations have more social grounding in the communities where they are deployed. The station in Patongo has programming customized to the
patterns and needs of the community. Current practice, such as calling the station to report lost animals, or deeming that death announcements should be free to air, is not common to typical FM radio stations but totally makes sense in the Patongo context.

Challenges faced by the RootIO project and similarly scaled projects for village-based telecommunication.

The RootIO project was not without challenges. Given its novelty, RootIO was headed for some new challenges as well as challenges that have been associated for long with technology projects in rural regions of developing countries [2]. RootIO faced a number of issues and while it can be said for some that a solution was arrived at that permitted for the setup and operation of RootIO stations, the solutions for the rest of the problems remains on the horizon with plausible ideas already conceived.

Regulation: Existing regulation was designed with large electronic media in mind and in many cases entities attempting to gain access to the media space with intent of developing small community based technologies cannot afford - both financially and bureaucratically, to overcome regulatory hurdles. RootIO waited a year to get licenses to pilot four stations in Northern Uganda. Regulators in most cases are presented with community initiatives that do not fit in licensing regimes and the least progressive ones refuse to make provision for these initiatives, leaving community operators with options of operating illegally, or using less efficient technologies to circumvent regulation barriers [16].

Social: Social cohesion is key for community initiatives to thrive. In the absence of revenues to pay dedicated staff, community initiatives at the scale of RootIO stations are left to depend on volunteers to some extent to get their work done. RootIO stations have demonstrated that identification of devoted and talented local volunteers is necessary if the stations are to thrive. Unfortunately, there is demand for talent even at this level and good volunteers are often affiliated with multiple other projects or leave these communities in search of better livelihoods. Failure to identify local volunteers results in missing good opportunities such as those mentioned above to tailor services delivered by these technologies to the communities in which they are based.
**Power and Infrastructure:** In rural areas of developing countries, access to reliable electricity is still a challenge. Many of these communities being situated off the electricity grid means any electronic technology initiatives with considerable energy requirements have to invest in expensive energy options such as solar energy and fuel powered generators which are not cheap and put inhibitive costs in the way of scaling these solutions to more communities [19]. Each RootIO station was setup with solar equipment worth roughly 1500 US dollars.

**Economic barriers:** Community-level technology solutions can be much cheaper than commercial large-scale alternatives. These solutions are still untenable financially by the communities they serve partly because members of these communities have limited income, but in discussions held with members benefiting from RootIO stations, it was revealed that many of these communities have gotten used to donations for most services, a mentality stemming from massive “NGO-Ization” [19] as a result of government insufficiencies and inefficiencies.

**Technological:** While community level electronic technology interventions attempt to lower technology to these communities, they expose them to technology components that they otherwise would not have to worry about. As such, these interventions require some sort of technology “sagesse” in these communities to a level that can fix the basic technological failures. It is also common that many technology projects are implemented by technologists from without the community, and inadvertently result in a communal feeling of constraint to the user-facing side of these technologies with limited contribution to the design and deployment of these technologies. Interactions with beneficiaries of RootIO stations revealed a desire by communities to own and control the technology that makes these stations possible.

**Lessons that can be learned from RootIO and village-based telecommunication projects**

Community-level solutions to technology problems have great potential to impact the communities in which they are deployed mostly because they shrink technology to fit these communities. These technologies however find themselves facing challenges that are either easily addressed by the models of
large-scale deployments, or simply not existent to the effect that there is no
generic way to address them. Nevertheless, lessons from village level GSM and
more recently FM radio deployments, bearing the same problems, can benefit
from approaches listed below that were arrived at during the pilot phase of
RootIO stations in Northern Uganda:

- Community technology solutions should not only be sanctioned by
  regulatory authorities for pilot studies but also planned for in the long
  run. Involving regulators and actively advocating for provisions for
  smaller communities in policy makes the environment more conducive
  for similar initiatives as opposed to “enclave” deployments that can not
  be replicated, and less efficient technological improvisations [16]. Mobile
  number portability [18] for example can help new small-scale entrants
  into the telecommunication market, but is not advocated for by village
  based telecommunication projects.

- Local populations should be involved in all phases of community technology
  projects, right from design to the support phase post deployment. While
  it is possible to propose usage cases basing from common practice, the
  risk is missing out on nuances and opportunities in particular
  communities that can be used to better mould technologies to needs of
  particular communities.

- In line with the above observation, it is not enough to avail these
  technologies to poor and rural communities but to also work with them
  to build products and services around them that strengthen support for
  these technologies. East Africa for example is full of flourishing communal initiatives such as microfinance organizations
  and transport investments [15] which demonstrate entrepreneurial
  potential and problem-solving potential given understanding of
  opportunities within even communities at the low end of the social,
  economic, and political power scales.

- Community level technology initiatives should centralize technologies,
  allowing for the creation of a platform that can be used to launch
  similar solutions. Taking an example of village level telecommunication
  companies [16][21], each of these focuses on building community
  telecommunication entities from the ground up, however building a
  platform that is globally accessible incorporating sharable components
  would make it easier for community based technologists to scale these
initiatives with limited external intervention. Documented installations of village level telecommunication companies exhibit little possibility of setup without the team of engineers core to their design. While large commercial players have standardized systems for commercial grade deployments that are capable of interacting, some of the most cited village level deployments do not demonstrate this level of decoupling.

- Partnerships with larger-scale commercial operators should be examined where possible. RootIO for example in one community established rapport with an existing FM radio station to relay some of the latter's programming. Partnerships with bigger players means that smaller operators can bring some of the hard-to-implement services such as mobile money [7] to communities, in exchange for services such as interconnection that are largely untenable for small operators. By so doing, community technologies add to the available quality rather than substitute it.

Conclusion and way forward
While research continues to produce new and better electronic media technologies, and their adoption is relatively fast, a considerable population of earth's population has little or no access to these innovations. Enough generations of new technologies have bypassed these rural communities that to “just wait” is a disingenuous policy choice. This warrants research into improving the electronic media which are used the most in these communities. By scaling down, community-level ICT projects have chosen to focus on a particular segment of the bigger distribution and therefore have to deal with the resulting difference in financial, social and technological distributions - merely scaling down on approaches taken by the large scale commercial operators is not sufficient.

Having assessed the popularity of the two technologies (FM radio and GSM telephony) that are prominently used by communities at the lowest level of the socio-economic scale, our research will now focus on the use of platform architectures that can be deployed to create synergies that make hyper-local FM radio stations and telecom companies more resilient and sustainable given their tough choice of operating environment. Three propositions emerge out of
the study of distinct initiatives to scale FM radio and GSM telephony to “grassroots” levels:

- RootIO will seek to create a platform architecture that centralizes technological, skill, and possibly regulatory requirements, abstracting them from communities and thereby making it easier for communities to set up hyper-local community FM stations and telecommunication deployments.

- FM radio and GSM telephony, almost entirely constituting the electronic media space in the communities lowest on the socio-economic scale, would yield richer interactivity if these communities had more autonomy resulting from devolving control of these media to within these communities. We will devote time, as part of the RootIO project to exploring a composite network made up of GSM telephony and FM radio, allowing for peer-to-peer and broadcast communication, similar to what is possible with social media through the Internet.

- We will seek to identify the systemic limitations to usage and ownership of these communication technologies at grassroots community level, and try to design towards circumventing them, with the goal that people who depend on a medium the most are best placed to innovate around it and come up with social customizations that make its technologies more fit to these communities.

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An ANT assessment of m-business model of the “Dumsor rechargeable phone” in Ghana

Kweku Koranteng
PhD Candidate SUN
Research Fellow
kweku.koranteng@gmail.com

Abstract: The purpose of this study is to understand how constraints, cultures and context engenders technology adoption behavior in a developing country. Within the developing country, literature points to culture as a barrier to some technology adoption. This paper presents a unique adoption model emerging from the developing country context. Despite calls for cultural fit and contextual empirical evidence, studies on technological cultural fit remain limited. This study follows actor-network theory (ANT) as a lens and interpretive case study as a methodology to understand how a feature phone adoption become rife during the peak of Ghana’s historic power crises (Dumsor). The study further explored the business model that accounted for its success and lessons to be drawn to shape the adoption narrative within ICTD literature. The findings demonstrate an enabling perspective of developing country culture, complementing the dominant constraining view in the literature. The paper argues that although mobile phones emerged from the developed world, it could be malleable to varied contexts and be reflective of the socio-cultural and political aspiration of its users. The paper encourages developing country entrepreneurs and researchers to seek ways to align mobile interface design and application to local contexts as in the case under review.

Keywords: Mobile phone adoption, technology adoption models

Introduction

Ghana has one of the fastest growing mobile markets in sub-Saharan Africa. It has more mobile subscription than it population. There are more mobile phones than the population of Ghana. Mobile phone adoption and usage enjoyed dramatic and almost unprecedented success as far as the history of mobile technology adoption in Africa is concerned. Ghana’s mobile phone
ecosystem presents unique challenges and opportunities, as the electricity crisis hit the industry, leading to the emerging cases of resilience on both sides of the provider and consumer. The essence of this study is to examine the contextual factors such as the lack of electricity influencing the design of mobile phones that allow for power storage. These phones have the capacity to provide electric power for basic household appliances such as light, radio etc. The second part also exams the socio-cultural factors that may have contributed to its adoption through informal market channels.

The action network theory was proposed to help in examining the observed trend and the ensuing m-business model was developed.

Background

Indeed, mobile phone adoption has been researched from a variety of perspectives, for example, sociology (Geser, 2006; Ling, 2005), computer supported cooperative work (CSCW) (Brown and Randell, 2004; Green et al, 2001), information systems (Kleijnen al, 2004; Roberts, 2004) and from human-computer interaction (HCI) (Jones and Marsden, 2005; Kiljander, 2004). However, the issue lacking is a model that carefully integrates contextual challenges into design choices. Most literature point to technology adoption models and strategies designed to match mobile phone design to user's technological needs and expectations. On the other hand, there are limited studies that show the reverse, where needs and constraints influence design choices.

Ghanaian Context

According to Ghana Standard Living Survey (2014) mobile phone ownership at the household level is 80% hence making it the most sought for household device followed by television, radio set and refrigerator(#Ref). Ghana’s promising growth record in 2011 which posted an outstanding GDP rate of 14% was short lived with the looming power crisis in 2012. Ghana claims to have the fastest connection speeds in Africa. Ghana’s approach to building an ecosystem for Internet growth has focused on establishing a networked infrastructure and promoting government as an early adopter. It also boasts of high mobile telephony and fiber penetration in the sub-region.

Ghana currently has the largest mobile broadband subscriber base in Africa, suggesting the opportunity for domestic software developers to create platforms for the local market that may be extended to countries with much higher broadband penetration.
Methodology

In order to gain in-depth understanding of the case for the study, there is the need to appreciate the methodology adopted. This study follows a qualitative, interpretive case study approach in information systems (Walsham, 1995; 2006; Klein and Myers, 1999; Barrett and Walsham, 2004). The approach seeks to understand information systems development, implementation and use as social constructions (Myers, 1997; 2009; Trauth, 2001) and their interactions with their contexts (Walsham, 1993). Rather than seek objectivity, interpretive research considers reality and knowledge as socially constructed between the researcher and the participants (Walsham, 2006; Klein and Myers, 1999) and situated in socio-cultural contexts (Walsham, 1995; 2006). Interpretive case study has therefore been identified as appropriate for investigating information systems in real-life context (Walsham, 1995; Myers, 2009). It has also increasingly become a preferred methodology for actor-network based studies in information systems research (e.g. Cho et al., 2008; Rodon et al., 2008; Sarker et al., 2006; Thapa, 2011). As this study concerns mobile adoption in developing context and is guided by ANT, interpretive case study is considered the suitable methodology.

Research Setting and Data Gathering

This study forms part of a larger multiple-case study to understand ICT and business Development in Ghana(#ref). The setting for the study is Ghana, a developing country in West Africa with rich traditions and illustrious history on the continent. The fieldwork for the project occurred between June to December 2015. The current study concerns a small mobile adoption behaviour among mobile phone users in Ghana associated with the acute power cuts in the country.

Data collection

The case was found interesting as it offered the opportunity to understand the positive contribution of a Ghanaian context to mobile adoption, a contrast to the dominantly negative perception in the literature. The study gathered qualitative data from multiple sources (Walsham, 1995; 2006) including, semi-structured interviews, online search and participant observation through use of device and related artifacts. The researcher conducted an unstructured interview with 15 participants. In unstructured interviews, questions are not prearranged (Rogers, 1945). Fontana and Frey (1994) therefore see the unstructured interviewing technique to provide a greater breadth than the other types, given its qualitative nature. The participants included the entrepreneur, who is also the phone vendor, 5 phone repairers, 4 distributors and 6 regular users. The interactive questions focused on reasons for usage of the device and application within the context of use and non-human actors. The average duration of each interview was between 30 minutes to an hour, was tape recorded following participant’s consent and subsequently transcribed. The study gathered
additional data through participant observation of artifacts through a series of
demonstrations conducted by the vendors of the phones, its content and
innovation uses. After the fieldwork, the researchers presented initial findings
to the organization in two separate meetings. The meetings offered opportunity
for data verification and additional data from participants.

Theoretical Foundation

Actor-Network Theory (ANT)

ANT originated from the works of three researchers in science and technology
studies: Bruno Latour (e.g., Latour, 1987; 2005), John Law (e.g., Law and
Callon, 1992) and Michael Callon (e.g., Callon, 1986a; 1986b). The theory is
cconcerned with performative interactions between human and non-human
actors and how they converge to form sociotechnical networks of aligned
interests (Latour, 2005). ANT draws on a number of concepts. The
fundamental ones are summarized in Table 1. Of these, this study draws more
on actor, actor-network, translation and inscription.

<table>
<thead>
<tr>
<th>Actor (or actant)</th>
<th>Both human beings and nonhuman actors such as technological</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actor-Network</td>
<td>Heterogeneous network of aligned interest, including people, organizations and standards</td>
</tr>
<tr>
<td>Enrolment and Translation</td>
<td>Creating body of allies, human and nonhuman, through a process of translating their interests to be aligned with the actor-network</td>
</tr>
<tr>
<td>Delegates and Inscription</td>
<td>Delegates are actors who “stand in and speak for” particular viewpoints which have been inscribed in them, e.g., software as frozen organizational discourse</td>
</tr>
<tr>
<td>Irreversibility</td>
<td>The degree to which it is subsequently impossible to go back to point where alternative possibilities exists.</td>
</tr>
<tr>
<td>Black Box</td>
<td>A frozen network element, often with properties of irreversibility</td>
</tr>
<tr>
<td>Immutable mobile</td>
<td>Network element with strong properties of irreversibility, and effects which transcend time and place, e.g., software standards</td>
</tr>
</tbody>
</table>

Whereas some theories attribute agency - ability to act - to humans only, a
distinguishing feature of ANT is that both humans and non-humans are
endowed with agency (Latour, 2005). In ANT terms, actors refer to both
human and non-human entities or social and technical entities (Law, 1987; Latour, 2005). An actor can therefore be a person (human), an object such as technology (non-human), or a concept such as culture (non-human).

Callon (1986b) outlines three fundamental principles for ANT: agnosticism (impartiality of a researcher towards humans and non-humans), generalized symmetry (researcher’s commitment to treat humans and non-humans equally), and free association (eschewing separation between humans and non-humans).
ANT researchers therefore account for both human and non-human actors, investigating them from the same viewpoint and treating them equally.

The ANT concept of translation is used to explain how heterogeneous actors are brought together to form actor-networks. The actor who plays this role is called the focal actor (Latour, 1988; Heeks and Stanforth, 2007). Inscription involves embedding the interests and values of actors into technological artifacts (Akrich, 1992; Leonardi, 2009; Rodon et al., 2008) and can occur as part of translation.

A number of factors informed the choice of ANT for this study. First, this research acknowledges not only the role of human actors such as the entrepreneur, but also that of non-humans such as mobile phone technology and culture. By avoiding technological or social determinism, ANT escapes the problem of separating the social from the technical (Rose et al., 2005; Tatnall, 2009). By this, this study accounts for the contribution of all relevant actors regardless of their nature.

Walsham (1995) and Eisenhardt (1989) outline three uses of theory in information system research: to guide initial research design and data gathering, to guide data gathering and analysis, and as a final output from a study. In this work, ANT was used more in the second sense to guide data collection and analysis. Alternative theories such as technology acceptance model (Davis, 1989; Davis et al., 1989) and diffusion of innovation theory (Rogers, 1995) are well noted for investigating information system innovation processes. However, their limitations in accounting for agency of both humans and non-humans and for complex interaction between technology and organization are well noted (Tatnall, 2009; Orlikowski and Scott, 2008; Holstrom and Robey, 2005).

Translation Process and Inscription

The primary empirical focus of actor-network analysis is to investigate innovation processes through translation (Walsham, 1997; Latour, 1987; Callon, 1986b; Tatnall, 2009). Within information systems research, translation has been found useful for investigating system development, implementation, use and maintenance (Tatnall, 2009; Walsham and Sahay, 2006; Walsham, 1997). Callon (1986b) outlines four moments of translation: problematization, interessement, enrolment and mobilization. These are summarized in Table 2 and explained below.

**Problematization** is the initial planning phase where an entrepreneur or a focal actor identifies problems and interests of other potential actors, proposes an innovation as a solution to their problems and suggests roles for them to help develop the innovation. The focal actor conceives the innovation as an
obligatory passage point, the conduit through which interested actors would have to pass to address their problems and satisfy their goals. Callon (1986b) summarizes problematization as a proposed system of alliance between entities, which define their identity and their interests. During interessement, the focal actor persuades the proposed actors to join the innovation and accept their assigned roles. During enrolment, the focal actor negotiates with actors who would have accepted to join the network to perform their roles. During mobilization, the network gets established as actor’s interest aligned. Besides, the enrolled actors themselves become spokespersons, persuading more actors to join the network. Therefore, this study considers it appropriate for studying m-business formation through human and non-human interactions.

Table 2: Moments of Translation (Callon, 1986b)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problematization</td>
<td>A focal actor identifies other actors and their interests, proposes an innovation network as ‘obligatory passage point’ (OPP) through which the actors can satisfy their interests. The focal actor also suggests actor-network roles for them.</td>
</tr>
<tr>
<td>Interessement</td>
<td>The focal actor adopts various tactics and techniques to persuade the other actors to accept the innovation and the proposed roles.</td>
</tr>
<tr>
<td>Enrolment</td>
<td>Depending on the outcome of interessement, the focal actor coordinates the enrolment of actors who accept to join the network.</td>
</tr>
<tr>
<td>Mobilization</td>
<td>If enough actors get enrolled, the network becomes stable. The enrolled actors also become spokespersons for the network, helping to enroll more actors.</td>
</tr>
</tbody>
</table>

Inscription occurs as part of translation and involves the process of embedding scripts of actions, interests and behaviors into technological artifacts (Sarker et al., 2006; Shin et al., 2010; Cressman, 2009). For information systems, inscription may include programs of action for users and other stakeholders, their roles and interests (Holstrom and Robey, 2005). Inscription media in information system may include software, hardware, manuals, standards, processes and procedures. By undergoing inscription, the media also becomes an actor. In this study, inscription involves the process of embedding cultural values, contextual needs and traditions into technological artefact such as the “Dumsor Rechargeable phone.

Discussion of Preliminary findings

The purpose of this study has been to understand how developing country culture, context relevance to mobile phone usage. The identification of the Dumsor Chargeable phone in this study presents an alternative, positive perspective of developing country strong culture connections to product and service adoption. In applying the Actor-Network Theory, as a social actor, the Ghanaian culture of “who you know” contributed to the formation and
Case Study- Dumsor Rechargeable Phone

The emergence of the “Dumsor Rechargeable Phone” (Galace SQ) in response to the acute power challenges in Ghana since 2012 is example of contextual needs being addressed by market response. The “Dumsor Rechargeable Phone” is a basic feature phone with an attached power bank that has the capacity to charge other devices. It has three simcard slots, a built in FM radio, flash light, Facebook and a pre-installed WhatsApp. (See Fig. 1)

Context relevant services promote adoption as illustrated in the case of the “Dumsor Rechargeable Phone” (Galace SQ). This is an unknown product, an unknown brand, with no known advertising campaign especially in times when all devices are getting smarter and thinner. The main source of marketing for this phone has been through personal recommendation. The resilience of this phone was put to test during one advertising campaign by TigO in 2014, which suggested that consumers switch from their feature phone to smart phone – “Drop that Yam”. Contrary to this, the demand for the “Dumsor Rechargeable Phone” went up, to the extent that fake versions are now emerging. Even though the exact number of handsets sold is yet to be determined, the buzz created is substantial enough to merit the attention of this report.

推广 of this phone. Other human and non-human actors, including people, media, organizations and ICTs also contributed. However, the role of culture and contextual need (lack of electricity) was an enabling factor for this uptake. Given the dominant negative perspective of culture in the literature, which cites preference for established brands and superior advertising campaigns than anonymous recommendations?

However, the rationale for most of these findings seems to be based on mobile adoption practiced in the developed world rather than on developing country
culture, tradition, practices or environment. Nevertheless, the developed and the developing world operate under varied socio-economic rationalities (Avgerou, 2009; 2001). Hence, technologies and business models may not be readily and feasibly transportable from the latter to the former (Avgerou, 2009; Heeks, 2002). Although mobile technology and for that matter handsets originated from the developed world (Li, 2007), it is not essentially Western but potentially malleable to varied contexts such as developing countries. Developing country ICT research and practice therefore need to seek cultural fit (Mbarika et al., 2005; Boateng et al., 2009) rather than direct importation of models from the developed world.

Conclusion

The application of the Actor Network Theory in this study is opportune and hence, adds to the paucity of literature looking at adoption in this unique cultural context. The findings also support the view that m-business practices are bound to differ across the developed and developing worlds (Ferran and Salim, 2005). A growing number of developing country researchers (e.g. Laosethakul and Boulton, 2007; Boateng et al., 2009; Kamel and Hassan, 2003; Sia et al., 2009; Ferran and Salim, 2005) are therefore advocating m-business adaptation rather than direct adoption from the developed world. Because developed world business models embody their own values and practices different from those in the developing world, transporting ICTs to the latter may not be feasible (Avgerou, 1998; Walsham and Sahay, 1999; Heeks, 2002). This study thus demonstrates how m-business models can be developed from local practices and values. This is however not to suggest that all developing country values and practices are good for m-business inscription. There can equally be bad practices that need to be avoided in m-business design (Ferran and Salim, 2005). Moreover, entrepreneurs can learn from successful developed world m-business models and contextualize them without necessarily copying blindly.

References


Towards a Privacy Impact Assessment Template for Mobile Health Data Collection Systems

Leonardo H. Iwaya, Leonardo A. Martucci, Simone Fischer-Hübner
Department of Computer Science, Karlstad University
Universitetsgatan 2, 651 88, Karlstad, Sweden
{leonardo.iwaya, leonardo.martucci, simone.fischer-huebner}@kau.se

Abstract: Mobile Health (mHealth) refers to the use of mobile devices to support health care. Such technologies emerged, especially in developing countries, taking advantage of the flourishing mobile market. Many of them, however, do not properly address the privacy and data protection issues inherent to medical applications. For this reason, aiming to facilitate the developers’ work on implementing privacy, this paper motivates and preliminary proposes a Privacy Impact Assessment (PIA) template for Mobile Health Data Collection System (MDCS). PIA templates work as a guiding tool, allowing developers to: (a) understand important privacy principles, (b) identify the privacy threats in their MDCS, and (c) properly mitigate the privacy threats with proper use of technical and administrative controls. Ultimately, this research also intends to foster the development of relevant privacy frameworks for mHealth in general.

Introduction

The concept of mobile health care (mHealth) refers to the medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices [1]. The deployment of mHealth solutions is particularly promising in emerging countries, in which health authorities can take advantage of the flourishing mobile market to bring adequate health care to unserved or underserved communities [2]. Indeed, specialized applications for health surveys and surveillance play a crucial role in such regions, providing a rich repository for decision making on the field of public health [1][2][3]. However, many of the mHealth initiatives are growing in a hopeful atmosphere, but without much concern about the privacy implications [4].
The whole group of Mobile for Development (M4D) applications can indeed enable significant development in developing countries. Development, in turn, is only real if in consonance with fundamental human rights; and here we are particularly looking into privacy. Privacy as a human right has precedent in the right to freedom of opinion and expression, which includes freedom to hold opinions without interference and to seek, receive and communicate information and ideas through any media and regardless of frontiers [5].

This study has particular focus on privacy for Mobile Health care Data Collection Systems (MDCS). Such systems are intrinsically mass surveillance tools, and its use, without the proper care, can easily lead to privacy infringements. Therefore, it is of utmost importance to raise privacy awareness among developers and health care managers that use MDCS, and also, assist them to properly implement privacy-preserving technologies. To do so, this paper presents a preliminary proposal of a Privacy Impact Assessment (PIA) template, a risk analysis tool that helps developers to: (a) understand privacy principles, (b) identify the related privacy threats and (c) find appropriate countermeasures.

Mobile Health Data Collection Systems

Data collection systems are normally used to gather primary health care information and to track existing diseases of a given community [1]. The collected data is stored and used by health managers and authorities to identify problems and to make decisions, thus driving the promotion of health initiatives. Paper-based data collection systems are still common. The mobile phone can, however, substitute paper, and make data collection more efficient and less prone human errors (e.g., mistyping, poor handwriting, physical loss of forms/data). By exploiting the mobile’s communication capabilities, data can be delivered in a faster and more reliable manner, speeding up the whole process of decision making. This category of mHealth application is usually called Mobile Health Data Collection System (MDCS). Figure 1 illustrates such system, showing a generic architecture in which paper forms are replaced by a custom application in a mobile device.

Community Health care Workers (CHWs) are very often the key actors of such systems, acting as data collection agents. They are responsible for visiting families in their houses and for acquiring health-related information. During those visits, the agents fill out electronic forms containing several questions designed for this specific purpose and loaded into the mobile device. Partially
filled forms (i.e., forms lacking mandatory information) are temporarily stored in the device’s memory and, after consolidation, are delivered to the server (e.g., via 3G or Wi-fi). The server stores all received data in a database, which can then be accessed and analyzed by health managers (e.g., using a web-based management system).

Figure 1. General process of MDCSs. Adapted from [6].

MDCSs worldwide

Currently, there are many MDCS initiatives around the globe. As reported in (WHO, 2011), mHealth surveillance projects are more prevalent in countries in the low-income groups than those in the high-income groups, and particular high activity was found in the African and South-East Asian regions. Another report [7] presents a compilation of sixteen mHealth projects for health surveillance. These initiatives are mainly pilot projects, but the most successful programs are fortunately scaling up and being deployed in multiple countries. For instance, eSTEPS [8], a PDA-based data collection system tested in Fiji for comparing the gains in efficiency and data quality that electronic questionnaires have over paper. Similar studies were conducted with the Personal Data Collection Toolkit [9], in Cape Town (South Africa), and the Data Entry at the Point of Collection [10], in Tanzania. Another related application is described in [11], in which health agents employ MDCS for improving antenatal care and for promoting immunization services in Thailand. A more recent example is MoTeCH [12], deployed in Ghana, which empowers nurses and community health workers with a MDCS for recording and tracking the care delivered to
women and newborns, and generates management reports mandated by the
country’s health authorities. There are also standardized, general purpose tools
that help in the task of designing forms using a web dashboard and deploying
them to mobile devices, such as the magpi framework [13].

**Information Security and Privacy Perspectives**

Information security is commonly addressed by means of the principles of
information confidentiality\(^1\), integrity\(^2\), and availability\(^3\). Privacy, in turn, stands
for fundamental rights and freedoms of subjects to have their right to privacy
with regards to the manipulation and processing of personal data [14]. Regarding MDCS, it is also important to clarify a few other basic assumptions,
with respect to: the viable attack surfaces; the trusted/untrusted domains; and
the meaningful use of medical data.

Attack surface refers to the parts of the system where a malicious user (e.g.,
attacker) could try to enter or extract data from the environment, aiming to
exploit the system, e.g.: acquire unauthorized information and/or privileges;
disrupt system's functions; and other violations. In the case of MDCS, the
mobile phone and the web server are the main attack surfaces to the system.
Mechanism should be implemented at both sides in order to ensure
information security and privacy.

Another important assumption refers to the application’s environment. For
healthcare systems we typically consider an implied trusted domain and
confidentiality among medical staff (i.e., CHWs and health managers must
follow strict work policies and regulations). In other words, these actors have a
legitimate purpose to access to the individual’s or family’s data in order to
provide proper treatment, i.e., meaningful use of medical information.

Regarding security of MDCS, significant research has been already made, which
partially solves the problem, as described in Section Related Work. On the other
hand, such systems can be (deliberately or accidentally) misused, leading to
infringements of personal privacy. Typical cases include: (a) the lack of
informed consent before collecting subject’s data; (b) the lack of clear
statements about the purposes of collecting and using the data; and, (c) the lack
of transparency on how the data is processed and possibly shared. These and

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\(^1\) Confidentiality: information should not be made available or disclosed to unauthorized individuals.

\(^2\) Integrity: information should be maintained accurate and complete; should not be tampered with.

\(^3\) Availability: information must be available when it is needed.
other privacy and data protection issues are thoroughly discussed in Section *Privacy Groundings for mHealth.*

**Related Work - MDCS Security and Privacy**

The integration and implementation of security mechanism in MDCS is not trivial. Appropriate algorithms and protocols for user authentication, secure communication and storage rely on cryptography; and “cryptography is harder than it looks, primarily because it looks like math” [15]. Besides, it requires highly experienced teams, with profound knowledge of the field, to implement and configure it correctly. In order to facilitate this task, regular developers can rely on security libraries that were designed, implemented and maintained by groups of experienced cryptographers.

With respect to MDCS, two security frameworks have been proposed: SecureMDC [16] and SecourHealth [6]. Both proposals aim to provide highly usable (i.e., transparent to the end-user) and lightweight security implementation. Basic functions include: user online and offline authentication; secure data storage; and, secure communication between mobile and server. The SecourHealth was implemented into the GeoHealth [17], a mHealth data collection application used for primary health care in Brazil. Likewise, developers of SecureMDC integrated their solution into two open-source general-purpose MDCSs, i.e., openXdata⁴ and Open Data Kit (ODK)⁵.

The adoption of such security frameworks is an important step towards more secure and privacy-preserving mHealth systems. However, as aforementioned, security only partially solves the problem. In what follows, we provide a brief review about the privacy literature and its peculiarities in relation to mHealth.

**Privacy groundings for mHealth**

Addressing privacy in the ever-growing world of information technology is an unceasing challenge. The concept of Privacy by Design (PbD) [18] is remarkable example. Developed in the 1990s, its objective is to take privacy into account throughout the whole systems engineering process. PbD has seven foundational principles [18]: (1) privacy should be dealt in a proactive and preventive way; (2) it should be in the system’s default mode, and, (3) embedded in the system’s design; (4) it should not trade-off with functionality;

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⁵ [https://opendatakit.org/](https://opendatakit.org/)
(5) the whole lifecycle of information processing should be secured; (6) its mechanisms should be visible and transparent to the users; and, (7) consistently respecting users privacy.

In the 21st century, the concept of PbD has spread in various related fields of research and legal frameworks. A notorious example of PbD’s incorporation is the European General Data Protection Regulation (EU GDPR) [19], replacing the EU Data Protection Directive 95/46/EC [14], which intends to strengthen and unify data protection for individuals within the European Union.

Most countries, however, still lack legal framework for privacy and data protection (such as EU GDPR). Another alternative would be the adoption of practical guidelines regarding mobile privacy and information security for M4D (and mHealth). Some efforts have been made towards a collection of guiding principles for M4D projects, such as in [20] and [4].

In [20], the author “seeks to define guiding privacy and security principles for ICT4D projects, to provide a framework for project planning and evaluation, and to facilitate productive dialogue and action in the intersection of technology, privacy and development”. Although the author uses the (more generic) term ICT4D, actually the paper addresses use cases in mobile health, mobile finance and mobile governance. In the same way, the author of [4] stresses the importance of initiatives such as [20], and, advocates in the case of M4D “that putting the right to privacy and data protection into practice requires strengthening existing frameworks and developing new standards”.

Guiding tools, such as the one presented in [20], are noteworthy steps towards a practical assessment of privacy in M4D projects; and they are in line with EU GDPR. However, they still remain in a quite high-level. Developers need more accurate information regarding how to engineer privacy into their systems. As explained in [21], PbD principles are mostly “too vague”, displaying a disconnection between policy makers and engineers when it comes to how to technically comply with privacy and data protection. Also, the complexity of the engineering task can rarely be reduced to an easily ticked checklist; it requires deep analysis and understanding of the system in order to properly mitigate associated privacy risks [21]. That is, to close the gap between privacy principles and software implementation, we need application-specific methods, focused and close to reality. A well-known and established way to do so is by using Privacy Impact Assessment (PIA) templates.
The objective of the PIA template is to systematically identify the risks and potential effects of collecting, storing, and sharing personal data to mitigate potential privacy risks [22]. Also, as aforementioned, PIAs can be tailored to a specific technology and application (e.g., [23] for RFID\textsuperscript{6} applications). Accordingly, mHealth\textsuperscript{7} developers could also take benefit of PIA templates. Hence, this paper focuses on an initial proposal of PIA template for MDCS.

**Narrowing down: Engineering Privacy for MDCS**

This section describes the overall strategy towards the creation of a PIA template for MDCS. To do so, the research is grounded in the aforementioned PIA template for RFID [23]. Besides, we also take into account the important findings and discussions regarding MDCS, already made in the security frameworks (presented in the related work section). Notice that, this is a preliminary proposal of our PIA template. A complete version will require further analysis, thereby being matter of our future research.

A PIA template is typically structured in four parts:

1. Description of the application (i.e., MDCS), in terms of its objective, requirements, users, stakeholders, application architecture, and data flows.
2. Identification of privacy threats with respect to a list of privacy targets embedded in the legal framework EU GDPR.
3. Proposal of technical and organizational controls for mitigating the identified privacy threats, i.e., countermeasures.
4. Documentation of the PIA regarding the MDCS being analyzed.

In our case, the application description was already presented in Section *Mobile Health Data Collection Systems* (for further details we refer the reader to [6] and [16]). It is also worthy noticing that we are using the EU GDPR as our best attempt to cope with an established legal framework, since developing countries still lack such artifacts. Nevertheless, it should be possible to adapt or extend the PIA template in case of other specific privacy regulations, by redefining the privacy targets, its associated threats and proposed countermeasures. In

\textsuperscript{6} Radio-Frequency Identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects.

\textsuperscript{7} Notice that, mHealth by itself is only an umbrella term, with quite many applications falling under it (e.g., remote monitoring, health surveys & data collection, SMS reminders, treatment adherence, and others).
remainder of this section, we describe the EU GDPR’s privacy targets, and briefly explain the rationale regarding threats identification and mitigation.

Privacy Targets

In order to achieve privacy and data protection, the EU GDPR defines a set of (general) privacy targets that should be aimed when assessing a system or an application. These privacy targets are listed and explained in Table 1.

<table>
<thead>
<tr>
<th>Privacy Target</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance with Data Processing Principles, data protection by default (Art. 5, 23)</td>
<td>The key privacy principles, including the following ones, are to be ensured, and must be enforced by default:</td>
</tr>
<tr>
<td><strong>Purpose binding</strong>: Personal data must be collected for specified and legitimate purposes and may later only be used for those purposes (Art. 6 Ib).</td>
<td></td>
</tr>
<tr>
<td><strong>Data minimization</strong>: The amount of personal data and the extent to which they are collected and processed should be minimized (Art. 6 Ic EU Directive), i.e., in particular if possible data should be anonymized or pseudonymized.</td>
<td></td>
</tr>
<tr>
<td>Lawfulness of personal data processing (Art. 6)</td>
<td>Lawfulness of processing to be ensured by an unambiguous informed consent, contract or legal obligation.</td>
</tr>
<tr>
<td>Lawfulness of processing special categories of data (Art. 9)</td>
<td>Lawfulness of the processing of “sensitive” personal data (such as data related to health, ethnicity, union membership, religious beliefs and political opinions) must be ensured by explicit consent or special legal basis.</td>
</tr>
<tr>
<td>Compliance with the right to be informed (Art. 14)</td>
<td>A data subject is to be provided with required privacy policy information including the identity of the data controller and data processing purposes at the time when the data is collected from the data subject.</td>
</tr>
<tr>
<td>Compliance with transparency rights (Art. 15)</td>
<td>The data subject has the right to access their data (unless this adversely affects the privacy rights of others) and receive information about data processing purposes, data recipients or categories of recipients, the data retention period, the right to lodge a complaint with a supervisory authority as well as information about the logic involved on any automatic processing including profiling, and the significance/envisaged consequences of such processing.</td>
</tr>
<tr>
<td>Compliance with rights to data portability, rectification, erasure and restricting data processing (Art. 16, 17, 17a, 18)</td>
<td>The data subject can exercise the right to export data, correct or delete their data, the right to restrict its processing, the right to restrict its processing, and the right to be forgotten in a timely manner.</td>
</tr>
<tr>
<td>Compliance with the right to object (Art. 19, 20)</td>
<td>It must be ensured that the data subject has the right to object to the processing of their data, especially in the case of automated individual decision making.</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Security of processing (Art. 23, 30)</td>
<td>It must be ensured that suitable security measures, including data minimization and pseudonymization, are implemented.</td>
</tr>
</tbody>
</table>

### Threat identification and selection of countermeasures

By looking into the MDCS context, a list of privacy threats can be postulated and associated to the aforementioned privacy targets. This threat identification analysis can be carried out by a group of experts, using brainstorm sessions and iterative reviews. Two preliminary examples of such threats are:

- **Threat 1 – User profiling (data minimization threat):** The use of MDCS makes it fairly easy to link subject’s data (i.e., patients or families), activities, kinship, demographics, and etc. User profiling is inherent in the health surveillance process. The further exploitation of data relationships, creation of more complete profiles, might result in the use of personal data beyond the original purpose.

- **Threat 2 – Vague purposes (purpose bidding threat):** Vaguely defined purposes allow MDCS to be used for purposes not previously defined during the design stage. For example, do not follow the premises of meaningful use of medical data, and uses it for secondary purposes.

The next step would be the selection of appropriate technical and organizational security and privacy controls. Such measures should further explain to developers the privacy threat and address it with effective control, and therefore, reaching the privacy targets. If no countermeasure exists, it is important to emphasize the problem and discuss existing research challenges. Concretely, the examples of countermeasures for Threats 1 and 2 are:

- **User profiling –** Datasets can be shared, merged or linked in order to create enriched repositories, for primary use of data (e.g., merging public health care databases or sharing them with other governmental agencies), as well as for secondary use (e.g., sharing data with research institutions). Such data operations can extrapolate the original purpose of data collection. However, if that is necessary, health managers have to consider using pseudoanonymization or anonymization methods before releasing the data. Therefore, avoiding further profiling the data subjects.
• Vague purposes – Parties that have partial or full access to the dataset should be clearly declared. Also, their purposes for collecting data should be specific, explicit and legitimate. Practical guidance on purpose specification and compatible use (when further processing personal data) can be found in [24]. For instance, there are cases in which health workers snoop patient’s data (whom they are not in charge of), just because they are curious. This is clearly out of the original purpose, and such snooping incidents can be prevented with proper access control mechanisms, and machine readable privacy policies, enforcing that the personal privacy preferences are properly followed.

**Conclusion**

This paper is a preliminary effort towards the translation of privacy principles, from available legal frameworks, to a practical risk analysis tool (i.e. PIA) that supports MDCS’s developers in the implementation of secure and privacy-preserving mechanisms. In brief, we expect to develop a privacy framework for MDCS. Nevertheless, it is important to stress that PIA templates can also be created to other categories of mHealth applications, and, for M4D in general. The closer we can get to reality, with application-specific guiding tools, the easier will be the developer’s work on engineering privacy into various systems.

**Future Work**

Further analysis regarding the privacy threats and countermeasures is part of the future work. The objective is to compile a complete list of threats, summing up brainstorming sessions and discussions within a group of specialists. Therefore, based on the threat list we can start associating viable privacy-enhancing technologies, making it easier to the developer to know how to practically cope with each threat. As a result, we have a fully defined PIA template for MDCS.

**Acknowledgements**

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References


Information Needs of Startup Women Entrepreneurs in Uganda

Mary Komunte¹ and Rehema Baguma²

¹Uganda Technology and Management University, P.O Box 73307, Kampala, Uganda.
²College of Computing & Information Sciences, Makerere University, P.O Box 7062, Kampala, Uganda.

¹ mkomunte@utamu.ac.ug, ² rbaguma@cis.mak.ac.ug

Abstract

Women entrepreneurs play an important role in stimulating the economic development of nations and the world in general. According to the 2012 GEM Report, women in Uganda are almost as likely to be involved in starting an enterprise (35.6%) as men (36%). However, the failure rate of such enterprises is equally high compared to those led by men. This high failure rate has been attributed to inadequacies in business development information among others despite the information technology boom particularly the high rate of ownership and use of mobile phones. In 2014, Uganda had over 14 million mobile phone subscribers and 100% network coverage. Although there is growing use of mobile technology in socio economic development such as monitoring disease outbreaks, agricultural extension services, education, provision of market prices, etc., mobile phones are not yet widely used to avail Small and Medium Sized Enterprises (SMEs) in Uganda information required to support decision making. Most efforts have been focused on using mobile phone technology to provide SMEs with market and market price information. However, many other types of information are needed alongside markets and market prices to support effective decision making for SME startups such as source of loans and their conditions, training in selection of enterprises, basic book keeping, sensitization about relevant laws and policies, etc. This paper examines information needed to support decision making of startup women entrepreneurs in Uganda and the potential of mobile phone technology to facilitate easy access to such information.

Key Words: Startup women entrepreneurs, Information needs, mobile technology and entrepreneurship.
1.0 Background

Women entrepreneurs play an important role in stimulating the economic development of nations and the world in general. According to the 2012 GEM Report, women in Uganda are almost as likely to be involved in starting an enterprise (35.6%) as men (36%). Therefore, women led enterprises have been increasing since 2003 and by 2015, they stood at 45% (UBOS, 2015). However, the failure rate of women led enterprises is equally high compared to those led by men. This high failure rate has been attributed to inadequate business development information among others especially in developing countries. According to UNIDO (2005) in most developing countries, the SMEs sector suffers from inadequacies in the provision of business information - which is often either unavailable or slow and cumbersome to access; limited in scope; and not provided in an integrated manner. According to Zororo (2011), startup women often lack information about how to access loans, lack the necessary collateral to obtain one and/or face discriminatory laws or practices related to finance and credit (Commonwealth secretariat, 2013). In addition, women entrepreneurs have financial social demands that compete with business capital, leading to a diversion of capital away from business needs (Makokha, 2006).

On the other hand, the availability and use of mobile phone technology has been continuously growing in developing countries. In Uganda, there were over 14 million mobile phone subscribers and 100% network coverage in 2014 (UCC, 2014). This has enabled a number of mobile phone technology supported socio-economic services such as mobile money, monitoring disease outbreaks, supporting disease diagnosis and treatment, sending health education messages, sending several drug intake reminders a day to HIV-positive patients, providing agricultural advisory services (Aker & Mbiti, 2010). However, mobile phones are not yet widely used to avail SMEs in Uganda information required to support effective decision making. Most efforts have been mainly focused on using mobile phone technology to provide SMEs with market and market price information (Aker & Mbiti, 2010). However, many other types of information are needed alongside markets and market prices to support effective decision making for SME startups such as; source of loans and their conditions, training opportunities in entrepreneurship development, sensitization about relevant laws and policies, etc. This paper examines information needed to support effective decision making by startup women entrepreneurs in Uganda and the potential of mobile phone technology to facilitate easy access to such information by startup women entrepreneurs.

The study focused on women entrepreneurs located in Kampala city, Uganda, because urban enterprises have 25% survival chance beyond six months compared to similar rural enterprises (Mead Liedholm, 1998). Secondly, with regard to the availability and use of mobile phones and other ICTs in general, ICTs were rolled out earlier and presently have a higher penetration rate in urban areas compared to rural areas (UCC, 2016; Castells et al., 2007). Moreover, to-date there are more studies on mobile phones and enterprises in rural settings such as (Acker and Mbiti, 2010; Jensen, 2007; Jagun et al.; 2007 and Ducommbe and Heeks, 2002), compared to studies on small
scale women entrepreneurs in urban areas and mobile phones (Svensson and Wamala Larsson, 2015, Chew, Ilavarasan and Levy, 2010).

More so, our choice of women entrepreneur as subjects of research is motivated by the fact that increased use of mobile phones by women entrepreneurs for business development might increase the effectiveness and profitability of women led enterprises which in turn will increase their empowerment (GSMA, 2016 and Huyer, 2005). Therefore, by studying women entrepreneurs and mobile phones, we hope that our research might provide some understandings into the efficacy of mobile phones in bridging the gender digital divide. GSMA (2016) noted tackling the gender gap in mobile phone ownership and use is a critical topic that still needs attention. Digital inclusion for women is essential because when women thrive, societies and economies thrive too.

The main aim of this research was to investigate the information needs of startup women entrepreneurs in Uganda to support decision making and the potential of mobile phone technology to facilitate easy access to such information. The next sub section presents the motivation for this study

1.1 Motivation for this Study

The informal sector in Uganda is growing at more than 45% (UBOS, 2016) of the total economy and majority of Ugandan women entrepreneurs fall in the informal sector category (Word Bank Report, 2005). According to the 2013 World Bank Global Entrepreneurship Monitor (GEM) report, the informal enterprises are the biggest source of employment in urban cities. In Kampala, Uganda’s capital, 15 % of informal enterprises are urban market stalls (World Bank, 2013).

The informal sector is characterized by job insecurity, weak labor laws, and inflexible working hours. However, this sector continues to facilitate the marginalized especially women to secure employment for survival. Women entrepreneurs dominate the informal sector in Uganda (UBOS, 2016). The increasing participation of women in the informal sector is explained by lack of access to, control of and ownership to property and land which makes them lag behind in accessing startup capital and finances to grow their businesses.

Access to reliable information is vital to all businesses including those in the informal sector. For any business to survive and thrive in the digital era, it should have access to timely information for decision making (Tawah, 2013). Therefore, startup women entrepreneurs need reliable information in the process of starting up enterprises.

However, startup women entrepreneurs face challenges in accessing information required to start and effectively run their enterprises because they lack exposure to formal sources of information due to social cultural norms among other causes (Namatovu et al; 2012). As a result, they receive incomplete, distorted and or out dated information (Namatovu et al; 2012). Furthermore, the hurdle of access is complicated more by lack of relevant skills in accessing information using modern communication technologies like mobile phones, internet, social media networks and others ICT
tools (Rangongo, 2013). Other difficulties faced by startup women entrepreneurs in accessing business development information include: limited awareness about where to get required information from, and lack of trust in the available information (Ikoja, 2004). Uganda has numerous entrepreneurship training organizations and advisory networks such as Women Entrepreneur Associations which provide social and economic support, but their reach is limited to a few educated women, mostly in peri-urban and urban areas and they are highly dependent on volunteerism (Namagala, 2007). Therefore, few women are able to access these services on an affordable and ongoing basis.

In Uganda, there is still a gap in literature about how women entrepreneurs can access and utilize business development information in decision making in order to operate and succeed in an increasingly competitive and challenging business environment.

There is, however, a consensus that mobile phones can support the development of businesses enterprises (Donner, 2007; Acker and Mbiti, 2010, Komunte, Rwashana and Nabukenya, 2012, Svensson and Wamala Larsson, 2015, Chew, Ilavarasan and Levy, 2010). Several researches offer insights on the benefits of mobile phones and the Internet among entrepreneurs. These include price determination (Jensen, 2007) reduction of transport costs by substituting long journeys, marketing products using social media networks, improved information access and financial inclusion through mobile money and many others. However, few studies have studied the information needs of women entrepreneurs particularly small scale women entrepreneurs in the informal sector.

Although there is no reliable count of women entrepreneurs who use mobile Internet, Smartphones and basic phones are thought to hold significant development potential, particularly in urban settings, where they are providing inexpensive internet access to people without personal computers (GSMA, 2016; Svensson and Larsson, 2015). Kuzabiashara.com believes that the overwhelming majority of mobile Internet users are young men and women who buy data for gaming, online chats, online marketing especially on social media networks, pornography, and seeking information about jobs and education opportunities.

Several studies carried out in Africa on the use of mobile phones for enterprises development such as Boating, Hinson, Galadima and Olumide (2014), Komunte, Rwashana and Nabukenya (2012) and Tawah (2013) found out that mobile phones facilitate access to reliable information, including locating suppliers and customers, thus enhancing effective communication and business processes and eliminating middlemen and increasing productivity (Donner and Escobari, 2010). However, limited research has been carried out about the information needs of startup women entrepreneurs for effective decision making and the extent to which these needs can be met through the widely used mobile phone technology. The next section presents the methodology that was used to achieve the objectives of this study.
2.0 Methodology

The aim of the study was to investigate the information needs of startup women entrepreneurs in Uganda for effective decision making and the potential of mobile phone technology to meet these needs. The study was carried out in Kampala district, Uganda in December, 2014 in three markets namely Nakasero (a high end market for the rich and elite), Nakawa (a middle end market) and St Balikuddembe (a low end market). These markets were selected due to the fact that majority of the market vendors are women running very small scale businesses in particular groceries who trade mostly in groceries (Development Initiative International, 2015). The study was carried out using an administered questionnaire that was largely quantitative on 150 women startups entrepreneurs (50 from each market). The participants had to have started their business less than 6 months ago (to qualify as startups); had to be owners not employees; completed primary level of education and above, and selling groceries. An incentive of mobile phone airtime worth 1,000 Uganda shillings equivalent to approximately USD 0.3 was given to each participant to motivate them to participate in the study.

The pilot study was undertaken at Uganda Technology and Management University (UTAMU) to validate and polish the questionnaire before actual administration. The pilot questionnaire was distributed to 10 students perusing Bachelor of Information Systems and Technology and 5 Lecturers in the School of Business and Management who had personal businesses. The results from the pilot exercise were used to refine the questionnaire before actual administration on the women entrepreneurs in the three markets.

After piloting, the questionnaire was translated into Luganda, the language most market vendors in Kampala are comfortable with and the Research Assistants were trained on how to approach participants and administer the questionnaire. After the training, the Research Assistants rehearsed as a team in the presence of the Researchers about how to approach and administer the questionnaire several times until they mastered the procedure. A total of 150 women entrepreneurs, (50 from each market) meeting the criteria of the study were randomly selected and studied. Permission was sought from Market leaders to conduct research in the 3 markets and the interviews were held with the market vendors in the market besides their grocery stalls. Before each interview, potential participants were briefed about the study and asked whether they were interested in participating in the study. Those that refused out rightly or had mixed feelings, they were not interviewed. The collected information was entered into an excel sheet, analyzed and synthesized together to generate interpretations in relation to the aim of the study. The next section presents the findings from the study.

3.0 Findings from the Study

This section presents the findings obtained in the study from the questionnaires administered.
3.1 Introduction
A total of 150 questionnaires were administered in this study and all the 150 were responded to. All the 150 participants were female due to the special focus of the study.

3.2 Age of the Respondents
Most startup women entrepreneurs studied are between 26-45 years of age (64%). This finding concurs with Namatovu et al.; (2012) and Svensson and Larsson (2015) who noted that most women entrepreneurs are under the age of 35 years and this is the group with the highest number of startups. Levesque and Minniti (2006) noted the existence of an inverted U-shaped relationship between age and involvement in starting a new business, and Reynolds et al. (2003) noted that the most entrepreneurially active age group is 25 and 34 years. Details about the age groups of the participants are given in table 3.1.

Table 3.1: Age of the Respondents

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of Respondents</th>
<th>Percentage (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-35</td>
<td>52</td>
<td>34.7%</td>
</tr>
<tr>
<td>36-45</td>
<td>44</td>
<td>29.3%</td>
</tr>
<tr>
<td>15-25</td>
<td>26</td>
<td>17.3%</td>
</tr>
<tr>
<td>46-55</td>
<td>16</td>
<td>29.3%</td>
</tr>
<tr>
<td>56-60</td>
<td>6</td>
<td>4%</td>
</tr>
<tr>
<td>&gt;60</td>
<td>6</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>100%</td>
</tr>
</tbody>
</table>

3.3 How long Businesses of Participants have been in Operation
The majority of the participants had been running their businesses for 1-3 months. This implies that their chance of survival was still unknown since they were still in the vulnerable period (Namatovu et al, 2012 and Kunene, 2008). Details about the age of the participants’ businesses are given in table 3.2.

Table 3.2: How long Businesses of Participants have been in Operation

<table>
<thead>
<tr>
<th>Period</th>
<th>Number of Respondents</th>
<th>Percentage (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3 months</td>
<td>79</td>
<td>52.7%</td>
</tr>
<tr>
<td>Less than a month</td>
<td>37</td>
<td>24.7%</td>
</tr>
<tr>
<td>4-6 months</td>
<td>34</td>
<td>22.6%</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>100%</td>
</tr>
</tbody>
</table>
3.4 Highest Level of Education

Studies have revealed that education is a significant aspect of entrepreneurship among women because it inspires them to start enterprises (GEM Report, 2014; Minniti, Allen & Langowitz, 2006 and Edwards & Muir, 2005). Therefore, the study sought to establish the education levels of the participating women entrepreneurs and the results revealed that majority of the respondents had completed primary school and ordinary level secondary school (66%). Therefore, other factors constant, they all knew how to read and write hence if trained could use mobile services in their business effectively. This is attributed to universal primary and secondary education and business sensitization programmes like advisory business foras, investment clubs, TV and radio programmes on business development and business development services from financial institutions (Frank, 2012). Furthermore, the study reveals an increasing trend of graduates (20.7%) joining the business sector which points to a growing trend of fresh graduates becoming job creators than job seekers. This could also be partly attributed to teaching of entrepreneurship as an examinable course in secondary schools and universities. Mentorship programs in entrepreneurship and innovations in higher institutions of learning are also increasing (Frank, 2012). The distribution of the participants across the different levels of education is presented in table 3.3.

Table 3.3: Level of Education

<table>
<thead>
<tr>
<th>Level of Education</th>
<th>Number of Respondents</th>
<th>Percentage (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary level</td>
<td>53</td>
<td>35.3%</td>
</tr>
<tr>
<td>Primary level</td>
<td>46</td>
<td>30.7%</td>
</tr>
<tr>
<td>Tertially</td>
<td>31</td>
<td>20.7%</td>
</tr>
<tr>
<td>Advanced level</td>
<td>20</td>
<td>13.3%</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>100%</td>
</tr>
</tbody>
</table>

3.5 Reasons for Starting the Businesses

The study was also interested in establishing the reasons for starting the business and it was found that majority of the participants started business in order to be independent (74%), followed by desire to get high income (49.3%). This finding concurs with findings of other researches such as Minniti (2010), who noted that women in developing countries became active entrepreneurs due to necessity. Details are given in table 3.4.

Table 3.4: Reasons for Starting the Businesses

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>To be self-employed/ Independent</td>
<td>111</td>
<td>150</td>
<td>74%</td>
</tr>
<tr>
<td>Brings high Income</td>
<td>74</td>
<td>150</td>
<td>49.3%</td>
</tr>
</tbody>
</table>
To supplement Income/ No other alternative for income | 42 | 150 | 28%
---|---|---|---
Family Traditional | 40 | 150 | 26.7%
Had experience | 39 | 150 | 26%
Others: had no job and school fees, illiteracy, had enough income, lost spouses and my relatives initiatives | 20 | 150 | 13.3%

Note: Respondents could choose more than one option

3.5 Reasons for selecting the Business Idea

The basis for the selection of the type of business for the majority of the participants was based on formal training (36%) and personal initiative (52%). This concurs with findings of women entrepreneurship development in Uganda (ILO, 2014) which revealed that women in Uganda are more likely to start business related to their knowledge, experience and skill base. Richardson et al. (2014) and Bulsara and Pandurengan (2007) noted that most entrepreneurs receive some form of training before and or during the period of establishing their business. From the study, only 36% of the respondents received formal training before they selected their businesses. Hence, there is need for information on training opportunities for entrepreneurs and specifically women entrepreneurs about selecting businesses enterprises which could increase the success rate of women led start-ups. Details about the findings obtained on reasons for selecting the business idea are presented in table 3.5.

Table 3.5 Reasons for Selecting the Business Idea

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>My own initiatives</td>
<td>78</td>
<td>150</td>
<td>52%</td>
</tr>
<tr>
<td>Received formal training</td>
<td>54</td>
<td>150</td>
<td>36%</td>
</tr>
<tr>
<td>Advice from mentors</td>
<td>27</td>
<td>150</td>
<td>18%</td>
</tr>
<tr>
<td>Received informal training thru women groups</td>
<td>25</td>
<td>150</td>
<td>16.7%</td>
</tr>
<tr>
<td>Carried out research in different markets</td>
<td>23</td>
<td>150</td>
<td>15.3%</td>
</tr>
<tr>
<td>Others</td>
<td>13</td>
<td>150</td>
<td>8.6%</td>
</tr>
</tbody>
</table>

Note: Respondents could choose more than one option

3.6 Those that had a Business Plan

Most of the women entrepreneurs studied (60.7%) did not have a business plan. This is an information need since such women need to be sensitized about the importance of a business plan and guided on how to develop one.
3.7 Who Developed the Business Plans

As shown in table 3.6, majority of the women entrepreneurs (56.7%) sought external help from relatives and friends to develop their business plans. Details are in table 3.6.

**Table 3.6: Who Developed the Business Plans**

<table>
<thead>
<tr>
<th>Who developed the Business Plan</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>My friend/ Relative</td>
<td>85</td>
<td>150</td>
<td>56.7%</td>
</tr>
<tr>
<td>Myself</td>
<td>20</td>
<td>150</td>
<td>13.3%</td>
</tr>
<tr>
<td>Others</td>
<td>20</td>
<td>150</td>
<td>13.3%</td>
</tr>
<tr>
<td>A consultant</td>
<td>5</td>
<td>150</td>
<td>3%</td>
</tr>
</tbody>
</table>

3.7 Why some Women Entrepreneurs did not develop the Business Plans themselves

Of the 150 participants studied, 24% did not know how to develop a business plan, while 15% felt they did not need one. Therefore, women entrepreneurs need training on how to develop business plans but additionally, they need awareness about the importance of a business plan.

3.8 Source of Startup Capital

As shown in table 3.9, most women entrepreneurs (84%) and 41%) used personal savings and borrowed funds/gifts from relatives to start their businesses respectively. Therefore, there is need to provide women with information about other sources of business startup funds that are available. This will motivate and aid many more women to start up and expand their businesses. Merabu from Nakawa Market, a vegetable vendor when asked where she got the money that she used to start her business said: I had saved little money in my “safe box” as savings to start a business. I started small with 300,000 UGX but I have not ventured into getting a loan and I will never because their interest is high and I fear losing my property. Details about feedback given on the source of startup capital is given in table 3.8.

**Table 3.8: Source of Startup Capital**

<table>
<thead>
<tr>
<th>Source</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal savings</td>
<td>126</td>
<td>150</td>
<td>84%</td>
</tr>
<tr>
<td>Borrowed / gift from a relative</td>
<td>61</td>
<td>150</td>
<td>40.7%</td>
</tr>
<tr>
<td>Household /spouse</td>
<td>22</td>
<td>150</td>
<td>14.7%</td>
</tr>
<tr>
<td>A loan from financial institutions</td>
<td>12</td>
<td>150</td>
<td>8%</td>
</tr>
<tr>
<td>Others</td>
<td>-</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Note: Respondents could choose more than one option

3.9 Ownership of Business Location

Most participants (74%) were renting. Therefore there is need for information about available business locations and how to choose the best one for a given business.
3.10 **Basis of Decision on Business Location**

Half of the participants (50%) were referred to the business location by a third party and the rest made educated guesses. This means that startup women entrepreneurs need information on suitable business locations to avoid charges by middle men and sometimes being conned. Details about the basis for the business location are given in table 3.9.

**Table 3.9: Basis of Decision on Business Location**

<table>
<thead>
<tr>
<th>Basis of choosing the Business Location</th>
<th>No. of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>My friends had business there</td>
<td>51</td>
<td>34%</td>
</tr>
<tr>
<td>The place had many customers</td>
<td>39</td>
<td>26%</td>
</tr>
<tr>
<td>Just thought that it was a good place</td>
<td>27</td>
<td>18%</td>
</tr>
<tr>
<td>Advised by an experienced entrepreneur</td>
<td>24</td>
<td>16%</td>
</tr>
<tr>
<td>Others</td>
<td>9</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

3.11 **Number of Registered Businesses**

The study also sought to find out how many of the women entrepreneurs that participated in the study had registered their businesses. Majority of the women entrepreneurs (62%) had formalized their businesses. However, 37.3% were unregistered and these need information on how and where to register.

3.12 **Reasons for Registering their Businesses**

The reasons for registering their businesses for the 62.7% registered include: complying with the law (26%), accessing loans (32.7%), to avoid harassment from law enforcement agencies (26%), for security and expansion of business (21.3%) and to make the business known (22%). They noted that the registration exercise is easy but they need accurate information on types of fees they are supposed to pay to local councils and Kampala Capital City Authority (KCCA). Details are given in table 3.10.

**Table 3.10: Reasons for Registering their Businesses**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to loans</td>
<td>49</td>
<td>150</td>
<td>32.7</td>
</tr>
<tr>
<td>To comply with the law</td>
<td>39</td>
<td>150</td>
<td>26</td>
</tr>
<tr>
<td>To avoid harassment from law enforcement agencies</td>
<td>39</td>
<td>150</td>
<td>26</td>
</tr>
<tr>
<td>To make my business known</td>
<td>33</td>
<td>150</td>
<td>22</td>
</tr>
<tr>
<td>Security and expansion</td>
<td>32</td>
<td>150</td>
<td>21.3</td>
</tr>
<tr>
<td>To separate business from personal activities</td>
<td>1</td>
<td>150</td>
<td>0.6</td>
</tr>
</tbody>
</table>

*Note: Only those who had registered enterprises are counted in this table.*
Given that (32.7%) registered their businesses to be able to access loans from commercial banks and micro finance institutions. There is need for information on where and how to access loans for businesses of women small scale startups.

3.13 Reasons for Not Registering their Businesses

Less than a half (36.7%) of those who were not registered said that they did not see the need, 18% lacked information on registration procedures (18%) and 6.7% cited failure to afford registration fees. This shows that there is need to provide information to startup women entrepreneurs about the importance of registering their businesses and the registration procedure.

3.14 Possession of Trading License

Most of startup women entrepreneurs had trading licenses (82.7%). This is because it is a prerequisite for any entrepreneurs to operate in any market. Kampala Capital City Authority (KCCA) carries out routine checks and closes down all unlicensed businesses. However, the 17.3% that is unlicensed needs to be sensitized about the need for a trading license and how to get one.

3.15 How Information about Getting a License was got

As shown in table 3.16 more than a half of the participants studied got information about procedures for getting a license from third parties. Hence, making such information easily accessible to them will eliminate middlemen in the chain of securing/ getting a license, which might save them, extra cost and time.

Table 3: 11: How Information about Getting a License was got

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through market team leaders</td>
<td>85</td>
<td>150</td>
<td>56.6</td>
</tr>
<tr>
<td>Through local leaders</td>
<td>69</td>
<td>150</td>
<td>46</td>
</tr>
<tr>
<td>Through role models</td>
<td>30</td>
<td>150</td>
<td>20</td>
</tr>
<tr>
<td>Through friends</td>
<td>20</td>
<td>150</td>
<td>13.3</td>
</tr>
</tbody>
</table>

Note: Respondents could choose more than one option

3.16 Weekly Revenue in the first three Months of Operations

Majority of the participants (35%) were earning nominal revenue (0-250,000 UGX). Another considerable big number was uncertain about how much revenue they were earning. This means they need information and training on basic book keeping. Details about the amount of weekly revenue participants were getting are given in table 3.12.

Table 3.12: Weekly Revenue in the first three months of Operations

<table>
<thead>
<tr>
<th>Revenue</th>
<th>No of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-250,000 UGX</td>
<td>52</td>
<td>34.7%</td>
</tr>
<tr>
<td>Uncertain</td>
<td>36</td>
<td>24%</td>
</tr>
</tbody>
</table>
3.17 Current Weekly Revenue

Majority of the participants were earning the same amount of money they were earning in the first three months of operation. There was a slight increase in earnings in the category of 510,000-1,000,000 and above 1,000,000 shillings. This means that either the growth of women’s startup enterprises is slow or they lack skills in book keeping. Details about the amount of weekly revenue participants were earning at the time of the study are given in table 3.13.

Table 3.13: Current Weekly Revenue

<table>
<thead>
<tr>
<th>Revenue</th>
<th>No of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-250,000</td>
<td>52</td>
<td>34.7%</td>
</tr>
<tr>
<td>Uncertain</td>
<td>24</td>
<td>16%</td>
</tr>
<tr>
<td>510,000-1,000,000</td>
<td>21</td>
<td>14%</td>
</tr>
<tr>
<td>Personal information</td>
<td>18</td>
<td>18%</td>
</tr>
<tr>
<td>260-500,000</td>
<td>17</td>
<td>11.3%</td>
</tr>
<tr>
<td>&gt;1,000,000</td>
<td>9</td>
<td>6%</td>
</tr>
<tr>
<td>Did not give any answer</td>
<td>5</td>
<td>3.3%</td>
</tr>
<tr>
<td>Incurred losses</td>
<td>4</td>
<td>2.7%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

3.18 Person Responsible for Making Business Decisions

Of the 150 participants studied, 95.3% of the participants make business decisions themselves. This implies that they can easily take up use of information provided to support decision making in their businesses if it is available and easy to access. However, some participants (18.7%) revealed that their husbands are the major decision makers in their businesses while 5.3% take decisions with their husbands. This means that business information targeting startup women entrepreneurs should also be accessible to key third parties like husbands, fellow entrepreneurs including male entrepreneurs and mentors since they are sometimes part of the decision-making process for women entrepreneurs. Details of the responses are given in table 3.14.

Table 3.14: Person Responsible for making Business Decisions

<table>
<thead>
<tr>
<th>Decision Maker</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business owner</td>
<td>143</td>
<td>150</td>
<td>95.3</td>
</tr>
<tr>
<td>Husband take main decisions</td>
<td>28</td>
<td>150</td>
<td>18.7</td>
</tr>
<tr>
<td>Consult fellow entrepreneurs</td>
<td>12</td>
<td>150</td>
<td>8</td>
</tr>
</tbody>
</table>
### 3.19 Business Decisions Taken

The most regular decisions taken by women entrepreneurs are pricing (85.3%) and restocking (60.7%). Thus, they need up-to-date information on commodity pricing and the demand and supply trends of various goods they deal in. Details about the distribution of responses about the business decisions taken are given in table 3.15.

**Table 3.15: Business Decisions Taken**

<table>
<thead>
<tr>
<th>Decisions</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>To change product prices</td>
<td>128</td>
<td>150</td>
<td>85.3</td>
</tr>
<tr>
<td>To restock</td>
<td>91</td>
<td>150</td>
<td>60.7</td>
</tr>
<tr>
<td>To diversify products</td>
<td>77</td>
<td>150</td>
<td>51.3</td>
</tr>
<tr>
<td>To get a loan</td>
<td>29</td>
<td>150</td>
<td>19.3</td>
</tr>
<tr>
<td>To hire more employees</td>
<td>24</td>
<td>150</td>
<td>16</td>
</tr>
<tr>
<td>Others (To get products on Credit, time management)</td>
<td>15</td>
<td>150</td>
<td>10</td>
</tr>
<tr>
<td>Selecting a business location</td>
<td>13</td>
<td>150</td>
<td>8.7</td>
</tr>
</tbody>
</table>

Note: Respondents could choose more than one option

### 3.20 Source of Information to guide Decision Making

Majority of the participants (78%) consult mentors / fellow entrepreneurs for guidance on decision making. This means that one of the key support mechanism needed by women entrepreneurs is facilitating consultation with mentors and peers since this is already used a lot in business management.

**Table 3.16: Source of Information to guide Decision Making**

<table>
<thead>
<tr>
<th>Source of Information</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consult mentors/ fellow entrepreneurs</td>
<td>117</td>
<td>150</td>
<td>78</td>
</tr>
<tr>
<td>From investment clubs</td>
<td>63</td>
<td>150</td>
<td>42</td>
</tr>
<tr>
<td>From newspapers, TVs and Radios</td>
<td>32</td>
<td>150</td>
<td>21.3</td>
</tr>
<tr>
<td>From advisory business floras like Pakasa</td>
<td>28</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>From financial institutions</td>
<td>24</td>
<td>150</td>
<td>16</td>
</tr>
<tr>
<td>Others (specify) Use brains</td>
<td>20</td>
<td>150</td>
<td>13.3</td>
</tr>
<tr>
<td>Business information service providers</td>
<td>11</td>
<td>150</td>
<td>7.3</td>
</tr>
</tbody>
</table>
3.21 Those who would like to receive Business Development Information

Of the 150 participants studied, 93% would like to receive business development information to enhance their decision making in order to increase chances of success for their startups. This shows that majority of the startup women entrepreneurs are interested in being given business development information.

3.22 Preferred Ways of Receiving Business Development Information (BDI)

The most preferred means of receiving business development information are Voice SMS (52%), followed by text SMS (24%) and radios with 12.7%. This means that most startup women entrepreneurs prefer to receive information as Interactive Voice Response (IVR) and SMS. Details of the responses are given in table 3.17.

Table 3.17: Preferred Ways of receiving BDI

<table>
<thead>
<tr>
<th>Preferred Ways</th>
<th>Number of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile phone voice SMS</td>
<td>78</td>
<td>52%</td>
</tr>
<tr>
<td>Mobile phone text SMS</td>
<td>36</td>
<td>24%</td>
</tr>
<tr>
<td>Radios</td>
<td>19</td>
<td>12.7%</td>
</tr>
<tr>
<td>Investment clubs</td>
<td>8</td>
<td>5.3%</td>
</tr>
<tr>
<td>Others (Social media, churches and face to face)</td>
<td>6</td>
<td>4%</td>
</tr>
<tr>
<td>Internet</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>

3.23 Willingness to pay for Business Development Information

Majority of the participants (76%) are willing to pay for business development information. This means that there is a potential to offer business development information services commercially.

3.24 Types of Business Development Information Needed

Most participants were interested in information about developing a business plan (35.3%) market prices (28.7%), availability of products (18.7%) and sources of loans (9.3%). The existing research on business development services is not gender disaggregated.

Table 3.18: Types of Business development Information needed

<table>
<thead>
<tr>
<th>Type of BDI</th>
<th>Number of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing a business plan</td>
<td>53</td>
<td>35.3%</td>
</tr>
<tr>
<td>Market prices</td>
<td>43</td>
<td>28.7%</td>
</tr>
<tr>
<td>Availability of products</td>
<td>28</td>
<td>18.7%</td>
</tr>
<tr>
<td>Source of loans</td>
<td>14</td>
<td>9.3%</td>
</tr>
<tr>
<td>Others (How to market products, use mobile phones, book keeping &amp; how to grow their business)</td>
<td>7</td>
<td>4.7%</td>
</tr>
<tr>
<td>Taxation</td>
<td>5</td>
<td>3.3%</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>
### 3.25 Problems faced at Start-up for Women Led Businesses

The major problems women startups face include; getting customers (64.7%), getting startup capital (68%) pricing their goods (50%), developing a business plan (33.3%) and how to register a business (18.7%). Details are given in table 3.19.

<table>
<thead>
<tr>
<th>Problem faced</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting startup capital</td>
<td>102</td>
<td>150</td>
<td>68</td>
</tr>
<tr>
<td>Getting customers</td>
<td>97</td>
<td>150</td>
<td>64.7</td>
</tr>
<tr>
<td>Fixing prices of products</td>
<td>75</td>
<td>150</td>
<td>50</td>
</tr>
<tr>
<td>Coming up with a business idea</td>
<td>61</td>
<td>150</td>
<td>40.7</td>
</tr>
<tr>
<td>Developing the business plan</td>
<td>50</td>
<td>150</td>
<td>33.3</td>
</tr>
<tr>
<td>Balancing work and family</td>
<td>45</td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>Business registration</td>
<td>28</td>
<td>150</td>
<td>18.7</td>
</tr>
<tr>
<td>Hiring right staff</td>
<td>8</td>
<td>150</td>
<td>5.3</td>
</tr>
<tr>
<td>Premise/ location acquisition</td>
<td>7</td>
<td>150</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Note: Respondents could choose more than one option

Nabunya who trades in groceries in Nakasero market when responding to the question about the problems they face in their businesses said that they lack security/collateral when requesting for loans. Nabunya’s problem is shared by so many other small scale women entrepreneurs in Uganda/Africa given that majority of the women in these societies do not own property and to get a loan in the bank or Microfinance Institution (MFI) or investment clubs, you need collateral. Banks/MFIs ask for land, a house, farm, nice furniture, fridge, Gas cooker and others. When one does not have such, they do not get the loans. Therefore, startup women entrepreneurs need information on how to access cheap loans with less stringent collateral requirements, how to price their products, how to access markets for their products and how to develop business plans.

### 3.26 How Women Startup entrepreneurs address the problems they face

In response to how they have addressed the problems they face in their businesses, the following solutions were given: providing good customer care such as using a convincing language and giving customers incentives such as bonuses; seeking advice from/consulting fellow entrepreneurs/mentors and friends; patience; determination (persistence, perseverance) and resilience; employing relatives; trusting in God; getting loans from banks or relatives and friends; going for formal training; reducing prices compared to those charged by competitors and refraining from selling on credit. This shows that women entrepreneurs need information on customer care, credit facilities, training opportunities and pricing.

### 3.27 Challenges faced in Running the Businesses

Most entrepreneurs continue to face the challenge of getting capital to run their businesses (38%) which is also faced during startup. They also face a challenge of being able to keep business records (24%) and getting reliable suppliers (19.3%). In addition, balancing work and family was identified as a challenge by some participants (10%). They revealed that balancing work and family is more
challenging for them than it is for men led businesses. Social norms still require women to shoulder most housekeeping and child caring responsibilities. Details about the responses on the challenges faced are given in table 3.20.

Table 3.20: Challenges faced in running the Business

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Number of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting additional capital to expand</td>
<td>57</td>
<td>38%</td>
</tr>
<tr>
<td>Keeping business records</td>
<td>36</td>
<td>24%</td>
</tr>
<tr>
<td>Getting reliable suppliers</td>
<td>29</td>
<td>19.3%</td>
</tr>
<tr>
<td>Others (Balancing work and family)</td>
<td>15</td>
<td>10%</td>
</tr>
<tr>
<td>Getting customers</td>
<td>13</td>
<td>8.7%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

3.28 Measures employed to overcome the Challenges faced Running the Business

The key measures taken by women entrepreneurs to address the challenges faced include; getting loans from banks (60%), getting reliable suppliers (30%), diversifying stock (26%), prayers (trusting in God) (26.7%), changing location (23.3%), and persistence and patience (20%). This means women entrepreneurs need information on where to get credit and requirements, potential suppliers, demand trend of products and advice on where to locate their businesses.

Table 3.21: Measures employed to overcome the challenges faced running the Business

<table>
<thead>
<tr>
<th>Measures Undertaken</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Got a loan from the bank</td>
<td>90</td>
<td>150</td>
<td>60</td>
</tr>
<tr>
<td>Collaborated with reliable suppliers</td>
<td>45</td>
<td>150</td>
<td>30</td>
</tr>
<tr>
<td>Diversified/broadened my stock</td>
<td>40</td>
<td>150</td>
<td>26.7</td>
</tr>
<tr>
<td>Trusting in God</td>
<td>40</td>
<td>150</td>
<td>26.7</td>
</tr>
<tr>
<td>Changed location to a place with more customers</td>
<td>35</td>
<td>150</td>
<td>23.3</td>
</tr>
<tr>
<td>None</td>
<td>32</td>
<td>150</td>
<td>21.3</td>
</tr>
<tr>
<td>Persistence and patience</td>
<td>30</td>
<td>150</td>
<td>20</td>
</tr>
<tr>
<td>Sometimes evade taxes</td>
<td>3</td>
<td>150</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: Respondents could choose more than one option

3.29 Ownership of Mobile Device

Majority of the participants had a mobile device (96%), since it was a selection criterion and only six respondents (4%) refused to disclose. This means that startup women entrepreneurs can easily access and utilize business development information efficiently if made available via mobile technology.
3.30 Type of Mobile Device owned

Majority of the women entrepreneurs owned basic phones (98%) followed by smart phones (33.3%) and laptops (20%). This means that information services for women entrepreneurs should be accessible via basic phones.

Table 3.22: Type of Mobile Device owned

<table>
<thead>
<tr>
<th>Type</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic phone</td>
<td>147</td>
<td>150</td>
<td>98</td>
</tr>
<tr>
<td>Smart phone</td>
<td>50</td>
<td>150</td>
<td>33.3</td>
</tr>
<tr>
<td>Lap top</td>
<td>30</td>
<td>150</td>
<td>20</td>
</tr>
<tr>
<td>Tablet</td>
<td>1</td>
<td>150</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Note: Respondents could choose more than one option

3.31 Mobile Services Used by Startup Women Entrepreneurs

Mobile services most used include; voice calls (97.3%), sending and receiving mobile money (83.3%), text SMS (73.3%) and buying airtime using mobile money (57.3%). Radio was used by 22.7% of the participants. The mobile phone radio is the most convenient to these startup women entrepreneurs since wherever they are they can listen to it. They listen to news programmes and business development programmes like ‘pakasa’-make money and others. Therefore, there is need to merge radio with modern media. It was found out that 19.3% of startup women entrepreneurs use trade Info (MTN UG) and Trade (Airtel UG) services to check commodity prices in various markets. They also use mobile phones to call their suppliers. A representative of women entrepreneurs in Nakasero market said that she uses mobile phone services like voice calls and SMS to communicate with her suppliers, customers and fellow business colleagues on the go.

Table 3.23: Mobile Service Used

<table>
<thead>
<tr>
<th>Mobile service</th>
<th>Number of Respondents</th>
<th>Total Number of Participants</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voice calls</td>
<td>146</td>
<td>150</td>
<td>97.3</td>
</tr>
<tr>
<td>SMS</td>
<td>110</td>
<td>150</td>
<td>73.3</td>
</tr>
<tr>
<td>Surfing</td>
<td>40</td>
<td>150</td>
<td>26.7</td>
</tr>
<tr>
<td>Send money through mobile money</td>
<td>125</td>
<td>150</td>
<td>83.3</td>
</tr>
<tr>
<td>Receiving money through mobile money</td>
<td>125</td>
<td>150</td>
<td>83.3</td>
</tr>
<tr>
<td>Buying airtime using mobile money</td>
<td>86</td>
<td>150</td>
<td>57.3</td>
</tr>
<tr>
<td>Surfing</td>
<td>40</td>
<td>150</td>
<td>26.7</td>
</tr>
<tr>
<td>Accessing news &amp; weather forecasts (Radio)</td>
<td>34</td>
<td>150</td>
<td>22.7</td>
</tr>
<tr>
<td>Accessing market information</td>
<td>29</td>
<td>150</td>
<td>19.3</td>
</tr>
<tr>
<td>Others</td>
<td>150</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Note: Respondents could choose more than one option

217
3.32 Startup Women Entrepreneurs Interested in Receiving Business Development Information on their Mobile Devices

Majority (89%) of the women entrepreneurs are interested in receiving information on their mobile devices. This implies that they can utilize the services efficiently if made available to them. Details about the responses are given in table 3.24.

Table: 3.24: Women Entrepreneurs Interested in Receiving BDI on their Mobile Devices.

<table>
<thead>
<tr>
<th>Response</th>
<th>Number of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interested</td>
<td>81</td>
<td>54%</td>
</tr>
<tr>
<td>Very interested</td>
<td>53</td>
<td>35.4%</td>
</tr>
<tr>
<td>Not Interested</td>
<td>8</td>
<td>5.3%</td>
</tr>
<tr>
<td>Neutral</td>
<td>8</td>
<td>5.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

3.33 Kind of Information Startup Women Entrepreneurs would like to receive

They key information women entrepreneurs would like to receive include; suppliers of products, financial support services, product prices, and sources of markets for products. Financial support services have been identified by researchers as the most pressing information needs of startup women entrepreneurs. Details are given in table 3.25.

Table 3.25: Kind of information startup women entrepreneurs would like to receive

<table>
<thead>
<tr>
<th>Type</th>
<th>Number of Respondents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suppliers of products</td>
<td>54</td>
<td>36%</td>
</tr>
<tr>
<td>Financial support services</td>
<td>34</td>
<td>22.7%</td>
</tr>
<tr>
<td>Product prices</td>
<td>20</td>
<td>13.3%</td>
</tr>
<tr>
<td>Source of market for my products</td>
<td>15</td>
<td>10%</td>
</tr>
<tr>
<td>Others</td>
<td>13</td>
<td>8.7%</td>
</tr>
<tr>
<td>Coming up with a suitable business idea</td>
<td>9</td>
<td>6%</td>
</tr>
<tr>
<td>Business locations</td>
<td>5</td>
<td>3.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

3.35 Those that currently receive Business Development Information (BDI) through Mobile Devices

Forty four percent (44%) currently receive business development information on their mobile phones. Therefore, a considerable number of women entrepreneurs are already familiar with accessing business development information through the mobile phone. Hence, it will not be a challenge to get them to access information needed to support decision making through their phones.

3.36 Information Received and the Service Provider

Most women entrepreneurs currently rely on mass media and financial institutions most of which are not focused more specifically on gender aspects, for their business development information as
indicated in the results in table 3.26. The findings of the study show that all respondents were not aware of key service providers of business development information for small scale women entrepreneurs such as Uganda Women Entrepreneurs Association Limited (UWEAL), the National Association of Women’s Organizations in Uganda (NAWOU), the Women of Uganda Network (WOUGNET), etc. Hence they need information about the availability of these services and how they can access them.

Table 3.26: Information received and the Service Provider

<table>
<thead>
<tr>
<th>Type of information</th>
<th>Service Provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of products</td>
<td>Televsions (NTV and Bukkedé)</td>
</tr>
<tr>
<td>Business management</td>
<td>Bukedde Television and Financial institutions</td>
</tr>
<tr>
<td>business florals- Pakasa</td>
<td></td>
</tr>
<tr>
<td>Coming up with a business idea</td>
<td>Financial institutions and TVS-UBC, NBS, Bukkedé</td>
</tr>
<tr>
<td>Coming up with a business plan</td>
<td>Financial institutions and TVs</td>
</tr>
<tr>
<td>Communicating with customers</td>
<td>Telecom companies (MTN, Airtel, UTL, and Orange)</td>
</tr>
<tr>
<td>Financial support services</td>
<td>Banks and Micro Financial Institutions (Pride, Finca and investment clubs).</td>
</tr>
<tr>
<td>Keeping business records</td>
<td>Television (Bukedde and NTV, UBC, NBS)</td>
</tr>
<tr>
<td>How to market products</td>
<td>Television (Bukedde and NTV, UBC, NBS)</td>
</tr>
<tr>
<td>Commodity prices</td>
<td>Telecom companies (MTN, Airtel) and Televsions (NTV, Bukedde, NBS and UBC)</td>
</tr>
<tr>
<td>New products</td>
<td>Airtel Telecom</td>
</tr>
<tr>
<td>Supplier of products</td>
<td>Airtel Telecom</td>
</tr>
</tbody>
</table>

Note: This was an open ended question

4. Discussion

4.1 Information needed to support the decision making process of start-up women entrepreneurs

From literature review and the survey carried out, the information needed to support the decision making process of start-up women entrepreneurs includes the following:

How to develop a business plan: Most of the women entrepreneurs surveyed (61%) did not have a business plan. This is an information need since such women need to be sensitized about the importance of a business plan and guided on how to develop one. Majority of women entrepreneurs (85%) solicited for help from third parties to develop a business plan. A business plan is a tool that can facilitate startup women entrepreneurs to get startup capital and loans to expand their businesses (Rangogo, 2014) from investment clubs, micro finance institutions and banks. It can be used to monitor growth and to control their businesses. Therefore, more women entrepreneurs need support on how to develop business plans.

Source of funds and the different requirements. Majority (84%) of the women entrepreneurs that participated in the study, used personal savings or borrowed from friends or relatives (40.7%), and 38% noted that they had a challenge of getting capital to expand their businesses, 23% indicated getting capital to expand their businesses as one of the challenges they face while 23% said they
would like to receive information on sources of financial support services on their mobile devices. Therefore, information on relevant sources of business funding is an information need. Financial constraints negatively affect women’s motivation to engage in entrepreneurship. Lack of access to finance has been overwhelmingly investigated as a hurdle limiting enterprise startup and growth especially among women (Rangogo, 2014; ILO, 2014, GEM Report, 2014 and Mulira et al, 2010). The United Nations report on trade and development titled: ‘a survey on women’s entrepreneurship and innovation noted that the primary force holding women and men back from achieving their entrepreneurial dreams is the difficulty of accessing capital (UNCTAD, 2013). The same report noted that access to finance is one of the primary challenges entrepreneurs face when they first start their business (UNCTAD, 2013). The UNCTAD report also referred to access to finance as the key obstacle to business growth and innovation today. Startup women often lack information about how to access loans, lack the necessary collateral to obtain one and /or face discriminatory laws or practices related to finance and credit (Common Wealth Secretariat, 2013; Zororo, 2011). In addition, women entrepreneurs have financial social demands that compete with business capital, leading to a diversion of capital away from business needs (Makokha, 200).

Choosing a business location: Majority (74%) of the women entrepreneurs surveyed were renting hence information on how to choose a good business location for different types of businesses would be useful to them. Currently, majority depend on their intuition and referrals from friends/family which may not be accurate. There are numerous stories of women killings, harassment and rape for women entrepreneurs in the informal sector though not much is documented (Saskia, 2013). This creates stress, constant fear and limits the number of women venturing into starting their own businesses (Rajender et al, 2012).

How to register a business. Although 62% of the women entrepreneurs had registered businesses, the 38% that was not registered is big and should be availed with information on how they can register their businesses. This is important given that it is a statutory requirement and more so registered businesses enjoy a lot of advantages as opposed to the non-registered ones like access to loans. However, most of the women entrepreneurs are not aware of the statutory obligation and benefits of registering a business. Of the 150 women entrepreneurs surveyed, 38% said they did not see the need of being registered while 18% did not know what to do.

How to get a trade license: Although 83% had trading licenses, information on the importance of a trade license and how to get one is important for women entrepreneurs. Currently women entrepreneurs go through middle men such as local leaders, market leaders and friends to get guidance on how to get trading licenses. This could be taking them a long time and costing them a lot of money. An enterprise is considered formalized only after the local authorities have acknowledged its existence for example after an entrepreneur has paid market dues or local council fees to operate in given market or area. More so, registered business stand a better chance of getting loans for growth than unregistered ones.

Guidelines on basic book keeping: All entrepreneurs need skills on book keeping but the surveyed women entrepreneurs lacked book keeping skills. Twenty four percent (24%) of the surveyed women entrepreneurs were not certain about how much their weekly revenue was in the first three months of their operation, while 4.7% did not respond to this question. Additionally, 24% said they had challenges with keeping business records.

Information on up-to-date market prices and potential buyers: Twenty nine percent (29%) of the women entrepreneurs surveyed said they need information on market prices, while 65%
reported that they had a challenge of getting customers. This concurs with previous research findings conducted in Uganda by Ikoja (2001) where marketing information was rated the highest information need for rural women small scale entrepreneurs. However, Ikoja’s (2001) study was not gender disaggregated.

4.2 Mobile Technology as the preferred means of Accessing Information needed for Effective Decision Making by Startup Women Entrepreneurs

The study also investigated the extent to which mobile technology would facilitate access to information needed for effective decision making by startup women entrepreneurs. From the findings, ninety six percent (96%) of the participants had mobile devices (basic phone-98%, smartphone-33.3%, laptop-20% and tablet-0.7%). Seventy three percent (73%) were using the mobile phones for voice calls, 73% for SMS, and 83% for mobile money, accessing news and weather forecast-20% and accessing market information-19%. Additionally, thirty four percent (34%) of the participants were very interested in receiving business development information on their mobile device, and 54% were interested in receiving business development information on their mobile device. Forty four percent (44%) were already receiving business development information on the mobile devices mainly from telecom companies, the media and financial institutions. Therefore, mobile technology can to a great extent facilitate access to information needed for effective decision making by startup women entrepreneurs.

However, although technology can save women entrepreneurs some costs, increase profitability and cultivate important networks beyond borders, a section of women entrepreneurs in Uganda still fear using technology (Namono, 2016). The United Nations report on trade and development titled: ‘a survey on women's entrepreneurship and innovation,’ reported that few women are more likely to use social media accounts such as Facebook and Twitter for business marketing and communications than men (UNCTAD, 2013). In Uganda specifically, 28 per cent of women entrepreneurs use social media networks compared with 24 per cent of men (UNCTAD, 2013).

Conclusion

This paper has identified the information women startups need to improve the quality of their decisions in order to increase their success rates. It has also demonstrated that mobile technology has a potential to facilitate access to this information. Therefore, the quality of decisions made by start-up women entrepreneurs can be improved through provision of information necessary to support decision making via the mobile phone which in turn can increase the success rate of women led start-ups.

Future Work

In the near future, we plan to conduct a qualitative study to supplement the results of this largely quantitative study. The results of the study and the qualitative study will form the basis for the development of a mobile decision enhancement model for startup women entrepreneurs.

References


Mobile Phone Voting Acceptance Patterns in Uganda

Emmanuel Eilu
School of Computing and IT
Makerere University Kampala
eiluemma@yahoo.co.uk

Abstract: Using mobile phones as an end device for voting can provide an opportunity for the 14 million Ugandan mobile phone subscribers to vote easily and enjoyably from anywhere at any time. Using mobile phone technology would offer governments of the world’s poorest nations with a direct conduit to its citizens and this would expand citizen participation in decision making. However, it is important to carry out an assessment of people’s perceptions towards using their mobile phones for voting. This would guide the design and implementation process of the mobile phone voting system. It would also help to address underlying issues before the technology is adopted. We carried out a study to assess the current citizen perception and interest towards the use of mobile phones as an end device for national voting two years before the 2016 general elections in Uganda. The study found out that close to 60% of the respondents sampled did not favour the use of their mobile phones for voting, while only 36% were in favour of using mobile phones for voting. The study also revealed that political, technological, social and cultural factors play a critical role towards acceptance of mobile phones for voting.

Introduction

In recent times, citizen’s interest in democratic participations, and more particularly in general elections in both developed and developing nations have been falling. In developed countries, turnout has drifted lower in recent decades. Japan for instance, has seen turnout fall from 75% in 1990 to 52% in 2014. Greece, despite having a compulsory-voting law on the books, has seen turnout fall from 89% in 2000 to 72% in the 2015 elections. And in Slovenia, from post-colonial time till now, voter turnout has drastically fallen from 85% to 54% in 2014 (Desilver, 2015; IIDEA, 2015). The 2014 election in the United States of America registered the worst ever voter turnout in over 72 years with 42.5% voter turnout (IIDEA, 2015). The elections for the European Parliament also registered the worst ever voter turn up of 42% since 1979 (EP, 2014). While, voter turn up in Switzerland has consistently been low at 48% (Desilver, 2015; IIDEA, 2015). Elsewhere in developing countries, voter turn up is even lower that developed countries. Africa as a continent has the lowest voter turnout (65%) in the entire world (Vergne, 2009). The voter turn-out in countries like Uganda under-score this assertion. For example, the 2005 referendum in Uganda had a 47% voter turnout (Petersen, 2006), while in the 2011 presidential elections registered 57% voter turn-out (EU, 2011; Oola, 2011). Tanzania’s case is not different, in 1995 elections, there was a
76% voter turn up, but kept on falling through subsequent elections to the lowest of 43% in the 2010 elections. However, there was a slight improvement in 2015 with about 67% (2015; IIDEA, 2015). The 2015 elections in Nigeria had 43% voter turn up, down from 53% in 2010. This kind of trend is registered in many other countries like Mali, Zimbabwe and Burkina Faso among others had registered a voter turn up of less than 60% (IIDEA, 2015). When citizens do not turn up to vote, their willpower will not be demonstrated. They lose out on equal representation. According to Pintor et al., (Nd), voter turnout is measured as the extent to which citizens participate in how they want to be governed and by who. *It is usually expressed as the percentage of voters who cast a vote* (i.e., “turnout”) *at an election* (Pintor et al., Nd). By voting in competitive elections, for example, they hold within their authority, the power to grant political legitimacy on any leader or withhold it from any leader, institution and regime (Bratton, 2013). Therefore there is need to study ways in which the organization and execution of elections in developing countries can be improved so as to increase voter participation. The use of mobile phones for voting has been cited as one of the solutions for low voter turn up.

**Using Mobile Phones for Voting**

Over the last ten years, mobile phone coverage in Africa has remarkably grown. In Uganda alone, over six (6) giant telecommunication companies and about over fourteen (14) million Ugandans own cell phones. By December 2009, the coverage for mobile telephony in Uganda reached 100% with a total of 2300 base stations erected throughout the country (Sin et al,. 2008). Mobile phones are so far the most adopted mobile computing devices in developing countries (Marsden *et al,.* 2008). Mobile phone technology has supported various successful projects in Africa. These projects range in variety and scope, for example, mobile phone have been used for monitoring measles outbreaks in Zambia, supporting diagnosis and treatment by health workers in Mozambique, and sending health education messages in Benin, Malawi and Uganda (Aker & Mbiti, 2010). In Kenya, Malawi, and South Africa, mobile phones are being used to send several reminders a day to HIV-positive patients (Aker & Mbiti, 2010). Farmers in countries as diverse as Niger, Senegal, Ghana, Kenya, Uganda and India have either used mobile phones to type in a code, send a text message, and receive the prices of a variety of goods immediately or text hotlines to ask for technical agricultural advice (Aker & Mbiti, 2010). Politically, mobile phone technology has also been used to improve election monitoring, report on human rights abuses, strengthen civil society, and democratize the flow of information (Kalil, 2008). For instance, the National Democratic Institute (NDI) introduced short messaging technology (SMS) as a reporting tool for election observation in Indonesia and Palestine, and has continued to successfully integrate SMS into subsequent observation missions in Bahrain, Albania and Sierra Leone. As seen from the above discussion, mobile phones have virtually been used in every field in today’s African society. The focus should now be on new and innovative ways of integrating mobile phone technologies into sensitive processes like national voting (UNDP, 2012). Mobile phone voting if adopted well, promises much cheaper and more secure voting processes than paper ballots, far simpler vote counting and high voter turn-up compared to other voting Information and Communication Technologies
(ICTs). Hence mobile phone technology would pass as the cheapest and most appropriate form of technology to be used in national voting. Whereas mobile phone may be widely acceptable for other services discuss earlier, its acceptance as a voting tool for national elections in many developing countries is very low. According to Sin et al. (2008) close to 50% of the educated class in Malaysia have a negative perception and expectation towards the use of mobile phones for voting. This is mainly as a result of a society influenced by cultural norms, laws and beliefs. A survey conducted in Lagos-Nigeria revealed that 27.4% of the elite population in did not prefer using mobile phones as voting tools mainly because of apathy and illiteracy (Ayo et al., 2011) However, it is worth noting that ICT acceptance patterns may differ from one place to another. Kaikkonen (2009) observes that the factors affecting adoption and acceptance of any given technology may differ from one place to another. This is because of the different needs, perceptions and interests in different societies. Therefore, it is important to carry out an assessment of people’s perceptions towards the use of any given technology before it is adopted. This would guide the design and implementation process and would help address underlying issues before the technology is adopted.

This Paper

This paper, discusses the current citizen perception and interest towards the use of mobile phones as an end device for national voting about two years before the 2016 general elections in Uganda.

Methodology

The first survey was conducted in three districts in Uganda namely; Soroti, Serere and Kumi in eastern Uganda. The three districts were chosen because at the time of the study, the primary researcher was based in Soroti and the other two neighboring districts could easily be accessed from Soroti district that lies on the east of Kumi and west of Serere. This made it cheaper and convenient for the researcher. In addition and most importantly, the population in the three districts possessed most of the characteristics of typical voters in Uganda namely; different age groups, levels of education, political affiliations, rural, peri-urban and urban residence, gender, income groups and occupation. For example, according to the electoral commission of Uganda, the registered voters in Soroti are over 195,000 representing 76.5 percent of the voting population in Soroti, while in Kumi, there were 140,000 registered voters, representing 78 percent of the voting population in Kumi. Furthermore, the population in the three districts is nearly evenly distributed across the major political parties in the country namely; the ruling National Resistance Movement (NRM), Forum for Democratic Change (FDC), Democratic Party (DP) and Uganda People’s Congress (UPC). The respondents were mainly Itesots and Kumams who are the predominant tribes in the three districts. The research used stratified sampling to select the sample population to participate in the study. According to Amin (2005), stratified sampling is a process of dividing and
categorizing the population into homogeneous sub population for example male category, female category, age group etc. The study used a sample size of 1000 respondents from the 3 districts. The researcher then used Krejcie & Morgan (2006) approach to determine the number of participant or respondents for the study. Krejcie and Morgan (2006) presented a table that researchers can use when selecting the appropriate sample size; they indicate that for a quantitative study of a population of over 100,000, the sample size should be 386 respondents. However, Amin (2005) observed that the minimum number of participants believed to be acceptable for a study depends on the type of research involved. Perry (1998) puts it at 350 for Doctor of Philosophy (PhD) quantitative survey and 45 for a qualitative study. In this research, a sample size of 500 participants were sampled. In this research, a sample size of 900 participants were sampled. 300 participants were selected from each of the three districts, that is; Soroti 300, Kumi 300 and Serere 300. Each district was divided in to 3 major strata and each strata had 100 respondents, that is; Urban-100, Peri-Urban 100 and Rural 100. A total of 900 questionnaires were given to respondents of different age groups (from 18 and above-eligible voters), gender, literacy levels, income level, occupation and type of mobile phone owned. The questionnaires were design based on Likert scale of 7 (i.e. Strongly Agree, Agree, Somewhat Agree, Neutral, Somewhat Disagree, Disagree, and Strongly Disagree). Out of 900 questionnaires given out, 786 were fully filled and returned for analysis, thereby contributing to an 86.9 percent response rate. The completion of these questionnaires was voluntary and responses were anonymous. The completion of these questionnaires was voluntary and responses were anonymous.

Presentation of Results

In order to assess their perceptions and interests towards using their mobile phones for voting, the major statement that was presented using a closed ended questionnaire on a Likert scale of 7 was:

“I would prefer using my mobile phone as an end device for national voting”.

The tables below show the demographics of the respondents

Table 1: A, B, C: The place of interview, gender and age of the respondents

<table>
<thead>
<tr>
<th>Place of Interview</th>
<th>Frequency</th>
<th>Valid %</th>
<th>Gender of the Respondents</th>
<th>Frequency</th>
<th>Valid %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>260</td>
<td>33.2</td>
<td>Male</td>
<td>442</td>
<td>56.4</td>
</tr>
<tr>
<td>Peri Urban</td>
<td>250</td>
<td>31.1</td>
<td>Female</td>
<td>344</td>
<td>43.2</td>
</tr>
<tr>
<td>Urban</td>
<td>276</td>
<td>35.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age of Respondents</th>
<th>Frequency</th>
<th>Valid %</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-30 years</td>
<td>408</td>
<td>52.1</td>
</tr>
<tr>
<td>31-40 years</td>
<td>183</td>
<td>23.3</td>
</tr>
<tr>
<td>41-50 years</td>
<td>107</td>
<td>13.6</td>
</tr>
<tr>
<td>51-60 years</td>
<td>48</td>
<td>6.0</td>
</tr>
<tr>
<td>60 and above</td>
<td>39</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Based on the above statement, the study reveals that 449 (58%) of the respondents were not in favour of using their mobile phone for voting, while 281 (36%) were in favour of using it for voting. This shows that a sizable number of eligible voters do not prefer using their phones as a voting tool as shown in the pie chart of Fig. 1.

Fig 1: General response towards using mobile phones as an end device for voting.

In summarizing the findings, there is evidence that close to 60% of the respondents did not prefer using their mobile phones as an end device for voting. Among the voters who are highly expected not to prefer using their mobile phones for voting include; voters of the age of 50 years and above, voters who work in civil and informal sectors, voters who stay in urban areas, those who have no education, those that have a diploma and above and those who earn less than Ug Shs 100,000 (Note: US$ 1= Ug Shs 3,300). See summary below.

Fig 2: Voter categories that do not prefer using their mobile phones for voting

However, over 40% of the following voter categories were in favour of using mobile phones for voting, namely; the female respondents, age group between 18-39 years, those who worked in NGO and Private Sector, those who had attained A-level, voters who earn more than Ug Shs 600,000 and voters who mainly live in peri-urban areas.
In order to justify the statement (I would prefer using my mobile phone as an end device for national voting), a number of political, technological and socio-cultural statements were asked. The statements were designed in form of a close ended questionnaires based on a 7 point likert scale. (i.e. Strongly agree, Agree, Somewhat agree, Neutral, Somewhat disagree, Disagree, Strongly disagree) which was given out to the respondents. In order to simplify results, the study computed results of only agree, disagree and neutral. In summary, the study found out that a bigger percentage of the respondents was not willing to use their mobile phones for voting as a result of three categories of factors.

**Political Factors**

The study revealed that 70% of the respondents were not willing to use their mobile phones for voting because they did not trust the government, while 70% said they do not trust the Electoral Commission. 57% of the respondents believe that using their mobile phones for voting would not add quality to the general elections. With high levels of bribery and corruption especially among the political class, 60% of the respondents believe that they can be easily bribed to vote for another candidate when they use their mobile phones for voting. All in all, 57% of the respondents believe that the existing laws and policies on elections will determine whether or not they would use their mobile phones for voting.

**Social Cultural Factors**

About 58% responded that it has never been their dream or desire to use their mobile phones for voting. 24% of the respondents agree that they would not use their mobile phones for voting because of their status in the society, while 36% agree that it was childish to use their mobile phones for voting. 55.6% believe that they will not get satisfied if they voted using their mobile phones. 35.5% of the respondents believe that their cultural beliefs would hinder them from using their mobile phones for voting, 41% said that their spiritual values conflict with the use of mobile phones for voting.
Technological

About 61% of the respondents did not trust the mobile phone company mainly because of the past experience they had with particular company such as un-necessary charges on loaded airtime, expensive call and text message rates to mention but a few. 52% believed that the mobile phone voting procedure will be complex for them to easily vote, 54% of the respondents would not use their mobile phones for voting because of the poor network connectivity in areas where they live. About 64% agreed that they would not use their mobile phones for voting because it is easier to make a mistake and vote for the wrong candidate. 63.5% also believe that it is easier to rig elections using this technology than it is with manual ballot procedure.

In summary, the study reveals that social and cultural factors contribute 40% of the total factors affecting the use of mobile phones as an end device for voting. Political factors represented 31%, while Technological factors represent 29% of total factors affecting the use of mobile phones for voting.

Random sampling technique was used to select about 35 of respondents and they were asked to give remarks or opinions on what they thought about using their mobile phones for voting as a voting tool.

Question: what is your opinion on the use of mobile phones for voting?

Close to 90% of the respondents who were interviewed indicated that the acceptance of mobile phone for voting is underpinned on the trust and confidence people have in the electoral commission to conduct a free and fair mobile phone voting exercise. One respondent said “If the electoral commission can fail to adequately organize and execute a manual ballot paper elections, how can it organize a mobile phone voting exercise?”. About 86% of the respondents said that government was incapable of conducting a mobile phone voting exercise given the meager financial resources and the necessary skilled man power needed for the exercise. Some believe that election rigging would become easier than it was with manual ballot paper. The respondents also claimed that watching over their votes in polling stations during voting and counting processes would be difficult. One respondent recounted “since I am a pooling agent for my party, I will not be able to watch over my candidate’s votes because with mobile phone voting, every one voters from anywhere”.

72% of the respondents were disgruntled not only on how the government and the Electoral Commission have been conducting elections but also how political parties in Uganda have been treated by government. One respondent gave an example that the freedom to assemble and discuss political matters by opposition politicians has been prohibited by police. Other respondents (33%) were concerned of the technological challenges associated with mobile phone voting. From poor network connections to the
nature of basic mobile phones that many people have. One respondent said “there is very severe network problem in my area”. The study revealed that about 24% of the respondents cannot send a text message, while 44% could not send mobile money. “If I cannot send or open a text message, how will I vote?” one respondent asked. However, many secondary school students said that it would be an exciting experience since they would vote from anywhere at any time. Among the 35 respondents who were interviewed over 95% said that cultural factors could not influence the acceptance level. However, they said that social factors like low level of education and wider digital divide among the masses could greatly undermined the use of mobile phones for voting.

Discussion
The successful utilization of technology for any service in developing countries is more than a technological matter; it is influenced by many factors including organizational, social and cultural issues (Al-Shehry et al., 2006). Shaukat and Zafar (2009) also observes that successful transfer and adoption of ICT in socio-culturally diverse developing countries requires an understanding of micro-level cultures, organizational settings, social lives, beliefs, norms, preferences and many others.

Acceptance Patterns
From the results presented earlier in this paper, it is evident that there is a low level of acceptance of mobile phones as a voting tool in Uganda especially among the elderly, illiterate, low income earners, civil servants, informal sectors voters and the highly educated. According to Kailasam (2010) the older, illiterate and poorer groups in society tend to exclude themselves from this technology because of their negative perception and expectation towards technology. However, the study also found out that voter who would prefer using their mobile phones for voting included the following: female respondents, age group between 18-39 years, those who worked in NGO and Private Sector, those who have attained Advanced-level and voters who earn more than Ug Shs 600,000. Sin et al. (2008) observes that the youth (age below 35 year) and the women have higher acceptance levels towards using their mobile phones for voting. The low levels of acceptance is greatly influence by factors such as social, cultural, political (organizational) and technological factors.

Political Factors
Political attribute in user experience design has always been considered under social attributes or sometimes under organizational attributes. Politically, there has been a lot of discontentment with political leadership in many developing countries, especially in the way they conduct general elections. Nigeria for instance had general elections in 1999, 2003, 2007 and 2011, and the common feature of all four elections is the controversy
arising from the irregularities in the electoral processes. A lot of bitterness and animosity has risen among the political class, this has had diverse effects on the growth of democracy and the development of the country as a whole (Oyatoye & Adebiyi, 2011). The opposition in Uganda has expressed loss of confidence and trust in Electoral Commission citing that the chairman and all the commissioners are appointed by the president, who since 1996 has always been a candidate (EU Election Observation Mission, 2011). For example, the voter registry contained a lot of errors during the 2006 elections to the extent that the Electoral Commission deleted over 150,000 voters’ names from the register at the conclusion of 2006 elections (HURINET-U 2010). There is need to build confidence and trust in the political leadership, where the political leadership can be trusted to conduct a free and fair election using any means, either manual voting or electronic voting. The result of our study discussed earlier in this chapter reveals that political and governance factors are top on the list of factors that affect the use of mobile phones as an end device for voting. For instance close to 70% of the respondents surveyed were not willing to use their mobile phones for voting because they do not trust in either government or the electoral commission. The results of the study further revealed that 56% of the respondents believe that using their mobile phones for voting would not add quality to the general elections because of the current state of the political and legal environment in the country. The Birch (2008) observes that, rules of the game can be manipulated through legal or parliamentary means, and though there are international legal standards governing any electoral process, governments nonetheless benefit from considerable leeway in the interpretation of international norms. This becomes difficult for international observers to label the manipulation of rules ‘corrupt’ or ‘fraudulent’. The respondents believed that the existing laws and policies on elections do not favour a free and fair electoral process. There is no levelled political ground for the opposition politicians. The constitution for example empowers the president to appoint all the electoral commission commissioners who are most likely to conduct elections in his favour. Though there was a wide spread rejection of mobile phones for voting, sections of the respondents favoured its use. 40 % of the youth, those who work with private sector and respondents who work for Non Governmental Organizations said that the use of mobile phones for voting was timely because mobile phones have successfully been used for other services like in business, agriculture and health, and that there is a great political will to foster the use of technology in government as well. The conclusion here is that confidence and trust in the political system to conduct a free and fair election is key in improving poor experience. Trust and confidence in both the government and electoral commission would increases chances levels of acceptance of mobile phones for voting.

Socio-cultural Factors

Social and cultural factors contribute to 21% and 19% respectively of the total factors affecting the use of mobile phones for voting. Socially for instance, 24% of the respondents agree that they would not use their mobile phones for voting because of their status in the society, while 36% agree that it is childish to use their mobile phones for voting. Kailasam (2010) confirms this and observes that in many developing
countries, mobile phones are considered as a tool used by the youth for games and leisure. Culturally, 36% of the respondents believe that their cultural beliefs would hinder them from using their mobile phones for voting, 41% accepted that their spiritual values conflict with the use of mobile phones for voting. As discussed before, socio-cultural and organizational factors are more likely to determine the success/failure of an ICT project in developing countries more than any other place in the world (Evrensel 2010). The successful utilization of technology for any service in developing countries is more than a technological matter; it is influenced by many factors including organizational, social and cultural issues (AL-Shehry et al., 2006). Shaukat & Zafar (2010) also observes that successful transfer and adoption of ICT in the socio-culturally diverse developing countries requires an understanding of micro-level cultures, organizational settings, social lives, beliefs, norms, preferences and many others. In order to create some kind of excitement before use, there should be no or little conflict between socio-cultural lifestyle of the user and the technology being used. The low level of acceptance of technology in many developing countries is closely linked to negative social and cultural norms and beliefs (Khaled, 2008). Shaukat & Zafar (2010) plainly puts it that social-cultural factor in developing countries dictates how technology must be designed. There is need to design for acceptance amongst different groups of voter. The kind of design that supports essential needs of the user like; social, cultural and economic needs and values.

Technological Factors

Failures in ICT aided elections arise from a range of technological challenges; such as software engineering challenges, insider threats, network vulnerabilities, auditing challenges and many others (Heeks, 2003; Blanc 2007; Lopez 2011). For example, the whole voting process needs to be reliable and secure, there is need to keep the ballot secure during the entire voting process (Ayo et al., 2011). The study found out that, technology related challenges make up 29% of the total challenges affecting the use of mobile phones for voting. This challenges range from malevolent past experiences with the technology to complex voting procedure and poor network connectivity. This research also reveals that 61% of the respondents do not trust mobile phone companies mainly because of the past experience they had with them, such as un-necessary charges on loaded airtime, expensive call and text message rates to mention but a few, while 51.6% believed that the mobile phone voting procedure is complex for them to easily vote. About 54% of the respondents said that there was poor network connectivity in areas where they live. Most respondents also feared that it would be easier to rig using this technology than it is with manual ballot procedure. Jone (2002) concurs and observes that people believe that it is easier to make a mistake when using a mobile phone for voting and they may also be unsure whether they have voted correctly. Creating trust and reliability is paramount, it may include creating good network connection, efficient mobile phone services such as mobile money transfer, and bill payment and many others is a first step to building trust in the technology itself. This would create confidence in the technology to perform other services like voting which will in turn increase level of
acceptance in using mobile phones for voting. Creating user friendly mobile phone voting interface would enable voting with ease.

**Conclusion**

Using mobile phones as an end device for voting can provide an opportunity for the 14 million Ugandan mobile phone subscribers to vote easily and enjoyably from anywhere at any time. Using mobile phone technology would offer governments of the world's poorest nations with a direct conduit to its citizens and this would expand citizen participation in decision making. However, it is important to carry out an assessment of the people's perceptions towards using their mobile phones for voting. This would guide the design and implementation process of mobile phone voting system. It would also able help to address underlying issues first before the technology is adopted. We carried out a study to assess the current citizen perception and interest towards using their mobile phones as an end device for national voting 2years before the 2016 general elections in Uganda. The study found out that close to 60% of the 786 respondents sampled were not in favour of using their mobile phones for voting, while only 36% were in favour of using their phone for voting. Generally, Social cultural factors combined play the biggest role towards the acceptance of mobile phones for voting in Uganda. 72% of the respondents were disgruntled not only how the government and the Electoral Commission have been carrying out elections but also how political parties in Uganda have been unfairly treated by government. Although technological factors may not be as difficult to overcome like the political factors, technological factors were the second most important factors to address if mobile phones were to be used for voting. Poor network connectivity, network congestion and un-necessary deduction of air-time from the customers would be among the first challenges to be addressed in order to build citizen trust in using their mobile phones for voting. Social and cultural factors are the third and fourth respectively.

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A model for harnessing the power of the Mobile Phone Technology to improve Smallholder Agriculture in Zimbabwe

Samuel Musungwini
*Computer Security and Reliability, Computer Communications (Networks)*
*Midlands State University, Gweru, Zimbabwe*
*musungwinis5@gmail.com*

**Abstract:** Mobile technologies are capable of facilitating networks of farmers and agribusiness in a dynamic way such that these stakeholders can support each other. The initiative of using mobile technologies in agriculture is in its infancy stage in the world at large while in some developing countries it is already in use. The smallholder farmers largely depend on agricultural activities for food and income for all their requirements which include paying school fees for children, buying farming implements for next season and housekeeping requirements. The bulk of small scale farming systems in the developing world are very much limited in production and therefore inherently less profitable than they should be. The chief contributor to this is the information lopsidedness and the necessary farming skills gap that hinder the embracing of available technologies and management practices. This paper designs a model that could be used for harnessing the power of Mobile Phone Technology to improve Smallholder Agriculture in Zimbabwe. An analysis of the current array of models was done and their weaknesses evaluated. The proposed model is holistic in nature and build on the strength of current existing models but it stresses the need to integrate USSD technology, together with web-enabled and Android based platforms. It also stresses the need for a hybrid mechanism for data dissemination which facilitates for both push-based and pull-based data dissemination.

**Keywords** Mobile phone technology, Smallholder farmers, Harnessing, Agriculture, USSD.

1 Introduction

There have been exponential growths of mobile phone penetration in the developing world. In Zimbabwe the mobile penetration is 103% although this figure does not take into account such factors as dual and triple Subscriber Identity Module (SIM) card phones and multi handset ownership. The mobile technology ownership is so widespread in Zimbabwe that even in the most rural areas there is a very high level of mobile ownership. Mobile technology is unquestionably a boon to all the third world countries due to its capacity to make available information as well as transforming personal lives and businesses operations more efficiently through dual communication. Due to this capability this technology has since developed into one of
the fundamental building blocks of modern society, within a very short time. ICT covers any product that can accept, store, retrieve, manipulate, transmit or receive information electronically in a digital form (Aker & Mbiti, 2010).

Introducing mobile phone technology in agriculture can have a lasting impact on agricultural outcomes and the welfare of smallholder farmers in a variety of ways. According to (Silva, 2008) information asymmetry is a significant contributor to overall transaction costs. ICT is starting to influence the way agriculture is practiced in the world (Maumbe, 2013.) For instance the bulk of the Zimbabwean population (67%) (Agency, 2012) live in the rural areas and heavily depends on farming activities for a living. In actual fact there is empirical evidence of urban to rural migration in Zimbabwe as confirmed by the census of 2012 (ibid).

The smallholder farmers largely depend on agricultural activities for food and income for all their requirements which include paying school fees for children, buying farming implements for next season and housekeeping requirements. These smallholder farmers labour on their land but what is happening is that there are middlemen who are benefitting from these farmers' work as they prey on farmers poverty and bring second hand clothing and groceries to small holder farmers and take away the hard-earned farmers' produce as observed by this researcher in one area. There is need for boosting the performance of these smallholder farmers as this result in the uplifting of the overall level of standards of living of smallholder farmers and the development of the economy at large. This segment provides a source of living to 70+ percent of the Zimbabwean population and up to a third of the country’s labour force is employed in the agricultural sector.

2 Background

Smallholder farming activities in Zimbabwe include the practice of cultivating crops and breeding and raising livestock. Livestock save a number of purposes. Most smallholder farmers lack machinery like tractors and other implements hence livestock provides the draught power for the farmers. Over the years livestock have been harnessed for such activities as pulling carts, transporting people, hauling water, trashing harvests, ploughing and weeding of crop fields. In times of difficulties like drought the livestock is sold for income augmentation. The vast majority of smallholder farmers practice dryland farming. Dryland farming is a form of farming that is practiced in areas that receive inadequate rainfall. Farming in these areas highly depends on tillage methods. This results in the soil being more receptive of moisture but selection of suitable crops is required for each region. Failure to observe this results in very low or no yields at all.

Most smallholder farmers reside in remote areas where infrastructure is rudimentary and uncoordinated. Lack of capital causes a challenge in securing farming inputs. Lack
of good farming knowledge coupled with absence of information threatens viability of their activities. Some of the more mirrored problems include unavailability of credit facilities, unavailability of ready market for their produce, perishable products, unavailability of transport and high transport costs, erratic rainfall and frequent drought. It is these problems, coupled with absence of information that gave rise to the mushrooming of the middlemen. Smallholder farmers daily toil on their land putting in so much effort in their agricultural activities, but alas they remain considerably poor. This has always distressingly turned out that other players in the value chain of products produced by these farmers get richer and richer while the rural farmers wallow in poverty.

3 Literature

In September 2000 the world leaders came to an agreement in which they crafted 8 Millennium development goals (MDGs) which were targeted at being realised in 2015. The world development agenda was premised on the MDGs for the period in question. Since then contemporary discourses on development consistently identified ICT as a requirement for economic growth and the general improvement of Social conditions (Avgerou, 2003, 2008, 2010; Geldof, Grimshaw, Kleine, & Unwin, 2011; Perkins, 2010). According to (Stalker, 2008) the MDGs are credited for lifting approximately more than one billion people out of extreme poverty. A number of milestones were achieved as a result of MDGs, these include inroads against hunger, the enabling of more girls to attend school than ever experienced before especially in the developing world and environment issues protect our planet. MDGs initiated novel and innovative partnerships within and between countries; they influenced public opinion and reshaped decision-making in both the developed and developing countries to reduce poverty in all its extreme forms.

International development agencies make a strong association between ICTs and development. They argue that more successful economies have more technologies and are better prepared for using them to their competitive advantage (Avgerou, 2003). According to Norton (1992) the availability of ICT infrastructure lowers fixed costs of acquiring information and the variable costs of participating in the market. Professor Charles Schwab pointed out that ICTs are the best hope for developing countries to accelerate their development process. It is important to note that health and education have been given primacy by both researchers and policy makers the world over and therefore they have dominated ICT4D research over the years (Chepken, Mugwanya, Blake, & Marsden, 2012). Agriculture has been attracting very little attention until the recent years (ibid).

It is important to note that 60% of all ICT4D research was done in Asia especially India and by Indians (Chepken et al., 2012), hence this researcher believes that is why it is reported that there are a number of ICT4D success activities in India. In Africa
less research have been done compared to other regions of the world and most of it was not done by Africans and let alone Agriculture. Emulation of western practices in developing countries have rarely succeeded (Avgerou, 2003). Arguably, more successful commercial farmers have more technologies and they are better prepared and resourced for using them to their advantage. Therefore it is important for locals to be involved in the research and policy development agendas as they have a better appreciation of the local settings.

Smallholder farmers are the world’s largest group of working age poor yet much of the world’s supply will continue to depend on their effort (Bagazonzya, Bank, Safdar, & Sen, n.d.). ICTs increase efficiency, provide access to new markets or services, create new opportunities for income generation and give poor people a voice (AfricaPartnershipForum, 2008). The use of ICT in Agriculture is beginning to influence the way Agriculture is practiced (B. Maumbe & Owei, 2013). In a research conducted in Niger it was established that mobile phones helped to reduce information search costs and improved farmers bargaining power on the market (Aker & Ksoll, 2012). In Africa to include Zimbabwe the mobile phone is the predominant mode of communication. The mobile phone requires basic literacy to operate hence it is easier to use for the basic user. The mobile phones are increasingly being capacitated to offer facilities like data transfer. In Kenya there are using a facility called DrumNet to deliver targeted services to rural farmers. However this was found to be unsuccessful because of ignorance as most respondents could not send an SMS which is a basic requirement for one to use the system.

3.1 Models review

This researcher looked at different models that have been proposed and developed over the years in order to come up with an informed position for the model to be proposed in this paper. The issue of information dissemination models is not a new concept, it started in the early 1970s and it evolved over the years to its current scenario. In order to determine what is the most appropriate model to be adopted for a particular situation, there things to be considered and these are; the information infrastructure, operating costs, farmers’ capabilities, farmers’ information consumption behavior and, most importantly, the local context should be taken into consideration (Zhang, Wang, & Duan, 2016).

*Harnessing ICT to develop community and identity: a model for academic departments by Clara M. Chu and José Rodolfo Hernández-Carrión.* In this article the authors talked about the need to get access to the right information at the right time. They further talked about the new world order where technology has become ubiquitous and the world has become politically, economically and technologically integrated. Because of this interwoven of these aspects of the global world there is need for a transformation of the social processes to reflect the new dispensation. The authors then proposed to develop the web based community portal
for the university. While the model was then and probably still a good thing this researcher would like to think that it is relevant in a university set up in a developed country where web enabled gadgets are a common feature.

Agricultural information dissemination using ICTs: A review and analysis of information dissemination models in China. This article looked at a number of models that have and are being used in China and other advanced countries to support agriculture. With the rapid development of information technology, the agriculture information dissemination models have and are still constantly evolving and improving. These agricultural information dissemination models are therefore listed below.

- Web Based Portal – a collection of relevant web sites to form one stop centres for users.
- Voice-Based Service – information dissemination through telephone.
- Text Message (SMS)-Based Service – information dissemination through text message of mobile phones.
- Self-Support Online Community – information services provided by a community to its members.
- Interactive Video Conferencing Service – using online multimedia technology to facilitate information service.
- Mobile Internet Based Service – information dissemination through smart phone service.

These models are evaluated in Table 1.

These models have served and are still serving the agricultural community in China and other regions very well. However, it is important to note that the conditions in China and other countries are different from those in Zimbabwe and other developing countries. Zimbabwe’s high ICT Development Index (IDI) and the harsh economic climate make it difficult for most of the smallholder farmers to access and use these models. ICT Price Basket (IPB) is an exceptional metric that is used to track and weigh the cost and affordability of ICT services in more than 160 countries in the world. The IPB index measures communication costs such as call costs per unit as a percentage of Gross National Income (GNI) per capita, and reflect on the regional disparities in connectivity costs. According to the ITU report of September 2011, Zimbabwe is ranked number 3 in the whole world as the most expensive country to make a call. Smallholder farmers in Zimbabwe are poor by any standard, they cannot afford the smart phones hence cannot access the internet on their phones. Calling is very expensive hence smallholder farmers cannot afford to call for information services.
<table>
<thead>
<tr>
<th>Model</th>
<th>Operational features</th>
<th>Advantages</th>
<th>Shortcomings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Portal</td>
<td>A collection of relevant web sites to form a one stop portal for users</td>
<td>Easy access, compressive and in-depth information provision</td>
<td>One for all information, No customization. May not be relevant to an individual user’s specific information need.</td>
</tr>
<tr>
<td>Voice-Based Service, IVR</td>
<td>Information dissemination through phones or online voice calls.</td>
<td>Interactive communications, easy to understand and individual service</td>
<td>Require human involvement, time consuming and less efficient, more costly</td>
</tr>
<tr>
<td>Text (SMS)-Based Service</td>
<td>Disseminating information via Mobile phone texts</td>
<td>Push-based approach, very effective and efficient in sending short and timely messages</td>
<td>Cannot provide comprehensive and in depth information. One for all service. May not be relevant to individual user’s specific information needs</td>
</tr>
<tr>
<td>Online Community</td>
<td>A membership system involving all stakeholders comma share experience and exchange information through interactive service platforms</td>
<td>Interactive communications, relevant information, user participation, cost effective service</td>
<td>Require active user participation, efforts and good management. Service is only available for members</td>
</tr>
<tr>
<td>Interactive Video Conferencing Service</td>
<td>Information dissemination using online conferencing service</td>
<td>Easy to understand, very effective communications, interactive service</td>
<td>Require human involvement can be time consuming and less efficient, costs is high due to the involvement of human experts</td>
</tr>
<tr>
<td>Mobile Internet Based Service</td>
<td>Information dissemination using Mobile Internet service via smart phones</td>
<td>Ubiquitous, cost effective, easy access, can incorporate GPS technology to provide location related service</td>
<td>Require adequate infrastructure and the use of smart device. Require higher IT skills to use new technologies</td>
</tr>
</tbody>
</table>
Some of the models indicated there use a push based mechanism of data delivery where the system simply broadcasts messages to farmers without getting any form of feedback from the farmers. Some models are heavily skewed towards android Applications which only run on Smart phones. Smallholder farmers typically represent the working poor of the developing countries. That is the main reason as to why these writers believe that use of an integrated system which supports all web based system, the android system as well as supporting both the push based mechanism and the pull based mechanism.

4 Proposed model

4.1 Motivation

The motivation for this model is twofold

Firstly, this researcher being a son of a smallholder farmer parents, grew up in rural Zimbabwe where the better part of their formative years were spent doing these activities and have watched over this vicious cycle repeatedly over and over again. Yet Zimbabwe ranks as one the best countries in the world in terms of literacy levels with 91% literacy rate according to a recent survey (Musungwini, Zhou, & Zhou, 2014).

Secondly, Mobile technologies are preferred because of their ubiquitous nature and their ability to facilitate convenient, synchronized communication for the rural people. This apparently has become the source of information for these rural people who previously had very little to zero access at all to affordable communication channels. Interconnectedness between sellers and buyers are transcending the spatial confines of logistics. It is because of this ubiquitous nature of mobile technologies that this researcher strongly believes exploiting this technology will unravel novel ways of conducting business that could be boon to the small scale farmers in rural Zimbabwe.

ICT for development (ICT4D) has a large role in supporting the future of rural development with the integration of available technologies and the existing knowledge landscape (Brugger, 2011; B. M. Maumbe & Okello, 2010; Okwu, and T.I, 2011). The Egyptian Technology Development Centre, made the following statement in 1997:

The whole world is undergoing an overwhelming technological revolution in information, electronics, computers, and communication. This revolution will widen the gap between the developed and underdeveloped countries. Those who master science and technology and manage information will survive and those who do not will perish, at least economically.

4.2 Overview of the proposed model

A model is a graphical representation of a concept. In the model presented here, the writer focuses on the creation of a novel system of information dissemination to and
from all concerned stakeholders 24/7. This includes: Agriculture Technical and Extension Services (Agritex) Officers, Zimbabwe Farmers Union Officers, Meteorological Services officer, Agricultural Marketing Authority Officers, Veterinary Services Officers, Agricultural Research Council Officers, Independent Market Information watchdogs, Seed Company Officers, Smallholder Farmers in different parts of the country are connected. All smallholder farmers are supposed to be registered in the database and this will ensure that they receive real time and comprehensive farming information. This information includes weather forecast, market information (prices and marketplaces), disease outbreaks, loans availability and terms, input information and relevant newly published research. This model will also work as a knowledge hub for Agriculture information as it will facilitate production of history, projection and trend analysis. (Foran & Escobar, 1996; Nchise, Boateng, Shu, & Mbarika, 2012.)

4.3 Architecture of the proposed model

The proposed model should be composed of the Application layer and the Backend layer. These two layers are the fundamental building blocks of the proposed model.

4.3.1 The Back end layer

The backend part of the application layer is where a processing zone resides. The backend layer is responsible for receiving requests and processing them. In this Architecture it is made up of three (3) key components and these are the GSM modem, SMS gateway and a Database server.

4.3.1.1 The Global System for Mobile (GSM)

The function of the modem is for receiving SMSs from application layer and sending back SMSs to the application layer. GSM Modem can also be used to provide internet connectivity.

4.3.1.2 The Database Server (DS)

The DS will be used for storage of the database as the web application. All computations and processing will be done in the DS.

4.3.1.3 The Short Message Service (SMS)

The SMS Gateway will be used as a bridge between the GSM Modem and Database server. The SMS gateway simplifies the process of sending and receiving SMS text messages to and from a web browser, web server or email.

4.3.2 Application layer

The Application layer shall consist of ten (10) elements and these are Agriculture Technical and Extension Services (Agritex) Officers, Zimbabwe Farmers Union
Officers, Meteorological Services officer, Agricultural Marketing Authority Officers, Veterinary Services Officers, Agricultural Research Council Officers, Independent Market Information watchdogs, Seed Company Officers, Smallholder Farmers.

4.3.2.1 District Agriculture Information Systems Assistant (DAISA)
The District Agriculture Information Systems Assistant (DAISA) is a person responsible for all information in the District pertaining to Agriculture. The DAISA collects Agriculture information in the District, collates Statistics and produces monthly, quarterly and annual reports for their district. This data is then collected to produce Provincial Data repository and further collated to produce information and statistics for the whole country. In the proposed model the DAISA’s responsibilities would include registering all the ten (10) stakeholders named in 4.3.2 above, who are supposed to use the proposed system and system support and housekeeping. Ensuring that the system is up and running, updating, system backup and restore.

4.3.2.2 Agriculture Technical and Extension Services (Agritex) Officers
Agriculture Technical and Extension Services (Agritex) Officers are very critical in this model. In Zimbabwe Agritex officers are placed at various resource centres scattered all over rural Zimbabwe. These officers have their areas of coverage and there are demarcations where there are supposed to end and another starts. From time to time they hold meetings with smallholder farmers sharing information with farmers. Most rural populations are geographically dispersed and isolated from knowledge centres. This makes it difficult to provide information to everyone. Sometimes these Agritex Officers may travel to other areas within their area and at the same time some other farmer in the same area but from a different side may require emergence assistance and the Officer cannot be found.

After registration the Officer will then entirely depend on their cell phone to communicate anything with the system. Assuming that it happens that there is an emergency where a farmer requires immediate assistance the system should be able to select the Agritex Officer closest to him be able to relay information.

4.3.2.3 Zimbabwe Farmers Union (ZFU) Officers
In Zimbabwe smallholder farmers are encouraged to subscribe to the Zimbabwe Farmers Union (ZFU) and the benefits being that a ZFU member whenever they purchase any farming implements from seeds, fertiliser, chemicals etc, they are entitled to a 5% discount. ZFU officers are fewer than Agritex Officers and they are usually stationed at District offices. Their purpose is to register smallholder farmers to become ZFU members.

The ZFU Officer will depend on their cell-phone to communicate anything with the system. However, they require Smart-phones with internet connectivity capability because they need to interact with the backend. These Smart-phones should be
installed with an application which connects to the backend layer and uploads information to the server. In the case of an emergency where a farmer requires immediate assistance for registering with ZFU the system should be able to provide crucial information pertaining to the closest officer to them. These officers can also carry out field visits and register farmers there using their phones.

4.3.2.4 Meteorological Services Officers (MSOs)
In Zimbabwe Meteorological Services offices are found in provincial centres. The MSOs are responsible for gathering data about weather patterns, forecasting etc. This critical data is then disseminated through various media to include radio, TV, Newspapers, Internet etc. However there are a number of challenges impeding this information from reaching the critical recipients, smallholder farmers. The MSOs will then entirely depend on their cell phone to communicate anything with the system. However these require Smart-phones with internet connectivity capability because they need to interact with the backend. These Smart-phones should be installed with an application which connects to the backend layer and thereby enabling them to upload weather information to the server.

4.3.2.5 Agricultural Marketing Authority (AMA) Officers
The Agricultural Marketing Authority is a statutory board responsible for regulating the marketing of agricultural products in Zimbabwe. It sets up the producer price each and every agriculture year. In the proposed model, the AMA Officers will then make use of Smart-phones with internet connectivity capability to communicate anything with the system because they need to interact with the backend.

The AMA officers should be able to screen independent private buyers willing to participate in the buying of agriculture products. The selected private buyers should then be registered with the system providing their details like prices they offer and buying conditions. Smallholder farmers whenever they want to sell their produce should then check with the system and the system should be able to provide information about the best deals available at the time.

4.3.2.6 Veterinary Services Officers (VSOs)
Veterinary Services Officers (VSOs) are very critical in this model. In Zimbabwe VSOs are placed at various resource centres scattered all over rural Zimbabwe usually together with Agritex Officers. VSOs have their areas of coverage and there are demarcations where there are supposed to operate. From time to time they hold meetings with smallholder farmers sharing information with farmers about livestock. Most rural populations are geographically dispersed and isolated from knowledge centres. This makes it difficult to provide information to everyone. Sometimes these VSOs may make field visits to other areas within their area and at the same time some other farmer in the same area but from a different side may require emergence assistance and the Officer cannot be found. Assuming that it happens that there is an
emergency where a farmer requires immediate assistance the system should be able to select the VSOs closest to them to relay information.

**4.3.2.7 Agricultural Research Council Officer**
The Agricultural Research Council of Zimbabwe (ARCZ) is a statutory body born out of the Agricultural Research Act. This body is mandated to keep under review agricultural research in Zimbabwe. This encompasses Crop research, Plant and Animal diseases research and new chemicals for addressing such diseases. The ARCOs will then entirely depend on their cell phone to communicate anything with the system. These Smart-phones should be installed with an application which connects to the backend layer and uploads research information to the server. Whenever a smallholder farmer wants research information the system should be able to identify specific research for that particular farmer.

**4.3.2.8 Independent buyers (IB)**
Over the years the smallholder farmers in Zimbabwe have always been swarmed by the people from all walks of life wanting to do business with them. There are those that buy for cash, those that buy on credit and the bulk who want barter trade. Some bring groceries but most bring second hand clothes. These people have been depending heavily on inadequacy or total absence of information. While a lot of sinister activities have happened because of these people including using fake money to buy farm produce from smallholder farmers these people remain relevant in the proposed model. The IBs will then entirely depend on their phone to communicate anything with the system. These IBs should send their profile information, products they buy and the prices they pay and their terms of service by SMS. Whenever a smallholder farmer wants to sell anything, the system should be able to identify independent buyers offering the best prices and their contact details and then compare the prices being offered by the AMA.

**4.3.2.9 Agribusiness processing companies’ Officers (APCOs)**
Agribusiness processing companies play a crucial role in agriculture. These include Seed companies like Seedco and Pannar, Fertiliser companies like Windmill and Zimplos and other Agrochemical companies. All these companies play a crucial role in farming, they provide among other things seed varieties for different farming regions in Zimbabwe, variety fertilisers, pest and weed control chemicals. As time lapses they continue to produce new varieties to suit changing weather conditions and new diseases. These products are distributed through a number of outlets including retail shops. In the proposed system the APCOs will entirely depend on their Smart-phones to communicate anything with the system. These Smart-phones should be installed with an application which connects to the backend layer and uploads Product varieties, their prices and distribution centres information and their terms of service. Whenever a smallholder farmer wants to buy inputs the system should be able to identify best product varieties that are suitably priced for a particular region that the
farmer is querying from and be able to forward such information to that particular farmer.

4.3.2.10 Smallholder Farmers
In the proposed model the Mobile Network Operators are required to broadcast the message requesting smallholder farmers to register themselves into the system via Short Message Service (SMS). After registering with the system a farmer can send an SMS to the server seeking for any form of assistance described above in 4.3.2.1 up to 4.3.2.9. In each case the system then identifies the most suitable information appropriate for the farmer and the relevant persons in each case are notified. The system should also be able to schedule Farmer profiling, whereby each farmer’s information history like region, variety of seeds used, assigned Agritex Officers, VSOs, ZFU subscription status, Produce history etc. Any change to this information is then used to update the farmer’s profile.

5 Unstructured Supplementary Services Data (USSD) Technology
USSD technology can also be exploited in this model because of its robust nature. This is a messaging service that is almost seven times faster than SMS and is highly cost effective, its operations are simple and handset independent because the service can be accessed from almost any mobile device from old cell phones to the latest Smart-phones (Aricent USSD White paper, 2011). USSD is a messaging service used in Global System for Mobile Communications (GSM) networks similar to SMS. However USSD is capable of real time and instant messaging. This makes it faster and cheaper than SMS. Communication using USSD codes takes the format *3digit# or *3digit*3digit# in whatever case the asterisk marks the beginning of the format string and the hash symbol marks the end. Worldwide USSD software solutions have been developed for many applications. In Zimbabwe it is being used mainly in Mobile money transactions therefore it can be extended to agriculture.

The proposed architecture of the model is illustrated in Fig 1.

6 Conclusion
Sustainable Development Goals (SDGs) post 2015 – 2030 development agenda are premised on ICTs. The United Nations placed ICTs at the centre of all the identified 17 SDG goals to drive world development. Most of this development is mainly targeted on the developing world, including Zimbabwe. In developing countries however it has been established that there is virtual absence of other ICTs infrastructure except mobile technologies and therefore this places mobile technologies at the focal point to drive development forward in the developing world.
The vast majority of Zimbabweans reside in the rural areas of Zimbabwe. Most Zimbabweans solely depend on agriculture for their living. Most of these people are wallowing in poverty; hence there is need to redress the present situation. The country is struggling to find its foot on the economic front. The proposed model will see to it that the life of the smallholder farmer is highly improved and in the process helping the country to eradicate extreme poverty and hunger. Smallholder farmers will get
crucial farming information from this model such as weather forecasting, market prices information, inputs information and help services on time. Harnessing mobile phone technology has a positive impact on the activities surrounding farming and therefore should be seriously considered if the story of the smallholder farmer is to change. This model may be extended to other areas as well.

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Creative Learning through Wearable Technology – The Bangladesh Story

Tanim Laila
Institute of Hazrat Mohammad SAW, House 3, Road 25/A, Block A, Banani, Dhaka 1213, Bangladesh
Contact Information: tanim.laila@gmail.com , +8801711504543

Abstract: Bangladesh is a low-income country with a dense population, 30% of which live below the poverty line. With a large youthful population (50% below the age of 25) enabling access to education for the masses ranks highly on the list of government priorities. Three of the six mobile operators in the country have made lasting contributions in education through a number of creative initiatives using wearable technology devices such as mobile phones. These initiatives have been in the areas of creating access, availing information, facilitating advisory services. Access has been possible through various affordable internet offerings for youth. Information has been available through call-centre based educational support and advisory support was possible through recorded lectures from expert teachers available through mobile applications. This paper will detail the creative initiatives undertaken by the major operators towards enhancing education. It will highlight how public private partnerships can contribute towards enhancing learning outside the classroom overcoming the barriers of distance and cost for low income countries like Bangladesh.

Learning through wearable technology
Smartphones and tablet computers are radically transforming how we access our shared knowledge sources by keeping us constantly connected to near-infinite volumes of raw data and information. Meanwhile, IT experts were researching how learning models are evolving—and how they can be improved—via the influence of mobile technologies. The wide scale availability of handheld devices and their constantly lowering costs has enabled the idea of classroom following the learner and lessons being at your fingertips.

Up until now, most people considered education a specific phase in life. Entering school at around five years and attending schooling institutions all the way to
university. Education had an expiration date, then working life began. This model is quickly becoming less relevant to our current lifestyles in the knowledge economy. Education is getting increasingly intertwined with our daily activities. On our phones, tablets, and PCs, we download and absorb relevant articles ranging from means to fix a faucet to boarding a new application platform. Many people across age groups enroll into formal online courses. With the influx of low-priced computers, tablets, and cell phones becoming more accessible even in resource-poor households, education is breaking free of the formal schooling system.

**Bangladesh situation**

31.5% (CIA Factbook) of Bangladesh’s 169Mn (CIA Factbook) people live below the poverty line, universal education represents a mammoth task although the country has always placed high priority on education. Bangladesh has made remarkable strides in primary school enrolment and gender parity. Nevertheless, improvement areas remain in adult literacy, post-primary education, quality of education in general, competency of resource persons and job oriented education. There exist opportunities for collaborations between government and the non-government organizations.

In November 2014 the International Telecommunication Union (ITU) published a report on global ICT development where Bangladesh was placed 145th among 166 countries in the global ICT development index. However, telecommunication network covers 97% of geographic area and 99% of population. Total number of mobile phone and internet users stands at 129 million and 43 million respectively as of July 2016 as reported by the Bangladesh Telecom Regulatory Commission. Among the 63.9 million internet users approximately 94% uses mobile internet.

Mobile tariff in Bangladesh is one of the lowest in the world. Telecom industry especially mobile phone industry is one of the major drivers of the economy in Bangladesh. Mobile industry contributed more than 3% of GDP growth. It is one of the largest employers, the largest contributors to the Foreign Direct Investment as well as the biggest source of government’s tax revenue in the country. The sector is also playing crucial role in realizing Government’s vision of Digital Bangladesh.
Vision 2021

The political pledge of the government reflected in Vision 2021 provides a framework for shaping objectives, priorities and strategies for educational development for the nation. Achievement of universal primary education and elimination of illiteracy, better remunerations and training for teachers and overall improvement of quality and equity in education are the major targets of Vision 2021. One of the major focus of Vision 2021 is to build a Digital Bangladesh with a new generation skilled in and equipped with technical and scientific knowledge, supported by creation of gainful employment opportunities. The National Skill Development Policy aims to materialize the long-term objectives of the government of Bangladesh for becoming a poverty-free middle-income country by 2021 by attaching highest priority to building a skilled labor force. The policy aims to improve quality and relevance of skill development programs; to establish more flexible and responsive delivery mechanisms; to improve access to skills development for various groups; and to involve industry organizations, employers, and workers in skills training and acquisition processes.

ICT Policy

The first ICT Policy of Bangladesh was formulated in 2002. It has been revised in 2008 adopted by the government in April 2009. Key feature of ICT policy includes mainstream social advancement opportunities for disadvantaged groups as an immediate priority to minimize economic disparity and bridge the digital divide for (a) lower income groups, (b) ethnic minorities, (c) women, and (d) persons with disabilities and special needs. The ICT policy encourages maximum utilization of ICT services nationwide to boost productivity of small, medium and micro enterprises and agriculture sector, and focus on innovation and competitiveness. The policy calls to establish interconnectivity across government offices for effective sharing of data and build capacity of public functionaries and foster leadership for electronic service delivery and fostering education and research by assessing skills of ICT professionals and meet gaps with targeted trainings and capacity building programs.

Learning Innovations

Alternative learning platforms have been introduced mainly for complementing existing framework, responding to new global trends and meeting service gaps.
Mobiles have become the most favorable technology of modern time in Bangladesh as evidenced by the chart below:

<table>
<thead>
<tr>
<th>Bangladesh media exposure - 2011</th>
</tr>
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<tbody>
<tr>
<td>Watch TV</td>
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<td>74%</td>
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The above examples reflect how low cost mobile phones provide unprecedented opportunities in the educational arena. The teacher to student ratio in Bangladesh is around 1 to 47. According to a research by Save the Children, Bangladesh has achieved remarkable success in enrolment of primary education, with 91% of children enrolled in primary education. Even then, 50% of the children drop out before they complete primary education. Attending school is particularly difficult for working children, children with disabilities, children of very poor families and those living in remote areas. Moreover, the quality of primary education in Bangladesh lags behind the expected standard. The main reason for this fall back is a shortage of schools and most importantly scarcity of teachers particularly in rural and remote areas. The concept of mobile learning has been triggered in part by the use of mobile technology in the educational sector in the developed world. This has enabled developing country counterparts to leapfrog and adopt.

**M-Education**

BRAC Institute of Languages (BIL) and BEP jointly launched mEducation support in July 2013, in 35 secondary schools across Bangladesh. Students can contact the call centre (situated in BRAC’s head office) between 6-9 pm every day for their academic queries. The call centre is equipped with resource persons and subject matter experts to provide suggestions, concept clarification to queries from students. This enables students to have direct interaction with resource persons from their convenient time and place.

**English in Action (EIA)**

English in Action Project utilizes a mobile based innovation for enhancing English Language proficiency for classrooms and adult learning in Bangladesh.
The project targets to improve English language skills of 25 million primary and secondary students and adult learners by 2017. Mobiles are used to deliver audio materials directly to students and to deliver audio and video materials to teachers for their own professional development. 30,000 teachers and 4.8 million students are now participating in EIA schools intervention.

Part of English in Action, BBC Janala is an award-winning, multi-platform service which is enabling millions of Bangladeshis to learn English affordably – through their mobile phones, the web, television programmes, print media and peer-to-peer learning.

The mobile phone service transforms a simple handset into a low-cost learning device. Anyone can learn and practise English by calling a mobile shortcode, from any Bangladeshi mobile operator. So far, more than 7 million people have accessed 3-minute audio lessons for the cost of less than 50 paisa per minute. 95 percent of surveyed teachers reported that EIA had helped them improve their own language skills and 90% feels EIA has an impact on the way they teach.

**Online Schools**
Grameenphone, the largest cellular mobile operator in Bangladesh, in collaboration with JAAGO Foundation has launched the country’s first online schools. JAAGO Foundation is registered non-profit organization that caters to the educational needs of children from socially and economically disadvantaged background and empowering the youths along with inspiring volunteerism. Under the concept a remote classroom is connected online with a classroom in JAAGO’s teaching center in Dhaka where the teacher conducts the session through video conferencing technology. While the class is on, both the teacher and the students have the freedom to interact live.

The online teachers delivers the lecture followed by an interactive session with the student for every class. The facilitators at the receiving end assist the children during in class work and help maintain a disciplined classroom environment. The program contains interactive whiteboard, slide-sharing and video-sharing features and combines a sketch-board to acquaint the students with alphabets through just a stroke from its virtual tutor. The first online school started in August 2011 with 80 students. Today there are 10 online schools. (Jaago Foundation website)
Youth Competition

To stimulate awareness on the internet and create a platform for first experience and progressive usage and adoption, Grameenphone has taken up the I-gen Competition. I-gen stands for Internet genius. This Internet-based competition using mobile phones among the students of the villages and rural areas aims to trigger interest on the internet and wear off the negatives vibes associated with the internet. The initiative has been embraced with huge eagerness among the youth population in Bangladesh. Grameenphone’s I-Genius competition has successfully promoted the power of the Internet to youth across Bangladesh since 2012.

My Study

MyStudy is a mobile learning application service offered by Grameenphone. It currently targets the Secondary School Certificate (SSC) students in Bangladesh reflecting 9th and 10th grade curriculum and focusing on Maths & English. The purpose of the mobile application is to work as a supplementary tool that helps students to understand and learn the curriculum and prepare for the board exams. The application enables the student to go through the content, self-assess performance through mobile based tests and receive guidance from competent teachers as well as question-answer sessions. It also has a module for parents that shows the student’s performance through the application.

Studyline

Studyline was another innovative service brought for the first time in Bangladesh by Grameenphone with the intention of serving the school, undergraduate and graduate students. It was a call center based service where human agents were assigned for answering queries placed by the callers.

2.1 million Internet hours

Grameenphone has launched a program to provide 2.1 million free Internet hours to 250 schools across the country. The initiative is part of global campaign titled "Safer Internet" aimed at creating awareness about internet safety for young users. Rural Bangladesh is still struggling with poor ICT infrastructure, low internet penetration, lack of awareness and limited access to different required information and content services, which has created a major digital divide between rural and urban societies. This program aims to help broaden access to the world of ICT for school children in rural Bangladesh. The campaign
contributes towards the creation of equal opportunities to access educational content, news, information and knowledge for all.

**English in Schools & Internet Corners**

Another cellular network operator Robi Axiata Limited believes education platform remains the main focus to develop a nation. Robi and a national daily the Daily Star have jointly initiated English in Schools (EIS), a language learning program to promote English language learning at secondary schools across the country. Moreover, Robi with the support of Department of Public Libraries – a government organization- has established internet corners at all seven divisional public libraries of Bangladesh with the objective of creating opportunities for experiencing the internet.

**Mobile Education**

Robi has launched a service called Robi Mobile Education. Robi subscribers are able to enjoy the m-education service to get educational information through IVR and advice from the teachers through call center on English, phonetics information on admission to colleges and universities etc.

Robi Shikkharthi Service is another m-education service from the same operator that utilizes the SMS, IVR & WAP/WEB platform. It aims to serve the school, undergraduate and graduate students. It disseminates educational information contents related to vocabulary, grammar rule, general knowledge through SMS. It also offers recorded content for public exams through IVR and allows the download of audio and video content through WAP/WEB.

The “Robir Gyan” is a SMS and IVR based m-Learning service from Robi designed to drive people to seek knowledge utilizing technology like mobile and internet for all age groups. This service is designed to deliver knowledge through SMS and IVR. The service provides SMS (Short messaging services) content about amazing facts on Great heroes, Science, Technology, History, Art & Literature, Earth and Space. Each SMS is embedded with an IVR link which contains detailed descriptions about the fact.

Robi’s 10 minutes school - As part of Robi’s corporate responsibility initiative, Robi has extended its support towards 10 Minute School – an online platform that offers comprehensive study solutions anywhere, anytime “free of cost” for public exam students, university admission seekers, and university students. It
offers admission guidance and model test options for all leading public and private universities in Bangladesh, thus reducing dependency on expensive university admission coaching for all students seeking tertiary level education.

**Zero-Rated Access**
Another cellular network operator Banglalink has set up computer labs in different parts of the country. Banglalink in conjunction with Wikimedia Foundation has launched ‘Wikipedia Zero Project’ that provides a free use of Wikipedia through mobiles for a stated time.

**Idea Contests**
To encourage students and young people to act on their ideas, Banglalink conducts Grandmaster- Idea Contest. It motivate students to think of some unique ideas that may be implemented through a mobile application and has the potential to help society and change millions of lives. More than 20,000 students participated in the last Banglalink Grandmaster Idea Contest. In another initiative, over 300,000 students across the country were educated through Banglalink’s nationwide internet awareness campaign.

**Airtel Learn**
Airtel Bangladesh Ltd, one of the fastest growing telecom operators of the country, offers an educational portal called ‘Airtel Learn’ targeted to help students before examinations. Airtel Bangladesh Ltd, partnered with an education service provider Saifur’s and a technology solutions provider Live Technologies for ‘Airtel Learn’ services. This service offers suggestions on different assessment as well as general knowledge through SMS and WAP. The service comes with SMS based content for customers. Airtel’s customers can choose from a range of educational packs and receive daily tips and content accordingly. The educational packs provide information and exam tips for ongoing examinations like HSC, University and College admissions. Through WAP, students also get a chance to receive important suggestions and tips through a WAP portal. The service is available through weekly and monthly subscriptions.

**Recommendations**
Bangladesh has made progress in enrollment and gender parity at the primary level. However, there remains considerable rooms for improvement in the other
four goals namely expanding early childhood care and education, promoting learning and life skills for young people and adults, increasing adult literacy by 50 percent. A major reason behind this lacking remains inadequacy of resources. Moreover it is worth noting that 51.85% of Bangladesh’s 169 million people are below the age of 25. (CIA Factbook)

Hence we find there is a huge and growing demand for education and owing to resource constraints there remains improvement areas in areas of skill development and adult literacy. This is a space where despite the best of intentions, there are services gaps which the private sector can fulfill. It is all the more relevant as Bangladesh will have to leapfrog into the Digital Era. Hence they will need access to quick and relevant education at affordable prices. This affordability can be fulfilled through mobile based education services where the cost of infrastructure and delivery design can be spread across a large mass.

It may be noted that presently the m-education services from the operators have some common traits – most of them are SMS and IVR based, providing recorded lectures, exam tips and information about board exams. While there is significant demand for this, the operators can consider expanding into other areas such as offering mobile based skill development courses and adult learning.

**More Video Based learning** - Grameenphone’s Online School – has shown that it is possible to create access to education for children in remote areas who for one reason or the other are missing out on regular, traditional schools. The current service delivery platform may be enhanced through the inclusion of video based learning. The screen used to deliver the teacher’s lectures can be used for accessing educational videos and thereby making school learning more colorful and enjoyable. The general education system in Bangladesh has been frequently criticized for its overemphasis on rote-learning rather than encouraging creative thinking and problem-solving skills. Inclusion of video based learning in online schools can help stimulate more creative thinking among the student viewers. Moreover, online schooling need not be limited to schools for economically disadvantaged children. This can be used in conventional schools as well.

**Service Expansion** - Robi’s 10 minute school has enabled access to exam questions and quizzes for students free of cost except the cost of connection. It connects students from any part of the world, saves time and money and provides opportunities for self-learning and development at the students’ own pace.
However, going forward to remain relevant the service content of this program need to be constantly updated. Moreover the initiative may expand into offering adult learning and skill development programs at affordable rates as it will be targeting working adults.

**More Innovations** – it is not possible for every school to provide a laptop for a student. But students usually have access to mobile phones. And students in Bangladesh like their western counterparts also display strong interests in mobile technology and use them in their personal lives. Hence using mobile phones for more creative learning both inside and outside the classroom for traditional students is an area that is yet to happen. The Bangladesh curriculum needs to prepare itself for the digital era. Darrel West, the Founding Director at the Center for Technology Innovations, USA states Technology-rich activities can sustain high levels of student engagement and peer collaboration compared to less technology focused activities. The value of mobile devices is that they allow students to connect, communicate, collaborate and create using rich digital resources. While this use of mobile technology in classroom is now commonplace in the developed countries, it is rare if not totally absent in classrooms in Bangladesh. Educators in Bangladesh need to initiate policies that harness mobile platforms for instructional purpose and utilize them to boost educational learning. They may partner with mobile services providers towards this goal. Through proper cooperation and partnership the country can build an educational system that not only will help our future generation to develop but also nurture and value the unique potential of each student and support them towards realizing it.

**Bridge the Gap:** There remains a gap between the skills being taught in the classroom and the skills needed in the workplace. Understanding the complexity and interrelated nature of education quality, skills development, and the labor market can aid in policy planning. The country needs to shift and strengthen the focus on education relevant to the labor market and on the quality of education. Present University curriculum design is often prepared in isolation from businesses. This is an area where the mobile phones can contribute. Learning institutions can utilize the mobile platforms for conducting quick surveys of office executive to identify the skill requirements and then impart them in the curricula. Moreover, they may approach experienced executive for giving lectures. Office executives are usually very busy people and in order to secure their opinions, the capturing mechanism must be simple, convenient and come
with some form of incentive. Use of mobile platforms for conducting survey will offer the ease and convenience and the universities may offer a token of appreciation through mobile money transfer.

**Programming Opportunities**
MLearning could usher in a boom in interest in learning software programming languages. Numerous startup web-based businesses today such as Codecademy teach people via interactive lessons on how to understand and write software programs. This scenario is particularly relevant in emerging economies, where gaining software development expertise can introduce new opportunities for economic growth and address unmet local needs.

**Online Resources**
Mobile learning is poised to tap into the vast amount of existing educational materials that could be made accessible via mobile channels. A report published by Global Industry Analysts projects the global market for online and other electronic distance learning to cross $100 billion by 2015. The same handheld-connected tools that enable children and adults to access existing educational solutions also provide the opportunity for them to capture and share knowledge in return.

**Conclusion**
Mobile learning can address the quality and competency issues in existing education system of Bangladesh in addition to promoting a personalized approach transcending barriers in distance, cost and ability.

It is worth noting that reduced overall cost is the most influential factor in adopting mobile learning. The elimination of costs associated with instructor's salaries, room rentals, and student travel are directly quantifiable. The reduction of time spent away from the job by employees may be the most positive offshoot. It is extremely relevant for a densely populated, resource constrained country like Bangladesh with a youthful population, a countrywide telecommunication infrastructure and one of the lowest tariff levels in the world.
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TV-White Spaces for Education: The Internet for Education in Boane

Salomão David\textsuperscript{1,2}, Ivan Ruby\textsuperscript{3}, Ermanno Pietrosimoli\textsuperscript{4}, Marco Zennaro\textsuperscript{4}
\textsuperscript{1}Universita della Svizzera Italiana (USI), Via G. Buffi 13, Switzerland
\textsuperscript{2}Instituto Nacional das Comunicações de Moçambique (INCM), Praça 16 de Junho, Mozambique
\textsuperscript{3}Concordia University (CU), Montréal, Canada,
\textsuperscript{4}International Center for Theoretical Physics (ICTP), Trieste, Italy
Contact Information: (cumbulas@usi.ch, ivanrubyds@gmail.com, ermanno@ictp.it, mzennaro@ictp.it)

Abstract: Deployment of Information and Communication Technologies (ICT) in schools is a multifaceted and complex process that involves providing reliable connectivity to schools, contextualized education software and long-term financing. This paper introduces TV-White Spaces deployment and a survey analysis to evaluate the usage of broadband for education. The survey results portrayed boys being substantially heavier users than girls even though girls had equal access to the internet. The access to the Internet at the school is done mostly using mobile phones. With regard to the impact of the internet on the campus, 88\% of students declared that they had increased the usage of the internet for education and the internet has a real influence in the realms of education and personal relationship. In general, Students transformed from passive to an active source of information, developing methods and techniques to implement specific curricular activities, while also forcing the instructors to adopt a more collaborative learning approach, where the exchange of information leads to better learning outcomes.

Keywords: Participatory Design, ICT4D, TV White Spaces, Education

Introduction

TV-White Spaces correspond to a range of frequencies in the realm of TV broadcasting that is not being used at a particular site at a given time and can, therefore, be leveraged to provide other services. Since they are more abundant in sparsely populated areas, where there is no economic incentive to sustain a high number of TV broadcasters as is the case in cities, they have been proposed as means to provide Internet access in rural areas, both in developed and developing countries. Because of their lower frequencies, they have propagation advantages as compared with microwave frequencies regarding
greater range, lower dependency on the line of sight requirements between transmitter and receiver and less absorption loss by vegetation and obstacles. Many trials of TVWS have been conducted in United States of America (USA), United Kingdom (UK), Philippines and several countries in Africa, which have proved the feasibility of the technology. While TVWS has been touted for its capability of avoiding interference to television signals and other licensed users while delivering reliable connectivity in rural areas (Gonçalves & Pollin, 2011), in sparsely populated areas the spectrum availability is well known to the regulator who can therefore assign frequencies for TVWS Internet access without the need of costly and cumbersome continuous spectrum occupancy assessment. The use of Information and Communication Technologies (ICT) in schools is an action that led to an expansion of education and improvement beneficial to both students and teachers (Mingaine, 2013). Mozambique like many other African countries has adopted the usage of Information and Communication Technologies (ICT) for learning as it encourages learner-centered learning, active, exploratory, inquiry-based learning, and collaborative work among learners and teachers (Kozma, 2001). In some schools in Mozambique, where students have access to the internet, teachers have pointed out that students participate effectively in the class since they had an opportunity to explore the topic before the lesson and combine, compare with the contents found in books (Matavele, 2009). Such affordances of ICTs in education supported the development of creativity, analytical skills, critical thinking and informed decision-making (Muianga, Hansson, & Nilsson, 2013). However, the cost of computers and internet access, ratio computer-to-user, limited skills of users, dependency on donor and private sector funds for the implementation of initiatives and a lack of local contextually relevant learning content all pose a challenge to the process of implementation of ICT in Education. The emergence of low-cost and low power consumption devices such as the Raspberry Pi, Mobile phones coupled with alternative and cost-effective methods of internet access such as TV-White Spaces, present a promising avenue for future initiatives and development. This paper aims at answering two research questions:

RQ1: How can Tv-White Spaces lower frequencies be used in a remote area to support the enhancement of education quality and equality in Boane?
RQ2: What and how the Internet is used in the Boane Municipality?

This paper is part of a research and development project conducted by the Mozambican Institute of National Communications (INCM), the International Centre for Theoretical Physics, the Network Startup Resource Center (NSRC) and the Universal Access Fund of Mozambique (FSAU). The project aims at deploying TV-White spaces for technical, vocational and higher education institutions, in the Municipality of Boane.
From 1975 to 1992, the Mozambique telecommunication sector policy and regulation were under Portugal's telecommunication laws and legislation. Communications were provided by a state-owned operator until 1992 when the telecommunication market was gradually harmonized and liberalized (Mustafa, Laidlaw, & Brand, 1997). The state-owned operator was split into three new institutions, namely: Instituto Nacional das Comunicações de Moçambique (INCM), Telecomunicações de Moçambique E.P (TDM) and Correios de Moçambique (CDM). TDM and CDM were entrusted with operating the telecommunication and postal sector respectively. The INCM was entrusted with the regulation of both telecommunication (spectrum management, number planning) and postal sector.

The appearance of a regulator and the rapid evolution of the telecommunication sector worldwide led Mozambique to establish telecommunications and Information and communications technologies (ICT) development programs. The development programs consisted of measures to accelerate the growth of the telecommunication sector by tax exemptions, bureaucracy reduction and expedited administrative procedures for telecommunication equipment and services. Within the development project public access venues such as Millennium villages, cybercafés, telecentres, and community radios were also created. Most of the public access venues were established in rural areas with cybercafés being established in urban areas by business entrepreneurs (Rega et al., 2013).

The country geographical location was leveraged to develop telecommunication infrastructure by installing an underwater cable landing point connecting Mozambique with Asia and Europe. This infrastructure can also be used to provide connectivity to African nearby landlocked countries like Malawi and Zambia.

Mobile cellular communication came relatively late to Mozambique, with a growth of 70% in 2001, with currently 14 million subscribers registered of which approximately 90% are pre-paid customers and the remaining 10% are post-paid subscribers (Brouwer & Brito, 2012). The Mozambican mobile market is very competitive, and it has three mobile operators: Moçambique Celular (Mcel), a state-owned company, and two private companies; Vodacom and Movitel (Brouwer & Brito, 2012).

Internet access in Mozambique is provided by several technologies including 3G, WiMAX, and fiber optics in urban areas. The rural Mozambique access to Internet is provided mostly using WiMAX and GPRS. The problem in Mozambique lies in the connectivity, and connections need to make it to homes and businesses. The national fiber-optic grid currently reaches only major cities. The extension to the last mile in sparsely populated areas is too expensive, and clearly, wireless technologies have a definite cost advantage.
The Mozambican Education system is composed of 3 subsystems:

- **Pre-school education**: Optional and provided by day-care centers and kindergartens, Governmental and Non-Governmental organizations as well as private operators
- **School-based education**: Comprises General (Primary and Secondary), Technical, Vocational and Higher Education
- **Non-school based education**: Covers literacy activities, cultural and scientific capacity building and refresher courses that occur outside the mainstream school system.

**The Boane Municipality**

The Boane municipality is located 22 Km from Maputo City (capital of Mozambique). The municipality has a population of approximately 102,457 inhabitants.

The town’s main economic activities are agriculture and commerce.

**Methodology**

To answer both research questions this paper takes as premises two approaches:

1. Deploy the Internet using TV-white Spaces technology in all academic institutions (technical, vocational and Higher Education) in the Boane Municipality;
2. Using survey and monitoring data conduct a quantitative analysis to understand the devices, usage, and digest of the internet in Boane.

The deployment of Broadband Internet would be carried out following a top-down approach while literature stresses the need for community involvement to create a sustainable social participation and empower itself. To do so, a multi-stakeholder decision-making forum was carried to avoid the risk of activities on the project being viewed as irrelevant by specific project participants. The Boane community has come to rely on an expensive and sometimes unresponsive Internet service. Hence, a workshop about TVWS was conducted by the INCM, having as participants all Internet Services Providers (ISPs) of Mozambique, Universities, civil society and the community from the Boane Municipality. The workshop ensured participative decision making and design regarding essential content and services to be offered to the community using TVWS. The TVWS technology in this context allows the technical community to become a superhighway source of Information, the information and technique gathered revolutionized the way education is provided by the academic institution. Students are expected to become an active source of information, developing methods and techniques to implement specific curricular activities, while also forcing the instructors to adopt a more
collaborative learning approach, where the exchange of information leads to better learning outcomes.

During the months of October and November of the year 2015, we surveyed students from the Instituto Agrário de Boane (IAB), Instituto Superior de Tecnologia e Gestão (ISTEG), and the Instituto Agrario de Umbeluzi (IAU). The sample comprised of students who use free internet provided by the schools. Our survey was conducted face-to-face on 236 individuals consisting of a random sample of young students with ages ranging from 17 to 22 years. We cluster the individuals in post-ratification weights to match known distribution of population used by the Mozambican statistical agency (age, sex, education, and local of residence).

The survey contained a set of questions related to the usage of the Internet, e-mail, and the perceived effects of Internet for education. We later crossed this information with monitoring tools hosted at the Matola Water tank. The monitoring tools provided information about the history of web browsing and network traffic, used devices, and bandwidth consumption.

TV-White Spaces for Rural Connectivity

Members of INCM attended a TVWS workshop held at the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste during March 2014 and proposed to do a pilot installation in a rural area adjacent to Mozambique's capital, Maputo with the purpose to provide Internet access to a rural school, an agriculture secondary education Institute (IAB) and a community garden in the village of Boane. The Internet Point of Presence (POP) was to be hosted at Matola Tower, a water tank on a 40 m tall structure that offered a commanding view of the surrounding area.

Simulation

Using the free tool Radio Mobile, simulations were carried out to ascertain the feasibility of connecting the proposed sites from the Matola Tower, using the TVWS solution provided by 6Harmonics, which consists of a Base Station fitted with a sectorial antenna and clients with directive antennas. In Figure 1, we show the layout of the sites involved.

After performing the simulation, we found that the distance from Matola Tower to the proposed sites (about 15 km) was too great to allow for a signal-to-noise ratio that would guarantee the maximum throughput attainable, with the antenna gains, output power and receiver sensitivity of the equipment to be deployed. This is evidenced by the red lines shown in Figure 1. Therefore, it was decided to look for a suitable site somewhere in between the Matola water tank tower and the sites to be served to locate the base station. ISTEG, a private university located about midway on the path, proved to be a good place
for the installation of the base station since there is electrical power, security, and good visibility to all the sites of interest.

![Map of sites](image)

**Figure 1 Map of sites**

We decided to install a point-to-point microwave link using low-cost unlicensed modified WiFi radios to carry the signal from Matola tower to ISTEG and to erect a 12m tower at ISTEG to house the TVWS base station and the microwave link. The dotted lines in Figure 1 corroborate the feasibility of coverage from ISTEG to the IAB, Boane Garden and the school.

The simulation showed that after halving the distance on the original plan, the signal-to-noise ratio could now guarantee maximum throughput to the three planned sites.

**Deployment**

At Matola Tower we installed a modified WiFi radio with an antenna pointing towards ISTEG. This radio was connected through a router to the Internet provider. Another modified WiFi radio in the 5.8 GHz band was installed in the tower at ISTEG to complete the link, connected to an Edge Router that linked to the TVWS base station oriented towards Boane. The layout is shown in Figures 2 and 3. An additional WiFi radio with an antenna pointing towards Boane was also installed for redundancy and future comparison of the microwave link with the TVWS one. At each of the subscriber sites, we installed a TVWS Consumer Premises Equipment (CPE) inside a weatherproof enclosure that also housed a router and a directional antenna. A redundant 5.8 GHz radio was also installed for comparison propagation studies.
The throughput tests performed (Figure 4) showed an average throughput of around 6 Mbit/s between the Base Station and the subscriber, which is more than satisfactory in our case since the committed Internet access provided at Matola tower is only 2 Mbit/s.
Data Analysis

Demographics

There were 236 respondents with a mean age of 18 years. The majority of respondents were women’s (151 [64%]), and most respondents came from the rural areas (205 [87%]).

Internet usage

About the Internet usage, boys reported being substantially heavier users than girls even though girls had equal access to the internet and school devices. With regard to the impact of the internet on the campus, (207 [88%]) of students declared that they had increased the usage of the internet for education, and the internet has a real influence in the realms of education and personal relationship, while (12%) of the students reported that there is a negative rather than positive impact on morality. The internet was declared as the source used to prepare classes, do assignments rich in information. Most of the respondents (212 [90%]) reported that the access to the Internet at the school is done mostly using mobile phones rather than computer labs. The remaining 10% use gadgets such as tablets. When it comes to web browsing, students from the IAB are among the highest consumers of bandwidth, most of the access to the internet is related to science, agriculture, technology, commerce, and socialization. At the ISTEG social networks or socialization comes as the most used type of web browsing corroborating the questionnaires answered where it is reported that the most preferred type of digital activity is socialization.

Findings and Conclusions

The internet integration in the education system of Boane technical school goes far beyond providing access to the Internet. The TVWS technology in this context, allows the technical community to become a superhighway source of Information. The information gathered revolutionized the way education is provided by the academic institutions. Students transformed from passive to an active source of information, developing methods and techniques to implement specific curricular activities, while also forcing the instructors to adopt a more collaborative learning approach, where the exchange of information lead to better learning outcomes.

The technology allows the student to perceive schoolwork as an easier and fun activity, with great interactive sharing of resources being the preferred modus operandi, thus completely overhauling the traditional tedious schoolwork into something challenging and rewarding that put them on equal footing with students from other countries.
Learning became much more interesting using the Internet: students grasp a large number of topics in less time, as digital study material is easily available in a context where traditional books are inaccessible. Teachers find it easy to prepare classes and motivate students to acquire better thinking skills. Furthermore, excluding academic activities, socialization is the preferred type of digital activity, with health care, government and career activities being the secondary preferences of digital activity.

References


Abstract: The GovEnsino, the Information and Management System of the Technic Professional Education, has been designed to support the efforts of the Government of Mozambique, through MCTESTP, to improve the management of the Technic Professional Subsystem. Through the GovEnsino, and using its mobile application enablement, it is possible to benefit wide coverage of the mobile services in Mozambique and allow for the fast collection of reliable data about the Technic Professional Subsystem. The GovEnsino is a web application consisting of a data base with basic data of the Mozambique Technic Professional Institutions, and it can be access through mobile devices and computer in fixed networks. The implementation and operation of the GovEnsino in 2015 in its initial phase has contributed to the increase of contributors on data collection, in the coverage of this process, as well as of the decision making process taking advantage to the mobile phone coverage in Mozambique.

Resumo: A Aplicação de Informação e de Gestão das Instituições do Ensino Técnico Profissional (GovEnsino), é uma aplicação Web com dados e informação básica de Gestão das Instituições do Ensino Técnico Profissional de Moçambique.
que funciona em dispositivos electrónicos, sejam eles móveis (Smartphones, Tablests e Laptops) ou fixos (Desktops) independentemente do seu sistema operativo, desde que estes tenham um browser instalado. O GovEnsino tem como principal objectivo registar todas as instituições do ensino técnico profissional existentes em Moçambique e a geração de relatórios com informação específica solicitada pelos utilizadores ou gestores do ensino técnico profissional. Permite a disponibilização pública e em ambiente privado de alguns dados e informação sobre as actividades realizadas pelas instituições tais como os cursos a decorrer e a duração dos mesmos nas instituições, bem como saber que infra-estruturas de apoio ao ensino existentes nas instituições.

1. Introdução

O Governo de Moçambique tem estado a adoptar nos últimos anos políticas e estratégias que promovem a expansão do uso de Tecnologias de Informação e Comunicação (TICs) em diversas áreas, com particular atenção para a área da educação. Como resultado da implementação das políticas e estratégias de TICs o número de utilizadores de telefonemas celulares em Moçambique aumentou drasticamente nos últimos 5 anos como se pode ver na Tabela 1. Houve também um aumento de operadores de telefonia celular de 1 para 3 nos últimos 15 anos como ilustra a Tabela 2. Em 2015 estavam registados cerca de 17 milhões de clientes dos provedores de serviços de telefonia móvel em Moçambique [1]. As companhias de telefonia celular existentes em Moçambique são a mCel, a Vodacom e a Movitel [1].


<table>
<thead>
<tr>
<th>Ano</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total de Clientes de Telefonia celular</td>
<td>7,855,345</td>
<td>12,808,480</td>
<td>15,883,820</td>
<td>18,444,219</td>
<td>17,911,876</td>
</tr>
</tbody>
</table>

A primeira companhia de telefonia celular em Moçambique é a mCel (Moçambique Celular) e surgiu em 1997 [2], a segunda companhia é a Vodacom estabelecida em 2003 e a mais recente é a Movitel que iniciou as suas operações em 2012 [1]. Com

¹ Dados relacionados ao primeiro semestre de 2015
este quadro Moçambique era em 2014 o 59 país com o maior número de utilizadores de telefonia celular numa lista de 217 países tendo 18,400,000 [3]. Estes números mostram que os serviços de telefonia celular em Moçambique tem um grande potencial para servir como plataforma de apoio à prestação de diversos serviços nas áreas económica e social como consequência deste significativo crescimento. Com o uso da tecnologia móvel é possível alcançar um número elevado de usuários como mostra a Fig. 1.

![Figura 1. Número de Clientes de Telefonia Móvel por Operadora (Últimos 5 Anos) [4]](image)

<table>
<thead>
<tr>
<th>Ano</th>
<th>mCel</th>
<th>Vodacom</th>
<th>Movitel</th>
<th>Total de Clientes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>4,375,828</td>
<td>3,479,517</td>
<td>4,700,000</td>
<td>7,855,345</td>
</tr>
<tr>
<td>2012</td>
<td>5,214,336</td>
<td>2,894,144</td>
<td>5,900,291</td>
<td>12,808,480</td>
</tr>
<tr>
<td>2013</td>
<td>5,819,147</td>
<td>4,164,382</td>
<td>7,234,803</td>
<td>15,883,820</td>
</tr>
<tr>
<td>2014</td>
<td>6,159,992</td>
<td>5,049,424</td>
<td>7,196,147</td>
<td>18,444,219</td>
</tr>
<tr>
<td>2015²</td>
<td>5,817,605</td>
<td>4,898,124</td>
<td>7,196,147</td>
<td>17,911,876</td>
</tr>
</tbody>
</table>

² Dados relacionados ao primeiro semestre de 2015
Os resultados apresentados no Relatório do Projecto de Governo Electrónico e de Infra-estruturas de Comunicacao (Projecto MEGCIP), projecto do Governo de Moçambique financiado pelo Banco Mundial e implementado de 2010 a 2016 reforçam também a constatação sobre o potencial da tecnologia móvel como catalizador dos serviços de governação eletrónica em Moçambique, podendo contribuir para que os serviços públicos prestados com recurso a sistemas de governo electrónico possam abarcar um grande número de entidades públicas e privadas envolvidas no processo de governação bem como um número significativo de Mocambicanos.

2. Contextualização

O Governo de Moçambique tem como uma das áreas prioritárias de intervenção a educação e o desenvolvimento humano. Tem estado a desenvolver diversas iniciativas visando melhorar a qualidade de ensino existente no país bem como proporcionar melhores condições para os alunos actualmente existentes, tendo adoptado como estratégia começar pelas instituições do ensino primário, secundário e de seguida as instituições de Ensino Técnico Profissional de modo a dotar a camada jovem, que constitui a maior parte da população, de capacidade para contribuir no mercado de trabalho e dos diversos projectos de desenvolvimento económico e social em curso no país e os planificados para explorar as oportunidades oferecidas pelas diversas iniciativas e projectos de exploração de recursos naturais em Moçambique.

A Direcção Nacional do Ensino Técnico Profissional (DNETP), que antes pertencia ao antigo Ministério da Educação e agora pertencente ao Ministério da Ciência e Tecnologia, Ensino Superior e Técnico Profissional (MCTESTP), é o órgão do Governo responsável pela recolha e pelo fornecimento de dados relacionados com as Instituições do Ensino Técnico Profissional de Moçambique. Este órgão tem como principal função o levantamento de dados relacionados com as instituições de ensino técnico e o fornecimento das mesmas a direcção máxima do Ministério de Ciência e Tecnologia, Ensino Superior e Técnico Profissional para que esta tenha dados que constituam uma base sólida de apoio aos processos de tomada de decisões de investimento e de desenvolvimento do Ensino Técnico Profissional em Moçambique. O desenvolvimento na área de Tecnologias de
Informação e Comunicação (TICs), em particular das tecnologias de telefonia celular, no que diz respeito ao grau de cobertura geográfica e ao número de utilizadores colocam a telefonia celular como uma opção a tomar em consideração para melhorar o processo de recolha e disponibilização e dados sobre as instituições de Ensino Técnico Profissional em Moçambique e da gestão deste subsistema de ensino.

3. Definição do Problema

O Ministério de Ciência e Tecnologia, Ensino Superior e Técnico Profissional (MCTE/STP), tinha dificuldades em sistematizar dados fiáveis sobre as Instituições do Ensino Técnico Profissional (IETP) que servissem de base para a tomada de decisão sobre os desafios de planificação e de gestão deste subsistema de ensino em Moçambique. Não tinha uma base de dados central que tivesse a localização geográfica exacta das IETPs, que tivesse a informação sobre a duração dos cursos e nem da totalidade dos cursos ministrados pelas IETPs. Estes dados estavam dispersos pelas direcções provinciais e pelos serviços distritais de educação e tinha uma actualização muito lenta devido aos desafios de extensão territorial do país e da dinâmica de desenvolvimento de Moçambique, que tem levado a construção de mais escolas de ensino técnico e de introdução de novos cursos neste subsistema de educação. A outra dificuldade estava relacionada com a recolha de dados em tempo útil sobre as infra-estruturas de apoio ao ensino e a capacidade instalada das mesmas (Oficinas, Laboratórios, Centros Internatos, Infra-estruturas Desportivas e Bibliotecas). É de realçar o impacto negativo na gestão deste subsistema que criava a falta de dados em tempo útil como por exemplo os dados sobre o aproveitamento de anos anteriores para que, ao nível central, fossem feitas estatísticas de aproveitamento, a falta de dados em tempo útil sobre os estudantes inscritos no ano em curso, a falta de dados consistentes e em tempo útil sobre o número de professores de cada instituição e do total de professores existentes no país. Esta situação criava dificuldades na operacionalização dos processos de gestão do ensino técnico no MCTE/STP pois os dados que não estavam disponíveis em tempo útil são de suporte para a tomada de decisões administrativas e a resposta de perguntas tais como em que província se deveriam introduzir mais IETP de modo a tentar suprir as necessidades da população? como ajudar as IETP já existentes em investimento nas Oficinas, Laboratórios, Centros
Internatos, Infra-estruturas Desportivas e Bibliotecas?; para que IETP deveriam ser direcionados os donativos internacionais bem como os nacionais? que directrizes tomar para maximizar o potencial das IETP no desenvolvimento social e económico do país e a responder ao potencial de desenvolvimento industrial do país?

É neste contexto que é proposta a Aplicação GovEnsino como forma de procurar dar respostas às perguntas acima apresentadas e contribuir para melhorar a gestão do sistema de gestão do subsistema de Ensino Técnico Profissional em Moçambique.

4. Objectivos

4.1. Objectivo Geral

Este trabalho tem como objectivo geral desenvolver uma aplicação informática de gestão de informação designada GovEnsino, a ser usada por todas as Instituições do Ensino Técnico Profissional de Moçambique e pelo MCTESTP, em particular a Direcção Nacional do Ensino Técnico Profissional (DNETP).

4.2. Objectivos Específicos

Este trabalho tem os seguintes objectivos específicos:

- Identificar os requisitos funcionais e não funcionais da aplicação;
- Seleccionar tecnologias de implementação da aplicação;
- Modelar a arquitetura de funcionamento da aplicação;
- Implantar a Aplicação de Informação e de Gestão das Instituições do Ensino Técnico Profissional de Moçambique que de entre outras actividades vai consistir as seguintes: Conceptualizar e desenhar a base de dados, conceptualizar e desenhar a interface da aplicação, gerar relatórios com informação de gestão, fazer projeções/simulações de dados estatísticos para os anos a seguir; e
- Testar o sistema consoante os requisitos definidos.
5. Metodologia de desenvolvimento da Aplicação

5.1. Metodologia de Desenvolvimento

Para o desenvolvimento do software foi usada a Metodologia Incremental e Iterativa pois o desenvolvimento incremental de um software permite descobrir problemas do projeto na fase inicial, que poderiam ser de dimensões muito grandes se detectados somente na entrega do produto. Também permite que o cliente esclareça os seus requisitos e as suas prioridades para os próximos incrementos, além de contar com os serviços da versão já produzida. Esta metodologia tem ainda a vantagem de reduzir o tempo de desenvolvimento da aplicação pois as probabilidades de mudanças nos requisitos do usuário durante o desenvolvimento são menores.

Para a construção da base de dados foi usado o Mongo DB, que é um sistema de gestão de base de dados livre, caracterizado por ser um sistema de base de dados flexível, por ser um SGBD não relacional, por ter um desempenho adequado (rapidez), por ser uma tecnologia que possui uma excelente integração com node.js que foi o framework utilizado para configurar o lado do servidor.

Para o desenvolvimento do Aplicação usou-se o IDE Sublime Text 3 e usou-se a plataforma node.js e linguagem de programação javascript.

De referir que para a construção da base de dados assim como da aplicação foram usadas ferramentas gratuitas.

5.2 Funcionamento da Aplicação

A aplicação GovEnsino funciona com base na arquitetura cliente-servidor como se ilustra na Figura 2, em que o cliente se conecta ao servidor de aplicação via Internet por meio de um browser, usando os protocolos HTTP e HTTPS da camada de aplicação da Arquitetura da Internet ou Modelo TCP/IP. Na camada de rede da Arquitetura de Internet é possível usar diversas tecnologias de acesso incluindo as redes de comunicação de dados sem fios, as redes Wi-Fi, e diversas tecnologias de transmissão, incluindo as redes de telefonia celular.
5.2.1. Arquitectura Cliente-Servidor

Nesta arquitectura, o sistema é composto pelos clientes e pelo servidor estes dois componentes, tem programas ou processos como representados na Figura 3, as tarefas a seguir descritas [5]:

5.2.1.1. Servidor

O Servidor oferece serviços aos processos dos usuários (clientes), ou seja, executam a tarefa solicitada pelos clientes e envia uma resposta a estes que se traduz nos dados solicitados.

O processo servidor é a componente central desta arquitectura, pois tem todos os dados e toda a informação relativa aos usuários da rede, suas actividades, medias compartilhadas, entre outros e provê estas informações aos processos clientes sobre a forma de serviços, centralizando a manipulação de dados, manutenção, consistência e integridade dos mesmos. O servidor realiza pesquisas, filtragens e actualizações sobre as bases de dados, portanto deve ter a capacidade de processamento, e de acesso aos meios de armazenamento de dados. É também responsável pelo controle de concorrência (quando existem várias requisições em simultâneo aos mesmos recursos do sistema) e de segurança (autenticação e autorização para aceder a certos recursos do sistema) [5].

Figura 2. Diagrama de Implantação
5.2.1.2 Cliente

O Cliente solicita um determinado serviço ao servidor, através do envio de uma mensagem a este.

O processo cliente é o responsável pela interação com os usuários, através de uma interface que o cliente usa para requisitar tarefas ao servidor, como por exemplo actualizar os seus dados de perfil [5].

![Figura 3. Arquitectura da Aplicação](image)

6. Relevância da Aplicação

A aplicação GovEnsino está a provar como sendo de grande utilidade, mesmo na sua fase de teste que começou em 2015. É apresentado a seguir a relevância desta aplicação, tanto para as instituições do Ensino Técnico Profissional como para o Ministério da Ciência e Tecnologia, Ensino Superior e Técnico Profissional.

É de realçar que o aspecto principal que tem permitida a rápida aceitação e utilização da aplicação GovEnsino é o facto de a mesmo poder ser acedida usando dispositivos de telefonia celular, explorando assim os resultados positivos da cobertura de telefonia celular em Moçambique e qualidade de serviços prestados pelas operadoras de telefonia celular, em particular para as instituições de ensino técnico profissional localizadas nas zonas rurais de Moçambique. Os funcionários
do Estado trabalhando nas IETP, nos serviços de educação ao nível do distrito e nas direcções provinciais de ciência e tecnologia, ensino superior e técnico profissional acedem a esta aplicação usando os seus próprios dispositivos móveis e actualizam os dados necessários. Os gestores do Ensino Técnico Profissional ao nível central também usam os seus dispositivos celulares para acederem aos dados disponíveis, incluindo para gerar relatórios.

6.1. Para as Instituições do Ensino Técnico Profissional

A aplicação GovEnsino permite, usando dispositivos de telefonia celular e aplicações web, fazer o registo dos cursos e sua duração, que são ministrados pelas mesmas, as infra-estruturas (Oficinas, Laboratórios, Infra-estruturas Desportivas, Centros Internatos/Lar e Bibliotecas), a situação de aproveitamento do ano “trasacto” e frequência do ano corrente, efectuar registo dos professores da instituição, oferece dados estatísticos da instituição (quantos professores existem, qual é a faixa etária dos mesmos, quantos anos possuem de experiência, quais disciplinas leccionam, qual é o curso mais aderido, quantos alunos existem na instituição, quantos alunos existem em cada curso, turno no total e por gênero).

6.2. Para o Ministério da Ciência e Tecnologia, Ensino Superior e Técnico Profissional

A Aplicação permite, usando interfaces gráficos disponíveis também para dispositivos de telefonia celular, ter informações precisas sobre a localização das instituições tuteladas, usando mapas, e dados tais como o total de instituições existentes no país, em cada região, em cada província e em cada distrito. Disponibiliza também dados sobre os cursos que são ministrados em cada uma das instituições do ensino técnico profissional, as infra-estruturas de apoio ao ensino que as mesmas possuem. Através da aplicação GovEnsino é possível gerar dados estatísticos globais e locais como por exemplo gerar dados que permitem saber quantos estudantes do Ensino Técnico Profissional estão inscritos em Moçambique, saber quantos estudantes estiveram inscritos no ano passado, permite saber que curso ou acção de formação teve um aumento do alunos assim como que curso teve uma redução do número de alunos entre um intervalo de anos específico. A aplicação permite a realização de projecções e simulações de
quantos alunos serão graduados num determinado ano, no ano a seguir, e em que áreas de formação serão graduados (por distrito, província, região e pelo País), por instituição, quantos professores serão reformados num determinado ano e nos 5 anos seguintes, que instituição irá precisar de novos professores e em que áreas de formação. Estes dados e informação são gerados pelo GovEnsino através do cruzamento dos diversos dados inseridos na Plataforma e na sua base de dados.

7. Resultados

Com a implantação desta solução o número de pessoas envolvidas no processo de recolha de dados estatísticos sobre o Ensino Técnico Profissional aumentou tornando este processo mais rápido. Foi possível em pouco tempo obter e sistematizar dados sobre o Ensino Técnico Profissional em Moçambique. Com base no GovEnsino os utilizadores, usando a telefonia celular, pode ficar a saber que existem hoje em Moçambique cerca de 70 mil estudantes inscritos no ensino técnico profissional contra os cerca de 33 mil estudantes que foram declarados no início de 2015, antes da instalação deste sistema.

Com a implementação do GovEnsino foi possível ainda constatar que existiam 146 instituições de ensino técnico profissional em Moçambique até ao final de 2015 contra as 108 instituições que tinham sido declarados no início de 2015, bem como conhecer a sua distribuição geográfica pelo país (Figura 7).

As figuras 4, 5 e 6 apresentam parte dos resultados obtidos com o uso do GovEnsino de meados de 2015 até agora. É de realçar que o aumento do número de pessoas envolvidas na recolha de dados do Ensino Técnico Profissional registo em 2015 como indicado na Figura 4 só foi possível com a utilização da telefonia celular como plataforma de acesso ao GovEnsino.

Figura 5. Comparação entre instituições conhecidas no País antes e depois do uso da Aplicação [6]

8. Conclusões

Com a implementação do GovEnsino foi possível reconfirmar que a disponibilidade de informação fiável, para além de possibilitar tomadas de decisão mais correctas, tem um papel fundamental na gestão das Instituições do Ensino Técnico Profissional de Moçambique. A plataforma GovEnsino possibilita o acesso aos dados e informações a sobre o Ensino Técnico Profissional a partir de qualquer parte do mundo desde que se tenha um dispositivo móvel com acesso à Internet, e que o utilizador tenha as permissões apropriadas para aceder ao mesmo.

Os objectivos definidos para este trabalho foram alcançados, que eram de desenvolver uma Aplicação Informática e de Gestão das Instituições do Ensino Técnico Profissional que pudesse tornar possível a obtenção de informações necessárias para a tomada de decisões para o desenvolvimento do subsistema do Ensino Técnico Profissional por parte do Ministério de Ciência e Tecnologia, Ensino Superior e Técnico Profissional com base em informações e dados fiáveis. A aplicação GovEnsino implementada permite restringir a visualização de menus a utilizadores que tenham permitir de acesso a determinados menus.

A Aplicação GovEnsino vai contribuir significativamente para simplificação e redução do tempo necessário para a obtenção de informações relacionadas com as IETP em Moçambique pois agora não mais serão precisas as viagens para as capitais províncias e para as sedes destritais para a obtenção de dados, visto que a aplicação permite a actualização dos dados existentes bem como a inserção de novos dados na aplicação pelos funcionários ao nível local.

9. Recomendações

A aplicação GovEnsino está em implementação em fase de teste desde 2015. A análise dos dados prelimares desta fase de operação do GovEnsino permitem propor as seguintes recomendações: Deverá ser implementado um upgrade na aplicação GovEnsino de modo a que esta possibilite a inclusão de todos os estudantes do ensino técnico profissional e de todos os professores deste subsistema como utilizadores do mesmo. Este upgrade nas funcionalidade do GovEnsino deve incluir a habilidade de os professores do ensino técnico
profissional disponibilizarem o material das aulas e as notas de todos os estudantes de forma online, e de os alunos acedeterem a esse material de ensino e às suas notas online, via telefones outros dispositivos móveis. O material e dados a incluir no GovEnsino pode incluir datas de realizações de avaliações, planos analíticos das cadeiras entre outros.

10. Referências Bibliográficas


As Múltipla Funcionalidade Social Telemóvel nas Comunidades Moçambicanas

Celestino Joanguete
Universidade Eduardo Mondlane, Escola de Comunicação e Artes
Maputo, Moçambique
celestino.joanguete@gmail.com

Abstract
According to the studies of Research ICT Africa, the African continent has been growing as the flow of information, thanks to the growth of communication, information and Internet connection technologies. The African continent is experiencing great leaps of development in the commercial, banking, communication, service delivery, governance monitoring, education and health. The same study indicates that 30 percent of sub-Saharan African countries use mobile services to perform payment services and money transfers. The purpose of the study is to explore the phone’s potential in the Mozambican social ecosystem, in particular, in multiple social functions in the new realities Mozambique in particular in electronic transaction processes, governance monitoring and strengthening the media in reaching new hearings before marginalized by traditional media. Drawing on empirical studies of UNESCO entitled Reading in Mobile Era and research entitled The Evolution of Information Systems in Africa: A Path to Security and Stability, the paper proposes to reflect on the three aspects: Cellphone role in social, economic and political. The study mapping the impacts of mobile phones in society, supporting the inclusion of “marginalized” communities in the digital society. The work structure is built by two strands. The first discusses the issue of mobile phone in the communication process in rural areas, which are emphasized the latest technological advances in communication infrastructure; the second describes the phone incorporating the impacts on the development of business processes and business transactions, with the focus on consulting services and bank transfers and utility payments.

Keywords: Mobile Phone. Enculturation. Communication.

Resumo
De acordo com os estudos da Research ICT Africa, o continente africano tem vindo a crescer quanto ao fluxo de informação, gracias ao crescimento das tecnologias de comunicação e de informação e da conexão à Internet. O continente africano está a registar grandes saltos de desenvolvimento nas actividades comerciais, transações bancárias, comunicação, prestação de serviços, monitoria de governação, educação e saúde. O mesmo estudo indica que 30 por cento dos países da África Subsariana utilizá serviços de telecomunicação móvel para efectuar pagamentos de serviços e transferências de dinheiro. O propósito do estudo visa explorar as potencialidade do telemóvel no ecossistema social moçambicanos, em particular, o seu uso em múltiplas funções sociais nas novas realidades ruralidades moçambicanas, nomeadamente, nos processos de transações electrónicas, monitoria de governação e no reforço dos media no alcance de novas audiências, antes marginalizadas pelos media tradicionais.
Recorrendo aos estudos empíricos da UNESCO intitulado Reading in Mobile Era e da pesquisa intitulada A Evolução dos Sistemas de Informação em África: Um Caminho para a Segurança e a Estabilidade, o trabalho propõe-se a reflectir em torno dos três aspectos: papel do telemóvel no desenvolvimento social, económico e político.

O estudo mapeia os impactos dos telemóveis na sociedade, sustentando-se nos argumentos que defendem a inclusão das comunidades “marginalizadas” na sociedade digital. A estrutura do trabalho é construída por dois momentos. O primeiro discute a questão do telemóvel no processo comunicativo nas zonas rurais, no qual são enfatizados os últimos progressos tecnológicos das infraestruturas de comunicação; o segundo descreve o impactos da incorporação do telemóvel nos processos de desenvolvimento do negócio e transações comerciais, onde se destacam os serviços de consulta e transferências bancárias e pagamentos de serviços.

**Palavras-chaves:** Telemóvel. Inculturação. Comunicação.

**Contextualização**

De acordo com os estudos da Cepal intitulado La Nueva Revolucion Digital, publicado sob a tutela das Nações Unidas, em Junho de 2015, indica que em 2014 estimava-se que havia 3.600 milhões de pessoas subscritores de serviços de telefonia móvel no mundo e 2.923 milhões de habitantes usavam a Internet.

A massificação de tecnologias sociais e as infraestruturas de telecomunicações aumentou o fluxo global de comunicação (Hamelink, 1998), consequentemente, reduziu os custos das transações, produção e distribuição de bens e serviços digitais.

No continente africano, entre 2000 a 2005, o acesso ao telefone móvel passou de 8 para 100 milhões de usuários, uma expansão de 107% anual. O país com maior índice de crescimento era a República da África do Sul com 34 milhões de usuários de telefone móvel, contra os 9 milhões de 2001. (Cava, 2011). Outros países africanos estão a registar crescimentos colossais no uso dos telemóveis como, por exemplo, em Botsuana onde em cada três pessoas um tem telemóvel, enquanto a República Democrática do Congo, Ruanda e Malawi estão apostar na instalações de infraestruturas de comunicação móvel, nomeadamente nos retransmissores para as redes móveis.

Um dos factores da massificação do telefone pela população africana deve-se à expansão das infraestruturas de telecomunicações para as zonas rurais e a consequente concorrência entre as empresas fornecedoras de serviços. Enquanto em Moçambique, o sucesso de telefone móvel associa-se aos motivos acima invocados e ao barateamento dos dispositivos móveis, graças à penetração massiva destes dispositivos produtos comerciais África/China.

O relatório do Banco Mundial sobre Moçambique está a perspectivar a análise dos impactos do telemóvel no combate à pobreza urbana. O relatório refere que o Banco Mundial pretende avaliar avaliar em que medida a resiliência às condições climáticas está a ser reforçada pelo uso do telemóvel, particularmente, para alertar os governos
de problemas locais de saneamento e drenagem bem como para mapear as comunidades.
O cenário de serviços de telefonia móvel tem vido a crescer de forma vitíginosa no ambiente urbano moçambicano. Regista-se, sobretudo, o crescimento nos pagamentos de serviços e transferências bancárias; monitoria da governação e reforço dos media. Este crescimento significa que os serviços de telemóveis estão atingir os níveis rurais e inclusão digital da população, antes marginalizada.

**Função do telemóvel na monitoria de governação**

A elevada taxa de penetração de serviços de telefonia móvel na sociedade moçambicana poderá provocar impactos profundos no sistema de governação. Por um lado, os telemóveis permitem a conexão à Internet e às redes sociais, consequentemente, aumento o fluxo de informação e partilha de ideias, facto que vai resultar numa sociedade civil reforçada, por outro, em consequência do primeiro impacto, obrigam a reavaliação das estruturas de governação.

O uso de telefone móvel pela sociedade civil permite a inclusão social das populações marginalizadas “em novos tipos de estruturas e actividades colectivas”. Neste processo, o aspecto mais importante das comunicações por telemóvel são as transmissões de dados via textos de mensagens, SMS, porque apresenta série de benefícios: Poupança de tempo; Capacidade de mobilizar ou organizar pessoas rapidamente; Capacidade de chegar a audiência que eram difíceis ou impossíveis de alcançar anteriormente; Capacidade de transmitir dados com maior rapidez e precisão e capacidade de recolher dados com maior rapidez e exactidão.


Não restam dúvidas que o telemóvel está desempenhar funções que vão além de simples comunicação interpessoal, muito mais que isto, permite a monitoria dos sistemas de eleição, de governação e de funcionamento dos serviços públicos.

Tem aparecido por diversos cantos do continente africano programas informáticos de monitoria de eleições, por meio de telemóvel como, por exemplo a *Frontline SMS*, que permite aos utilizadores enviar e receber mensagens de texto para grandes grupos de pessoas e a *Network of Mobile ElectionMonitors –NMEM e Uchaguzi* (usado no Quénia) possuem as mesmas funcionalidades da *Frontline SMS*, os dois exemplos permitem monitorar de forma abrangente os processos de votação nas mesas de voto, mesmo nas zonas mais recônditas com menos observadores credenciados, o que reforça o processo de transparência e credibilidade do processo eleitoral.

As fragilidade de supervisão dos sistemas democráticos pode permitir a corrupção nos processos eleitorais. A monitoria baseada em telefones celulares pode desencorajar fraudes ou outra forma de corrupção, porque o cidadão reforçado nas suas capacidades pelos dispositivos s móveis pode denunciar através de SMS qualquer tentativa de fraude.
A Organização das Nações Unidas, através das suas missões de manutenção de paz no mundo, empregam o telemóvel para alcançar as populações mais remotas, vulneráveis às violências políticas ou tribais ou outras formas limitação de direitos humanos. Na perspectiva das Nações Unidas, o telemóvel poderá melhorar a protecção da população civil e diminuir os riscos de desastres humanitários e fortalecer a interacção entre as componentes militares e civis.

Partindo desta perspectiva das Nações Unidas, o uso do telemóvel já está a ser aplicado por algumas organizações da sociedade civil moçambicana, não só para monitorar o atendimento no sistema nacional de saúde, o projecto pretende abranger as áreas de educação e de serviços de segurança pública e de trânsito.

A operação do processo de gestão das informações poderia ser entregue a sociedade civil, no caso de prevenções de desastres humanitários, através de criação de um centro de agregação de informação e de atendimento das chamadas, facto que poderá melhorar significativamente a intervenção em incidentes de desastres naturais ou humanitários, bem como transmitir a informação às outras organizações da sociedade civil.

A capacidade de prevenção de crimes violentos nos novos ambientes rurais, também poderá ser reforçada com a instalação de centros de atendimento de chamadas, que por sua vez transmite informações relevantes aos comandos das operações nos terrenos.

O aproveitamento das potencialidades de telemóveis em Moçambique está assumir todas as acções transversais à simples comunicação interpessoal. A informação em tempo real é deveras importante quer para a polícia quer para a sociedade civil.

1. O telemóvel no processo comunicativo nas novas ruralidades moçambicanas

Nos últimos anos, o sector de telecomunicações móveis em Moçambique tem vindo a crescer de forma assinalável em função de investimento das companhias operadoras e, consequentemente, a cobertura geográfica e a teledensidade móvel tem vindo a crescer visivelmente. Para um processo que começou nas zonas urbanas, hoje em dia as operadoras de telemóveis estão a expandir os seus serviços para as zonas rurais onde a aderência é maior graças ao crescimento do poder de compra.

Em 1997, os serviços de telecomunicações registavam uma media de 65.606 subscritores para serviços de telefone fixo e 2.500 usuários de telemóvel. Nessa altura o mercado era dominado apenas por duas companhias: Telecomunicações de Moçambique, TDM, para os serviços fixos e Moçambique Celular, MCEL, para serviços móveis.

Com aprovação da Lei Base das Telecomunicações, a Lei 14/99, de 1 de Dezembro e com a reforma do sector das telecomunicações em 2002, o panorama das telecomunicações mudou radicalmente com entrada em 2003 da nova companhia de serviços móveis, VODACOM- Moçambique tornando o mercado mais dinâmico e
competitivo e, consequentemente, o asfixiamento da única companhia estatal de serviços fixos, TDM\(^1\).

Atualmente as operadoras de telefonia móvel como a MCEL detêm 5.3 milhões de usuários, ainda continua a ser a companhia mais urbanizada juntamente com a ODACOM Moçambique detentora de 3 Milhões de Usuários. Uma terceira companhia móvel, MOVITEL, entrou no mercado em 2012, que resulta da parceria entre o grupo moçambicano SPI-Gestão e Investimento (20%), a IVESPAR (10%), subsidiária do grupo SPI e a empresa VIETTEL (70%) , controlada 100% pelo Ministério da Defesa do Vietnam. A MOVITEL investiu inicialmente 177 Milhões de Dólares, tendo instalado 12.500 Quilómetros de fibra Óptica e 1.800 estações de base para as redes 2G e 3 G\(^2\). Movitel foi a primeira a avançar para as zonas mais recônditas de Moçambique através de cabo de Fibra Óptica e linhas áreas.

Em 2013, um ano depois da sua entrada no mercado, a MOVITEL começou a operar em mais de 78 distritos e, hoje em dia, fala de forte presença em localidades remotas. Actualmente a companhia reivindica ter conquistado 80% do mercado nacional de rede móvel, com 2 Milhões de usuários potencialmente do mercado rural moçambicano.

Até o momento, as três companhias que operam no território nacional, Moçambique possui um pouco mais de 9.5 milhões de usuários de telemóvel, um número que apresenta tendência de crescimento para a metade da população moçambicana, nos próximos anos.

Reportando as teses defendidas por Hills, (2003) e Hamelink (2008) cruzando com os estudo mais recente da UNESCO Reading in Mobile Era, as mudança do cenário comunicativo no ambiente rural poderão registar mudanças significativas no processo comunicativos em três grandes sectores: saúde, educação e comércio, graças à liberalização do mercado das telecomunicações.

Mas os factores de mudanças da nova ordem mundial de comunicação, invocadas nos estudos retro mencionados, não são suficientemente sustentáveis se não existir uma vontade política interna e um regime democrático favorável a isto.

As aceleradas transformações das zonas rurais moçambicanas exigem um novo quadro de estudo sócial, político e económico que relacione o impacto do telemóvel nas novas ruralidades, de modo que o governo crie novas políticas públicas de inclusão digital.

Para uma alfabetização digital no ambiente rural moçambicano, algumas organizações Não-Governamentais moçambicanas implantaram vários Centros Multimédia Comunitários, criados por iniciativas da UNESCO e da Organização Não Governamental IBIS, podem ser potenciados e funcionarem como excelentes lugares de aprendizagem digital.

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1 http://www.acist.pt/publicacoes/estudos/dados_sobre_mocambique_vopen.pdf, consultado no dia 17/06/2014

2 http://www.macauhub.com.mo/pt/2012/05/16/movitel-terceiro-operador-de-telefonia-movel-democambique-iniciou-actividade/, consultado no dia 17/06/2014
Em última análise, os estudos empíricos levados acabo por UNDP e UNESCO intitulados, *Mobile Technologies and Empowerment*, *Turning on Mobile Learning in Africa and the Middle East Illustrative Initiatives and Policy Implications*, *Reading in Mobile Era*, e do *Mobile Africa Report 2012*. Os autores relatam as oportunidades que as tecnologias móveis de comunicação estão abrir para novas formas de comunicação entre as pessoas e os governos, dando mais acesso à informação pública e de serviços básicos para todos, nomeadamente. Os estudos destacam as oportunidades e desafios do sector das telecomunicações móveis que está a conquistar o mundo em curto período de tempo.

A massificação do telemóvel em ambiente rural deve-se a pouca exigência do dispositivo e a baixa infra-estrutura física, facto que reduz os custos de investimento e poder chegar as áreas rurais de uma forma mais rentável do que outras tecnologias como a Internet ou linhas de telefone fixo.

É sem dúvida, a exploração das potencialidades das tecnologias móveis no ambiente rural moçambicano tem grande impacto no desenvolvimento nas actuais áreas críticas da sociedade: governação democrática, educação, agricultura, emprego, mudanças climáticas e prevenção das calamidades naturais.

No que tange à governação, os telemóveis podem oferecer novas possibilidades de capacitação do cidadão de modo a ampliar o acesso aos canais de informação e comunicação e dando-lhes novos espaços de participação. O que antes era do domínio dos canais das elites urbanas, agora está acessível às pessoas comuns através do telemóvel.

### 2. Transações electrónicas

De acordo com o documento da UNESCO *Reading in Mobile Era*, bem como do estudo intitulado *Mobile Economy 2014*, trazem à tona uma informação importante relativa às 9 potencialidades do telemóvel como recurso de desenvolvimento comercial e aumento das competências de leitura em crianças que não têm acesso ao texto. O estudo recomenda a expansão de leitura móvel para as regiões sem recursos aos materiais didácticos convencionais traz benefícios educacionais, sociais e económicos, por isso a sua exploração pode avançar com alfabetização e aprendizagem em comunidade carentes.

O impacto do telemóvel em ambiente rural vai muito além de instrumento de desenvolvimento de processo de ensino/aprendizagem, ele também contribui para ampliar as possibilidades de prestação de serviços, particularmente, nas transações electrónicas através de serviços de transferências bancárias, pagamentos de serviços, compras, etc.

No sector da saúde e dos media, tem havido iniciativas pioneiras de resposta à emergência e transmissão de informação em áreas que são de difícil acesso, bem como para educar e manter o cidadão informado nas questões ambientais, mudanças climáticas e gestão ambiental sustentável.
Os estudos acima mencionados têm relevância por trazerem à discussão a questão do reaproveitamento das outras potencialidades dos telemóveis para as populações sem grandes recursos, mas conclusões apresentadas não adiantam em nenhum momento as diversas formas de subvenções para que todos tenham acesso à Internet barata.

De acordo com a directora da Ericsson na África Subsaariana, o uso da Internet no telemóvel aumentou 20 vezes em África em 2014 e com mais 635 milhões de subscriptores. Os países com mais subscritores móveis são, designadamente, Nigéria, República da África do Sul, Kenya, República Democrática do Congo e Gana³.

Estes indicadores permitem-nos afirmar que a Internet através do telemóvel, além de permitir as populações ao acesso às notícias e a informação de saúde, ela abre espaço de acesso ao conhecimento e aumenta as possibilidades de incremento de negócios familiares, gerir as poupanças de populações pobres, aumentar a renda e apresenta vantagens de transações comerciais e meio de pagamento de serviços de forma simples, rápida e sem custos acrescidos.

As desvantagem destes programas são nomeadamente: falta de massificação dos serviços para o interior do país, porque as empresas de telecomunicações ainda não completaram o processo de conectividade com as zonas rurais; os serviços de dinheiro móvel tem uma taxa de transação proibitiva para as populações que vivem abaixo da linha de pobreza.

Não resta dúvida que o telemóvel, nas comunidades rurais, ajuda a criar redes de comunicação entre os cidadãos, as organizações e agências de governo. Eles são ferramentas estratégicas para ampliar os programas de desenvolvimento e conectar as camadas pobres aos serviços e criar novas oportunidades para a participação cívica nos processos de governação.

**Conclusão**

Depois da reflexão em torno da inculturação do telemóvel na comunicação em Moçambique, salta-nos à vista duas situações: o telemóvel não só tem a função de comunicação interpessoal como meio de reforço das redes de comunicação entre a população, o governo e os media. Existem outras potencialidades que podem exploradas como meio de alfabetização/aprendizagem, reforço dos media e monitoria das acções governativas.

A segunda situação, em consequência da primeira, o telemóvel está assumir o papel fundamental no desenvolvimento economico das regiões rurais. Ele torna-se aos poucos uma ferramenta de transações electrónicas, de informação privilegiada nos negócios, nos pagamentos de serviços e no comércio electrónico.

O resultado decorrente do estudo empírico do papel do telemóvel na cultura moçambicana permite concluir que o barateamento do dispositivo, a expansão da rede electrica e a penetração das operadoras dos telemóveis para as zonas rurais pode

impulsionar a sua massificação. Do ponto de vista social, o telemóvel está a tornar uma das ferramentas de comunicação com grande impacto na cultura moçambicana e um dos elementos fundamentais na democratização de informação e, consequentemente, dispositivo chave de participação do cidadão no processo revolucionário da produção e distribuição de informação na Era digital.

As entidades governamentais devem assumir o papel activo na inclusão digital e encontrar soluções práticas para reduzir os custos de conectividade para as populações rurais, facto que exige deles uma luta, junto dos fornecedores de serviço da Internet e dos reguladores, para garantir a conexão de qualidade e de banda larga às famílias pobres.

Um estudo futuro mais aprofundado em torno do papel do telemóvel nas zonas rurais poderá explorar o seu impacto no processo de ensino e aprendizagem nas escolas e no empoderamento da mulher rural. No ensino, os alunos poderão melhorar as suas habilidades de aprendizagem através de exercícios interactivos em telemóveis se o governo e as operadoras assinarem acordos de cooperação que permitem aos alunos acessarem planos de aulas e matérias através de portal de Internet simples e básico.

Bibliografia


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Panels
Multi-stakeholder Policy-Making for Affordable Mobile Broadband in Africa

By Dhanaraj Thakur, Web Foundation

The goal of the panel is to highlight how diverse stakeholders can work together on policy change to lower broadband prices. It will include members of two multi-stakeholder country coalitions in Africa (Ghana and Mozambique) both of which are supported by the Alliance for Affordable Internet. Each panelist will also represent different sectors and will address specific policy issues that they are working on such as gender and infrastructure sharing. The list of panelists is:

1. Clara Pinkrah-Sam, leader of the consumer protection working group, A4AI Ghana Coalition.
2. Salvador Adriano, CEO, Internet Solutions - Mozambique.
3. Alsacia Atanasio Nhacumbe, Ministry of Science & Technology.
4. Sérgio Luís Cossa, SIITRI.

Moderated by Onica Makwakwa, Africa Regional Coordinator for the Alliance for Affordable Internet (A4AI)
Mobile technologies have for some time begun to lead changes in social, political and economic life of the Mozambican population. Nowadays in Mozambique there are more than 20% of the population living with less than 5$ a day and lacking most of proper social services like health, education, etc. However, the growth of mobile penetration rate in last few years is providing a new hope, with over 16 million registered customers within the three mobile service providers in the country. This is accompanied with the demonstration of the potential of Information and Communication Technologies (ICTs) on mobile devices, where a number of many different and successfully implemented applications may create and enable an environment that would drive the appearance of numerous services over all developed countries and Mozambique in particular.

Implemented services have for instance been employed to increase the efficacy of immunization programs, where caregivers and children are registered by a nurse using a mobile application. The caregivers receive an SMS reminder when they are due to go back to the health center for an immunization visit. In case a child fails behind on his/her immunization schedule, the system flags the case and allows the health center employees to intervene to ensure the child receives all the required vaccinations. Another area where some applications of mobile technologies have been developed relates to mobile banking, directed mainly to the fraction of the Mozambican population that cannot afford traditional bank accounts. Examples of these systems are Mpesa and Mkesh, delivered by a private (Vodacom) and a public mobile telecommunication companies (Mcel), respectively.

To this end, the challenge is to develop relevant and innovative applications that will meet Mozambique’s growing need for quality services at all levels. This set of panel presentations (part 1 and 2) aims at highlighting some of these applications that have been implemented and perhaps tested within the Mozambican environment and have some practical value to the development and growth of the society at all levels.

**Keywords:** Mobile technologies, applications, services, challenges
Moderator’s introduction: At this conference, three participants present reviews of M4D research. These are Heike Baumüller, “Are mAgriculture applications living up to expectations?”; Cecilia Strand, “Are mobile phones a viable anti-corruption tool?”; and Jean-Paul van Belle (with co-author Selina Mudavanhu), “A review of research on mobile phones and development published in three top ICTD journals”. These presenters evaluate claims concerning projects and trends in mobile communication technologies for development. Noteworthy in this connection is also a chapter by Caroline Wamala Larsson and Jakob Svensson, “Participatory approaches to development through mobile technologies: A review of the M4D biennial conference proceedings” that appeared last year in Mobile Participation: Access, Interaction, and Practices (Cambridge Scholars Publishing).

Caroline notes in her Introduction to this conference proceedings that Jonathan Donner advocates for the retirement of the term “M4D” as removed from “ICT4D” in his recent book After Access. Inclusion, Development, and a More Mobile Internet, (MIT press, 2015). In Donner’s opinion there has been too much focus on hand-held devices. But perhaps Donner’s book puts too much focus on Internet access as “the next step”. What is gained if researchers are Internet-centric (I4D rather than ICT4D), when access to any network is still an issue? Surely, cheaper internet access is also an issue and many presentations and the panels raise the issue of “affordable” means. In the same time, questions of content should come first and, as the “local radio” example by Jude Mukundane and Christopher Csikszentmihalyi shows, networking is still not necessarily a question of Internet access.

So what this last session of the conference is allocated to discuss is our “m” focus. The mobile phone – this little device with loudspeaker, microphone, display and keyboard, and often a camera, and wireless – does it deserve a special status when pro-development people look at what is locally feasible and meaningful (socially and not only economically)?

Initial comments by: Orlando Zacarias, Caroline Wamala Larsson, Jean-Paul van Belle, and Celestino Joanguete. An open discussion follows on these.
Posters
Mozambican TV stations on Android Devices: The case of Miramar Mobile TV (TV-Bolso)

Luis Siza Jó e Orlando Zacarias
University Eduardo Mondlane
Department of Mathematics and Informatics (DMI)
Faculty of Science, Maputo, Moçambique
luis_siza@live.com, ozacas@uem.mz / ozacas@gmail.com

Poster Abstract: Information is power and the role of any television station is the dissemination of information. The information contributes in some ways to the development societies. This has not been different in Mozambique. However, to access television content requires being close to a television set, a factor that can be limiting because of the daily activities of many of the television audience. In this respect, it is useful to resort to other means of television watching. The development of a mobile application that aims to provide television content through streaming with the aim of allowing the population to have information at anytime and anywhere is one such possibility.

This application was developed for the Miramar television company (TV Miramar), employing tools such as Java programming language and XML (Extensible Markup Language) within the Android Studio 1.5.0 environment. The prototype was developed using the design rapid prototyping (POP) framework.

This resulted in a prototype with three main features: showing the program that is in the air; showing weekly program scheduling; showing featured news as the most important headlines. With these results, it is believed that most of the Mozambican population can easily access the information of TV Miramar and thus help the TV station increase their audience.

Keywords: TV Station, Information sharing, Mobile technologies

1 Corresponding Author
Mobile Phones and Effective Resource Management in Developing Communities: The Case of Dwesa

Tatenda Chatikobo, Lorenzo Dalvit, Michele Cristoferi, Mfundiso Miya, Mbalenhle Buthelezi
Rhodes University, South Africa
tatendachatz@outlook.com, l.dalvit@ru.ac.za, michele.cristoferi@gmail.com, mfundisomiya@gmail.com, mbalenbe3@gmail.com

Poster Abstract: The Eastern Cape Province, where Dwesa is located, is a predominantly rural (63% of the population) and comparatively poor region of South Africa. Prevalent poverty and past apartheid discriminatory policies have led to inefficient resource management. This has seen precious resources like food and water wasted as well as toxic industrial waste (old car batteries, disposable nappies etc.) mishandled and posing threat of contamination to the water and food sources in the area. Research has shown that although rural, approximately 60% of the households in Dwesa have access to an internet enabled mobile phones and are actively engaged in networked activities like Social Media. Through participatory design, our ongoing project proposes the use of Information and Communication Technologies (ICT), particularly mobile phone applications as a tools that support civic engagement as well as effective resource management (both man-made and natural). The development and adaptation of mobile solutions in our action is grounded in research on the current practices and existing indigenous knowledge around the management of water, food and waste (A National Framework for Sustainable Development in South Africa, 2008, p.33).

In this ICT project, which is funded by the National Research Foundation of South Africa under the Human and Social Dynamics Funding Instrument, are several research activities. These are aimed at exploring the potential of ICTs in mediating and promoting a participatory culture and environmentally aware lifestyle premised on resource efficiency and self-reliance in developing communities like Dwesa. The different research activities under this project are outlined in the following paragraph.

Members of the community collaborate with ICT experts and software developers to adapt relevant mobile applications to the needs and context of
the community. The beneficiaries in the community are then trained in the use and further development of the mobile applications. Since the inception of the project, several proof of concept applications have been developed through Hackathons organised by Fondazione Bruno Kessler in Italy. Secondly to address some of the issues stated, a research aimed at developing a comprehensive theoretical framework to capture aspects of mobile phones in empowering/disempowering a developing community, across different dimensions (Castells categories) and approaches (political economic and critical cultural studies). Thirdly, a research aimed at investigating the reasons women in Dwesa acquire and use internet enabled mobile phones. This looks at the extent to which digital literacy allows for the women in Dwesa to become online participants using these devices. Forthly, establishing how the community members in Dwesa understand the concept of development (in their own terms) in relation to the ICT and mobile interventions deployed in their community and finding out the preserved usefulness of these initiatives or the lack thereof. A research has already been conducted to establish the money related uses as well as the cost and benefits of using and owning a mobile device in the Dwesa community.

**Keywords:** South Africa, Dwesa, Mobile phones, Resource management, Marginalised communities, Mobile applications, Software development, Information and communication technologies, ICT
**Poster Abstract:** Research is usually done to answer some particular research question. It is known that books have well prepared and elaborated content, being therefore recommended as basis in the preparation of research reports and papers. There are several websites that host relevant information about books including book content where many of these books are not free. This situation is further aggravated for third world countries like Mozambique, where services like e-business and e-commerce are not common. Thus the need to facilitate the search process in books indicating their location, i.e., libraries and bookstores where they can be found.

The mobile platform has been chosen for the construction of the search engine. The engine was constructed in three stages: registration of books in a database, building of a search engine and building of a website for the registration of bookstores and libraries. The website was build using the bootstrap front-end framework with the application of PHP, JavaScript and HTML languages.

This resulted in a search engine application based on Google books which makes content search in scanned books and indicates the virtual stores and libraries where these books can be found. The use of this application may significantly improve the demand for books since the search process using the content of the books and the indication of their location can reduce the effort and time spent in the process.
Model for a Consultation System of Identity Card Issuance (Txeca B.I.)

Abrantes António Cua  
*Universidade Wutivi – UniTiva, Mozambique*  
*Faculdade de Engenharias, Arquitectura & Planeamento Físico*  
*Departamento de Informática; Informática de Gestão*

Orlando P. Zacarias  
*Universidade Eduardo Mondlane, Mozambique*  
*Department of Mathematics and Informatics (DMI)*

**Poster Abstract:** In Mozambique the civil identification services are provided by national civil identification direction (DIC), where the identity card (BI) is a very important element to guarantee Mozambican nationality, since without it, the citizen does not have the privileges granted to all individuals belonging to the Mozambican state. Because the identity card serves as a document that certifies and guarantees the Mozambican nationality, it becomes a very disputed document concerning its obtaining or renewal. As a result of this demand, civil identification services reveal themselves unable to meet the deadlines with respect to the provision of identity cards, so that they could be picked up or delivered to its owner. This creates a certain discontent among citizens because they have to constantly travel to the responsible entities for issuing BI, failing to successfully obtain their individual documents.

The proposed model to solve the problem adopts web-based technologies, using principles of mobile development. The bootstrap framework and PHP were the main tools used in application development.

The application can be used as a solution to the frequent problem of travelling without the certainty that the identity card is available to be picked up, enabling citizens to previously check the availability of their identification without leaving home, going consequently to make its collection.
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