Centre for HumanIT

John Sören Pettersson (ed.)

Proceedings of

1st International Conference on M4D

Mobile Communication Technology for Development

M4D 2008, General Tracks

11–12 December 2008

Karlstad University, Sweden

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Foreword

With 133 registered participants, this conference surely surpassed our expectations. When we started planning this conference it was a smaller event we had in mind. It would be a "1st" conference, one of those fumbling starters to gradually build up to something larger. We wished to create something which would support research in the M4D arena by both encouraging academic discourse and feeding into and disseminating practitioners' experiences. With the help of all of you who have registered for this conference, coming from more than 30 different nations, we already have a flying 'something'.

It is interesting that we span not only the practitioners–researchers gap but also the social science–technology fields. By necessity, some sessions ran in parallel and people tended to go into the folds they are used to. But many sessions, and breaks, and indeed also the Lucia celebration on Friday morning, were common, and it is our belief that every participant at *M4D 2008* met people and perspectives she or he has not encountered before.

On behalf of the organizing committee we would like express our sincere thanks to all the presenters and panellists who shared their works and ideas with all of us, and especially we thank the three keynote presenters – Adam Denton from GSMA headquarters in London, Richard Heeks from University of Manchester, and Victor Bahl from Microsoft Research in the US – for accepting our invitations. We also want to acknowledge the important contribution of the reviewers for this conference and the proceedings.

We are also happy to announce contributions from several sponsors: the Centre for HumanIT, which put in both money and time, SPIDER for financing the workshop on Collaboration in East Africa, the E-CLIC project for supporting the workshop WIRELESS4D, LifeAcademy and Tieto for sponsoring our two lunches, the Ericsson corporation for sponsoring our conference dinner (and also for providing a history lesson during the dinner on the company founder Lars Magnus Ericsson), and Microsoft Research India as well as the network for post graduate students, IPID, for travel grants supporting scholars and research students attending this conference.

John Sören Pettersson	***Gudrun Wicander***	***Christian Christensen***
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See separate volume, series number 2008:62 (also available electronically at: http://urn.kb.se/resolve?urn=urn:nbn:se:kau:diva-3237).

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Policy Priorities to Connect Africa

Adam DENTON
GSM Association, Mid City Place, London, WC1V 4EA, UK
Tel: +44 (0) 7824 327 336, Email: adenton@gsm.org

Mobile communications have been truly transformational with over 3.5 billion people globally now having access to voice services using mobile technology. However, challenges remain, both in continuing to expand voice access and in delivering affordable mobile broadband services to bridge the digital divide.

To date, the mobile industry has invested over $40 billion into networks in Africa. In 2007 the industry committed to invest a further $50 billion by 2012 into mobile voice and data networks. For the social and economic benefits to be fully realised it is critical that governments provide an environment that supports this investment to ensure the economic and social benefits are fully realised. Inappropriate government tax policies, continued international gateway monopolies, poor spectrum planning, ineffective universal service management and unpredictable investment environments all increase the cost of ownership, reduce penetration and limit the economic and social potential of mobile.

A World Information Society report in 2007 stated “The debate over the future of the digital divide is now moving away from ‘quantity’ in basic connectivity and access to ICTs to measures of ‘quality’ and ‘capacity’, or speed of access”. The mobile industry is uniquely positioned to help bridge the digital divide with mobile broadband, but success will depend on government policies that support investment and competition.

White Space Networking & The Commoditization of Pervasive Internet Access

Victor BAHL
Microsoft Research Redmond
Tel: +1 (425) 706-1021, Email: bahl@microsoft.com

We began our journey with the goal of commoditizing pervasive connectivity for the masses. We gravitated towards providing neighborhood connectivity in developing and rural regions. Businesses saw an opportunity and local government began to value blanket city-wide coverage. But success was not inevitable. Deployments failed and critics questioned the promises. Perhaps the technology was not ready for prime time. So we began looking at "fixing" the technology, part of which included "fixing" of the governmental policies around low-frequency spectrum. Some government listened and new spaces for license-free operation were opened up.

In this talk, I will discuss the evolution of our thinking on how to achieve open pervasive internet connectivity. I will highlight promising new research directions that are full of interesting challenges. I will draw on solutions that researchers have developed and show some of their limitations. My objective is to present what I believe is a one of the new frontier for wireless networking research at the intersection of white spaces networking, cognitive networking, and mesh networking. I will challenge the audience into taking on new problems, which when solved will eventually lead us to success in our original goal of commoditizing pervasive connectivity for the masses.

Priorities in Mobiles-for-Development Research

Richard HEEKS
Centre for Development Informatics, University of Manchester
Tel: +44 (0) 161 275 2870, Email: richard.heeks@manchester.ac.uk

We can frame a discussion of priorities for mobiles-for-development (M4d) research around a set of questions. A major one would be: why do M4d research? Perhaps simpler, we could ask: where do M4d research?

In this keynote presentation, however, the focus will be on two other questions.

First, how to do m4d research? Put another way: how can we do m4d research right? I will discuss two main points on this. We have probably thought rather too little to date about the dissemination, the uptake and the impact of our research. But who should be the audience for our research, and how best should we reach them? Particularly for those working in a university environment, whom should we target with our research: practitioners, policy-makers or other academics?

M4d currently represents something of a research gold-rush. In populating this domain, have we paid enough attention to the conceptual foundations of our research? In particular, what are we missing given our relative lack of engagement with development studies; a toolkit of ideas that – for example – shapes the discourse within many international agencies?

Second, what m4d research to do? Put another way: how can we do the right m4d research? Again, I will discuss two main points. New technologies are exciting and they help to capture attention and resources for development, particularly in the global North. But are we all too ready to jump onto the merry-go-round of novelty? We can characterise innovation of relevance to development as pro-poor, para-poor and per-poor. Focusing on the last, should we be paying more attention to researching the adaptations and applications of mobiles that are arising bottom-up from within poor communities? Are we missing opportunities to harvest and scale such innovations in our research?

And have we followed the tracks of mainline telephony too readily, in conceiving mobiles as tools for consumption? Mobiles can also be tools for production – creating new content; creating new livelihoods; creating new micro-enterprises. Looked at in this way, mobiles provide a direct connection to the re-emergent development agenda of economic growth. Can we make this connection in our own M4d research?

Above all, do we need to reconceive the poor in the global South; seeing them not as passive consumers of M4d, nor just as project participants, but as active producers and innovators?

Practitioner Track – Papers with Oral Presentations

Waste of Technology

Scott LESCAK
Eazyfone, Guildford House, Heather Close,
Lyme Green Business Park, Macclesfield, SK11 0LR, UK
Tel: +44 (0) 1625 667 867, Email: scott.lescak@eazyfone.com

Abstract: Mobile communication technology makes our lives easier, improves our efficiency in business and industry, improves communications in many remote and rural parts of the world, and can even save lives. So with technology having such a profound impact on our lives, what happens when it comes to the end of its own? T-Mobile has estimated that there are over 52 million redundant mobile phones in the UK, and many estimates are closer to 80 million. With legislation such as ROHS and WEEE changing how we manage this technology at the end of it's life, and the fact that redundant everyday technology such as mobile phones can help bridge the digital divide and change others' lives, consideration must be given to whether redundant equipment like mobiles is really technological waste, or a waste of technology. This question is critical for growing markets in many of the developing regions of the world. This paper will look at how Eazyfone Ltd who are based in the UK manage the transfer and redistribution of redundant mobile phones worldwide, and some of the challenges they face in doing so.

1. Production in Today's World

A mobile phone is manufactured as many of our modern equipment, devices, toys and household items are. They require the mining, growing, or processing of various natural resources, such as oil, metals, and wood amongst others. The process by which these natural resources are obtained has traditionally been thought of in monetary costs, as opposed to environmental and social costs. Manufacturing has traditionally been based on monetary costs with various management styles developed over the years to ensure cost efficiency.

Yet only recently, in the last 30 to 40 years have we started looking at the other costs associated with the manufacture of our food, clothing, and electronic equipment amongst all the other day to day products we use. Our physical requirements have a number of other costs such as the pollution of our lands and waters due to the use of chemicals on crops, mining for metals leading to destruction of habitat and biodiversity, the consumption of non renewable resources, exploitation of human life for manufacturing purposes, or the depletion of worldwide fish stocks, the list goes on.

Today's production methods have questions surrounding them in relation to sustainability and ethics. As a result society is faced with more and more questions about sustainability, and our rights to exploit and develop in order to meet our modern needs.

2. Mobile Phones as Products: What Impacts?

There is no doubt that mobile phones bring benefits to all of us. However putting aside the economic cost of a mobile phone, what are the environmental costs associated with one of the most loved technologies of recent years?

With an estimated 3.3 billion mobiles in use worldwide [1], and anywhere from 50-80 million redundant phones alone in the UK, there is definitely a concern over how they are managed when no longer required. Heavy metals such as mercury, lead and cadmium are present in mobiles, particularly in older models [2], and can have detrimental effects on human, and animal health if they contaminate land or groundwater. The mineral Coltan is another component of mobile phones that has environmental implications. Coltan is used to regulate electricity in mobile phones and there are suggestions that it has helped fuel the war in the Democratic Republic in Congo (DRC) [3], and links between Coltan mining and the death of the DRC's Mountain Gorillas [4].

Some legal steps towards sustainability have been taken by Europe with the development of legislation such as the Restriction of Hazardous Substances (ROHS) which aims to reduce harmful substances such as mercury and lead being used during the manufacture stage of electronic and other products [5], also key is the Waste Electric and Electronic Equipment regulations (WEEE) which aim to ensure that electronic equipment is recycled and managed appropriately at it's life's end [6]. However what about the other aspects in the early stages of this equipments production? What about the natural resources these products require in order to come into being, and the social and environmental impacts, and implications of their production?

It has been estimated that the average mobile phone has a lifetime of between 12 and 18 months. Over this period of time, a mobile phone being used by the average person has been calculated to emit around 105 kgs of CO_2 [7]. Considering the UK has more 68 million phone contracts [8] that would be over 7 million tonnes of CO2 emitted every 18 months through mobiles alone.

Although many mobiles reach the end of their life before that 18 month period, the condition of the phone is less of a reason for a change in phone than perhaps the technology available on newer phones. The birth of Blackberries, I phones, and a wave of other smart phones will lead to a similar wave of mobiles that are no longer required, surplus to requirements and likely to be passed on to someone else, or kept as a spare, or back up phone.

This leads to millions of phones in the UK not being recovered for reuse or recycling. The same mentality can be seen with other products which have enough value to be kept until something triggers a need to dispose of the product, even if it still serves a purpose.

Now for every mobile phone, pair of jeans, or old personal computer we dispose of there is a finite amount of use left in that product, often without the need for refurbishment, or repair. However, putting an economic cost on these products in relation to transporting and refurbishing or repairing them for reuse often leads many of us to deem these products as beyond economical repair. A good example is that it's easier to put a mobile in the bin than to drive to the civic amenity site to recycle it. So as a result these products are disposed of. In the case of mobile phones which often have various technological benefits to offer still, this may be seen as a waste of technology. However, if these products truly are beyond economical repair, then they are the waste of technology and must be disposed of appropriately.

A key aspect when considering disposal of technology such as mobile phones is in not looking solely at the cost of repair economically, but in looking at the environmental costs not only in producing the product, but in not reusing the product. So as a result the product's scope for reuse should instead be expanded to consider the finite natural resources used, the suitability for reuse, development of markets for reuse, and transport and costs of shipment for reuse. These are all key factors which have led to the development of the market for used mobile phones that Eazyfone is now a part of.

3. Reuse – Ethical, Environmental, Profitable

Eazyfone have developed along with the mobile phone reuse market over the last 8 years and our model is simple. Our envirofone.com brand encourages consumers to visit our website, enter their mobile phones' make, and model, then see how much it's worth. Some mobiles

may have no value, while others may be worth up to £180 or more depending on the age and condition of the phone. We will ensure that phones with no value sent to us are end of life recycled at no cost to the owner.

Once the phones are recovered they are graded and where suitable refurbished for resale. We then put the phones in stock and up for auction. We sell the phones in large and small batches to buyers in the Asia, UK, Europe, and Africa. Most of our phones are sold to large buyers in Hong Kong and China, who then sell the phones to smaller buyers who in turn sell to shops and individuals for public purchase. In the UK Envirofone's recovery model may be seen as a sustainable business and environmental model prolonging the life of mobiles, and reducing their negative impacts, but it may also be seen as a closed system as it deals only with sustainability in the UK.

4. Thinking Outside the System

It is through its model of reuse and recycling that envirofone.com is able to help contribute to the development of growing economies by providing affordable and functional mobile phones to those who need them. Nigeria is by far our largest African market (Chart 1) and has a population in excess of 120 million people, with estimates of up 80% mobile penetration. The United Nations Conference on Trade and Development (UNCTAD) found that mobile phone subscribers "…have almost tripled in developing countries over the last five years, and now make up some 58 percent of mobile subscribers worldwide." [9] This would appear to give evidence that the digital divide is indeed closing, and that mobiles have a beneficial role in the process.

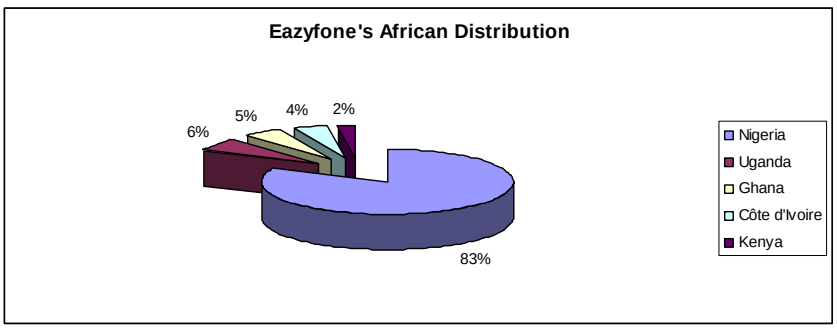

Chart 1

UNCTAD goes on to say "Mobile telephony provides market information for, and improves the earnings of, various communities, such as the fishermen of Kerala, the farmers of Rajasthan, the rural communities in Uganda, and the small vendors in South Africa, Senegal and Kenya," providing just one example of how mobile phones can have significant impacts in developing economies. Evidence that mobiles are growing in use in developing economies can be seen when comparing their growth in comparison to traditional landlines illustrated by data taken from an article by Leonard Waverman et al. [10] (Chart 2). Mobile use largely did not exist in 1995 for the countries in Chart 2, the registration of mobile users in 2003 is not only interesting because of their appearance out of seemingly nowhere but more so because in many cases they surpass the use of traditional landlines.

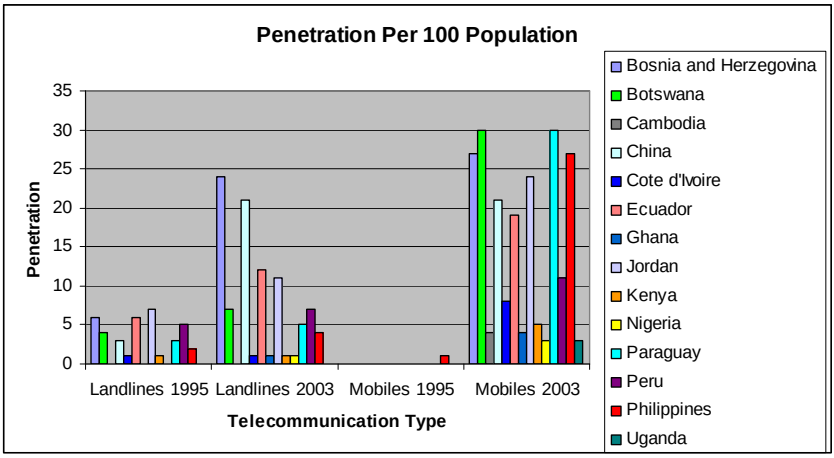

Chart 2

5. The Challenges

Although mobiles are undoubtedly beneficial for developing economies, and organisations like Eazyfone play an essential role, there are a number of challenges associated with what we do as an industry from an environmental and social point of view.

5.1 Environmental

Chemical Hazards
The mobiles phones contain small quantities of hazardous chemicals such as those identified earlier, and these must be managed appropriately at end of life. This is fine in Europe, but what about in Asia, Africa, and other developing economies and countries? As economies grow, so too hopefully will the infrastructure associated with developing economies, and the scope to manage waste in more improved manner.

Reuse and Recycling
Reuse over recycling should be a key priority, however with millions of mobiles estimated to be redundant within the UK, most of them will never be reused or recycled, but will end up in landfill. The mobile reuse and recycling industry is growing, and maturing which is allowing for a greater and more creative means to penetrate many levels of society in an effort to recover redundant mobiles.

Illegal Waste
The illegal shipment of electronic waste to foreign countries is an issue as often corrupt officials will allow these shipments to be received. The receiving countries will often dispose of this waste in unethical ways damaging the health of both workers, and the environment. The UK environmental authorities have regulations in place to prevent the shipment of electronic waste, however more enforcement is required on both sides.

5.2 Social

Clone Wars
It is believed that some Chinese manufacturers are purchasing used mobiles phones to produce "Clone" phones which are illegal. This causes frustration amongst those buying the phones as clones are often indistinguishable from the real thing, and are often less reliable. As a result sellers of quality second hand mobile phones may face reduced income, and have little recourse to combat this apart from relying on high levels of customer service and quality of phones to ensure that they meet their customer's requirements in order to compete with the sale of clone phones and keep their customers happy.

Affordability
Even though second hand mobiles are more affordable, there are still many people that cannot necessarily afford them. However, it would appear that the business of buying and selling mobiles is helping provide employment, and is helping some cities and towns develop economically while helping to provide a larger penetration of mobile ownership into developing economies. As mobile technologies improve, prices of older phones will drop making them more and more affordable.

Access
Having a mobile is one thing, but for many having access to electricity, and network coverage, as well the costs of talk time, can be issues. There is an amazing ability to find creative and innovative solutions such as using texts and phone rings without answering, as well as setting up solar powered charging stations and charging fees for use. There is also an increase of mobile networks developing worldwide. It is clear that mobiles have an integral role to play in developing economies, and that along with the many benefits they provide, that there are also some challenges. However what organisations such as Eazyfone are able to do is prevent equipment from being disposed of as waste of technology, which when it is still functional would also be a waste of technology, and instead help deliver this technology into hands that benefit from what we see as items or equipment that is surplus to requirements.

6. Summary

Developing a market for reuse of mobiles often leads to their reuse in developing economies, where it has been demonstrated that mobile use has a number of benefits to these economies, although there are also some environmental and social issues that must also be considered.

The ability for organisations such as Eazyfone to develop and thrive in a market based on reuse and recycling not only helps reduce the negative impacts these redundant phones have, but also creates a sustainable business and environmental model which is able to work with legislative requirements, and reduce the likelihood of wasted technology, by managing waste arising from technology.

However, at the moment these systems have only been considered as closed systems, and more consideration must be given to what impacts both positive and negative, these models are having outside the system.

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Exploiting Mobile Technology in the African Urban Low-Income Informal Music Industry

Jussi IMPIO[1], Mokeira MASITA-MWANGI[2], Lucy MACHARIA[3], Pauline GITHINJI[4], Moses SITATI[5]

[1]Nokia Research Africa (NoRA), Nokia International OY – Kenya, P O Box 29, Nairobi, 00502,Kenya, Tel: +254 20 3862243

Email: [[1]jussi.impio, [2]mokeira.masita-mwangi, [3]lucy.macharia, [4]pauline.githinji, [5]moses.sitati]@nokia.com

Abstract: Music making and distribution is a large scale phenomenon in urban informal settlements in Africa. The talent, vision and passion of the musicians living in the African slums would be appreciated by the music lovers around the world if only the artists had a chance to practice as well as possibilities for recording and sharing. Furthermore this would contribute significantly to livelihoods of the people living in the slums and to economic development of Africa as a whole given the estimates of the contribution that the informal music industry is already making. The obstacles discussed we believe can partly be overcome by creative thinking and new technology and we hope that this report works as a source of knowledge and inspiration for researchers and developers to develop meaningful services and support mechanisms for young musicians living in the slums around the world.

1. Introduction

This paper is based on a recent study of the informal music industry in Africa carried out by Nokia Research Africa (NoRA). The research is a combination of extensive desk studies and more than 220 interviews and observations which took place in Huruma between June and October 2008. Huruma is a slum of 260,000 people in Nairobi, Kenya. We created an overall view to the meaning of music among the general public in the slum and the scale of music as self expression and a form of micro entrepreneurship. Later we focused on upcoming musicians and other key players in the informal music industry.

How do the study results apply to the other slums in Africa? Indeed there are big differences between the slums in size, climate, political, cultural, and religious atmosphere. However there are also numerous common factors between the slums: high population density, young age profile, lack of sanitation and clean water. There is also high unemployment, low access to information and variety of health and social problems. The means of livelihood and enjoyment are also very similar in most of the slums. Very distinctively in most parts of Africa, music is one of the most important sources of information, hope and uplifting in spiritual and more earthly form. NoRA also plans to continue studying the informal music industry in Africa through comparative studies in other urban slums in Africa, as well as testing certain existing mobile music technologies amongst upcoming musicians to establish their suitability, whether they can potentially address some of the drawbacks in the informal music industry as unearthed by the research and hence what other gaps exist that require such technologies to be tailor made or other mobile music products be developed.

2. Music as a way of life

Music is an integral part of the African social life and communication. Although not captured in GNP (Gross National Product) or HDI (Human Development Indicator), among other creative arts, it makes a significant contribution in enhancing quality of life. This is similar to the objectives of many other development initiatives. Music is also a revenue earner thus improving incomes and living standards. In addition it is a source of identity e.g. nationality, community, work, language, politics, religion, etc. It strengthens solidarities and plays a unification role across narrowly divisive groupings. Music acts as medium of dialogue and, as a vehicle of communication giving voice to the voiceless.

2.1 Source of livelihood

Apart from entertainment, education, and personal expression and status in the community, music-making is an increasingly popular means of livelihood. This is because the early stages of music making do not require a lot of professional training. A market exists for upcoming artistes since local audiences want music that they can relate to and identify with. As such, local music and local artistes are very popular in urban slums. They speak the local language and they understand the life issues and experiences. Specifically, the case studies of upcoming musicians in Huruma clearly demonstrate that it is possible for music to provide a good source of livelihood even with a relatively small audience. This is due to the low standard of housing and generally low cost of living in the urban slums in Africa, but also because of the high appreciation of musical talent and a well told story.

From the in-depth studies of upcoming musicians in Huruma, income earned from music ranges between EUR 50 to EUR 600 per month while monthly expenditure is in the range of EUR 95 to EUR 410. This is largely income earned from live performances at concerts, clubs or shows for which the musicians get paid and is significantly better as compared to the average monthly incomes of other slum dwellers (EUR 50 to 75) whose occupations vary from small scale enterprise, casual labour, artisans, some in formal employment like watchmen, domestic workers, clerks and waiters. Table 1 shows one upcoming musician's income and expenditure.

The highest possible income as shown is lower than the estimated lowest possible expenditure. Because these are estimates given that the sources of income are very irregular and inconsistent, it is possible that this musician could make much more or probably even much less than has been indicated. Hence prioritization often has to take place when income is lower, meaning that not all needs will be catered for in that particular month. For this musician, his main priorities ranking number one on his list are food, rent, electricity, and support to family. Next are expenses on clothes and grooming, followed by airtime, transport and internet browsing. Finally if any money is left over he spends it on his music college fees and music materials. Based on basic needs alone, (first priority which totals to EUR 105 to 107) it is possible for this musician to earn a living from his music alone which brings in approximately EUR 93 to 116 in a month.

From a macro point of view, development of the music industry in Africa can make several contributions to economic development, social change, political cohesion and cultural progress. With sufficient scale, this can ultimately include diversification of economic activities away from primary commodities which have dominated the past several decades. Based on our studies and existing statistics of the formal side of the music industry, we estimated that the size of the informal music industry in Africa is annually between 250 – 350 million USD. This includes the payments musicians receive from live performances and directly from the CD/C-cassette sales. This however does not include markets of pirated CDs and cassettes which is the main way in which the music of informal artists is also being distributed but difficult to estimate in size due to the underground and illegal nature of the whole trade hence the size of the industry is likely much larger than this estimate. The table

below also shows the estimated size of the industry in terms of number of people working in various capacities.

Table 1: Upcoming Musician's Monthly Income and Expenditure

Source of income	Amount (EUR)	Expense Item	Amount (EUR)
Live performances about 4 per month @ EUR 200-250; save 10% for servicing band, 20% for band extras i.e. those hired to perform with them, then 70% split amongst 6 band members	93 to 116	Family support for siblings' education	48
Odd jobs (done mostly as a group so split between about 5 people) EUR 150 to 200 per job	60 to 80	Internet browsing at cyber cafe	6 to 12
		Transport (bus fare)	20
		Airtime for phone	30 to 40
		Hair grooming	6
		Rent	25
		Electricity	2 to 4
		College fees (music school)	24
		Clothes	20 to 30
		Food	30
		Music materials (strings for guitar, books, etc)	5
TOTAL	153 to 196		216 to 244

Source: NoRA Study of Informal Music Industry in Africa [2]

Table 2: Estimated size of informal music industry – Africa

Mainstream Urban Artists:	~ 2,000 (50 per country)
Approx. No. of Urban Artists Recording at any given time	> 150,000 (Over two-thirds recording with 'bedroom' producers)
Musicians interested in Recording	~ 250,000/Week
Independent Musicians (Church singers, cover bands, small groups, etc)	~ 50,000,000 (5 for every person interested in recording) (5% of population)
Performing Musicians:	Typically same as mainstream artists, recording artists and recognized independent musicians
Core Employment in Urban Music Industry	~ 200,000 (Artists, songwriters, producers, managers, etc)

Source: NoRA estimates based on industry interviews, October 2008 [2]

Desk studies also reveal more insights related to maturity of the music industry as shown in Table 3 as pertains to the performance industry as well as recording industry.

Table 3: Music industry maturity – Africa

	Established industry	**Emerging/ previously established industry**	**Embryonic industry**	**Craft-like scale**	**Unclear evidence of industry**
Performance Industry	Congo (Brazaville), Congo (DRC), Kenya, Mali, Senegal, South Africa, Tanzania	Botswana, Burkina Faso, Cameroon, Gambia, Equatorial Guinea, Guinea Bissau, Ivory Coast, Madagascar, Zambia, Zimbabwe	Benin, Cape Verde, Central African Republic, Ghana, Mauritius, Mozambique, Namibia, Uganda	Angola, Niger, Seychelles, Togo, Malawi, Gabon, Swaziland	Burundi, Chad, Djibouti, Ethiopia, Eritrea, Lesotho, Libéria, Mauritânia, Rwanda, Sierra Leone, Somália, Sudan
Total	**16 %**	**24 %**	**17 %**	**16 %**	**27 %**
Recording Industry	South Africa, Zimbabwe	Cameroon, Cape Verde, Ivory Coast, Kenya, Madagáscar, Mali, Mauritius, Senegal, Tanzânia, Zambia	Benin, Botswana, Burkina Faso, Central African Republic, Congo (Brazaville), Congo (DRC), Ghana, Guinea Bissau, Equatorial Guinea, Malawi, Mozambique, Namibia, Uganda	Gabon, Gambia, Niger, Seychelles, Togo	Angola, Djibouti, Burundi, Chad, Ethiopia, Eritrea, Lesotho, Liberia, Mauritania, Rwanda, Sierra Leone, Somalia, Sudan, Swaziland
Total	**3%**	**26 %**	**27 %**	**11 %**	**32 %**
Average	**9 %**	**26 %**	**22 %**	**14 %**	**30 %**

Source: UNESCO 2005, The Global Alliance for Cultural Diversity [3]

Key points of interest to note from the above table are:

- In 35% of all Sub Saharan African countries, there is an 'established' music industry. This means that there are people actively engaged in music creation and sharing and hence earning a living out of this.
- 66% of countries have not broken through embryonic stage which means that there are certain challenges or constraints that need to be overcome in order for the industry to flourish to an extent that people can make a decent living from music. Some of such constraints are likely to be (hypothetically) technological ones related to the limit or lack of access to suitable devices that can enable and enhance the music creation process.
- 30% of all SSA countries have no evidence of a music industry but this is mainly due to instability/economic position and not because music is not an integral part of the culture and way of life.

2.1 Challenges and constraints

Live performance is a key music sharing medium in urban slums. The main problem however with the earnings from live performances at least for upcoming musicians is that they are not regular nor are they consistent. Most upcoming musicians are unable to effectively market themselves to the organizers of these live performances because they have not recorded most of their music hence have no way of demonstrating their talent. They therefore believe that recording their music is crucial – they can market themselves more aggressively for invitations to live performances and also supplement this income with sales of their CDs.

Taking an example of the upcoming musician whose profile on income and expenditure has been discussed says that he and his band have created enough songs to produce two complete albums (about 10 tracks per album). None of this music has been recorded at the moment however due to financial constraints and is not of much use to them in income generating terms. Were they able to produce the 2 albums it would mean that they could sell each CD at about EUR2 within the slums and even up to EUR 10 in higher income neighbourhoods and assuming they were able to sell 50 CDs in the slums and another 50 in upper income neighbourhoods they would make EUR 600 as a band which means that this musician would have an extra EUR 100 to his name enabling him to fully meet all of his expenses as listed. Further with the recorded music they would be able to market themselves more by sending demos to various event coordinators and perhaps get invited to an extra 2 performances in a month meaning this musician would earn an extra EUR 46.5 to EUR 58 and with all the needs or expenses catered for this musician would now be in a position to save some money and plan for the future, maybe re-invest in his music.

Recording music is however a dream not in immediate reach of most musicians due to the high costs involved. Audio recording of a single in the informal music industry costs anything between EUR 50 and EUR 300 while video production for a single costs between EUR 100 and EUR 1000. This is hardly affordable for most musicians living in urban slums.

Many young, upcoming artists would like record their music if only they had the ability and/or could afford it. This is because they strongly believe that recording is the key to success in the music industry. Out of the 42% who have had an opportunity to make music, only 11% of them make use of a recording studio. A majority (82%) express their desire to have their music on record; but as shown in figure 1 below, 89% have not recorded any music at all while 11% have had an opportunity to record. 33% of these cite financial constraint as the main reason why they have not recorded their music.

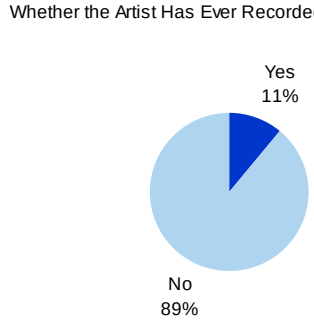

Figure 1: Percentage of music makers in Huruma who have recorded their music

Source: NoRA Study of Informal Music Industry in Africa [2]

Quality of production is another major challenge. In the informal music industry in Africa, most studio houses / producers give very poor quality service to musicians in the production of their music, yet quality is crucial if one wishes to get their music into the mass media. Most of the local music producers have little talent in music production and are often not musically oriented. They are mainly seeking to make quick profits and hence do not have the interests of the artists at heart. That notwithstanding, because the musicians are financially constrained and are unable to afford good recording studios, they have little or no control about the quality of the end product. FM Radio stations are forced to reject large number of CDs from upcoming artistes simply because of poor production quality not because of lack of talent.

3. Opportunity for mobile music technologies

Many upcoming artistes express the desire to produce their own music. Additionally, since experimentation is an intrinsic part of music making, musicians in this informal settlements desire to experiment more with their music so as to fully exploit their potential and come up with something that is of great impact with their audiences. This is however currently not possible in light of the constraints they face, as discussed: Commercially driven producers churning low quality music productions, the financial constraints of the musicians and a lack of their own equipment and instruments.

With the exception of mobile phones which most people own or have access to, majority of the artists in informal settlements have limited access to electronic devices such as computers. This limits their music making in terms of what they can do and how much they can control their music creation process.

There is therefore a gap that could potentially be filled by mobile phones with music making and recording capabilities. There is an existing and increasing appreciation for such mobile tools that can affordably support the artists work by recording and storing music (audio, video) as well as features that can enable sharing. The potential of mobile phones in music creation is also supported by the fact that many musicians are already striving to make use of the phones they currently own in their music creation process and have ideas of what more they could do for their music if they had higher end mobile phones with more features. For example even with the basic devices that musicians in Huruma own, they use the text messaging feature to key in ideas or song inspirations or lyrics that come to them wherever they are. Others whose phones have audio recording capabilities also use their phones to record their songs at the initial stages of creation and play back to themselves to inspire further development and refining. Most of the phones owned by these musicians are low entry phones with limited features hence not much that the musicians can use for their music making; they are limited by the capacity of the phones they own. In addition, the musicians have ideas as to what they would like to have in a phone in future and interestingly they link new features with their music needs. The features mentioned include: Bluetooth, Infrared for sharing / distributing music, audio recorder with long duration recording capability for recording their songs, video recorder for developing their videos, camera for still shots of interesting scenes and locations which they could one day use for shooting their videos, composer for composing tunes and beats, long battery life, large memory and memory backup for storing their music files and downloads, WAP enabled phone for downloading interesting software and music related content from the internet, etc.

Some of these features talked about already exist in higher end mobile phones and it is possible therefore that some of their needs could be met by simply upgrading to a higher end phone if only they could afford it. Some other features such as those that would enable fine-tuning and good quality song to be produced (studio-type equipment) may exist as software (mobile music technologies) that can be downloaded onto a phone and used but many musicians in Africa are not aware of such software and how they work, their phones may not support such software and the software may or may not be absolutely relevant and suitable

for their music creation process. Such technologies would therefore need to be tested and perhaps tailor-made to fit the upcoming African musician.

A multitude of mobile music technologies exist; below we highlight a few of these as uncovered by the desk research:

- Microbe, a compact and powerful music application for all the electronic genres – Microbe is an all-in one electronic music studio for PalmOS© Handhelds. Due to its 8 tracks drum machine, its 2 monophonic synthesizers and 18 effect plug-ins, it can generate a large palette of electronic sounds, rhythms and sequences. [4]
- Bhajis Loops turns your Palm into a portable sequencer and sampler – Bhajis Loops gives a musician everything they need to create compositions on the go, or to play complex arrangements during gigs: a complete sample editor, virtual instruments with wavetable synthesis, pattern editor and sequencer, effects, automation, and even a special mode for live performances. [5]
- miniMusic BeatPad 1.1 – BeatPad is a pattern based sequencer. It provides a simple yet powerful interface for creating musical patterns of various instruments or drum kits, layering these patterns, and performing them on a handheld or exporting them to a desktop/laptop. [6]
- miniMusic NotePad 1.4 – NotePad is a sketchbook for composers and song writers; it is great for music students or hobbyists learning to write and read music; it is also an ideal practice tool for singers and other musicians. [7]
- RhythmPro 1.2 (Drum Machine & Music Metronome for Palm Handhelds) – RhythmPro allows one to create and play own custom drum patterns with real digitized drum sounds on a Palm handheld. [8]
- PocketJam – PocketJam, is a tiny rack of virtual analog synthesizers, a sampler and effects for the Pocket PC. [9]
- AudioBox – Is an all in one virtual recording studio and sound creation tool for the Pocket PC. AudioBox is a complete music composition package with both track and score editing. [10]
- Syntrax (s60) – It has all the modern musician wants when away from the studio. A sequencer, sound synthesis and sample editor all wrapped up in one little package. [11]

Based on the relative size and maturity of the music industry in Africa as has been discussed in this paper, there is potentially a market and opportunity for relevant and suitable mobile music technologies to make a difference in music creation process of young musicians and help overcome their challenges and constraints and in the long run contribute significantly to livelihoods in Africa.

4. Conclusions and further work

With a better understanding of the informal music industry, music consumption and culture in urban informal settlements in Africa; the findings of this study are expected to begin to inform development of affordable mobile music technologies for the musically oriented but economically marginalized youth in Africa.

With this background information and insights (and continuing related studies) into the informal music industry in urban settlements; it will be possible for various innovations and technologies to be developed for mobile phones so as to extend to the user (music consumer / music maker / music entrepreneur) in an African urban informal settlement either or both incremental and transformational benefits. Additionally, beyond enhancing the work and life of musicians in this part of the world, perhaps we can introduce new and innovative ways of doing things in the music industry.

The diagram in Figure 2 summarizes the Informal Music Industry in Africa. In the centre is the opportunity which can be defined simply as music creation and sharing. There are motivations and supportive factors that can enable the opportunity be realized but at the same time there also exist key challenges that need to be overcome. These are as listed in the diagram and each of these individual aspects presents an opportunity for further in-depth investigation as relates to mobile music technologies.

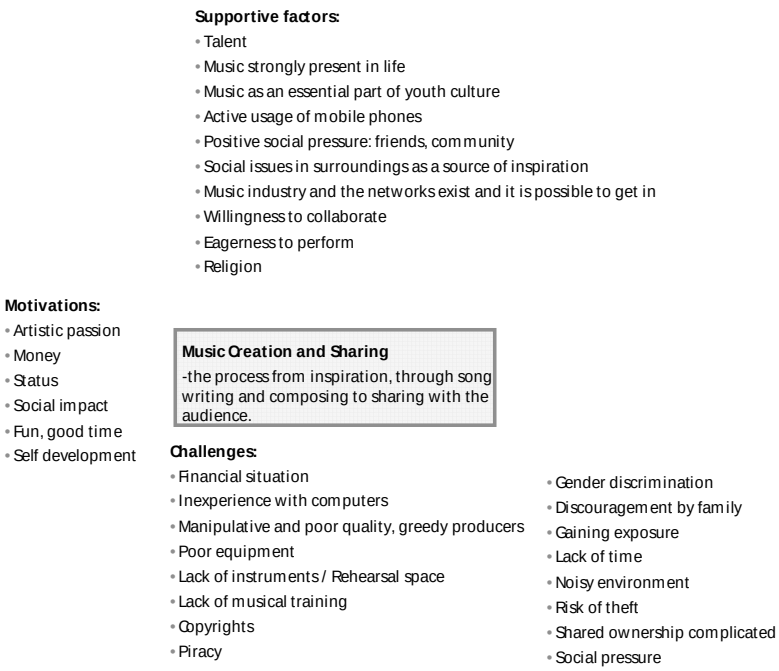

Figure 2: Framework: Informal Music Industry in Africa
Source: NoRA Summary Analysis of Study of Informal Music Industry in Africa [2]

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Broadband to Improve M-content: How the Internet Improves Life in Emerging Markets

Dag NIELSEN
Ericsson Response, Ericsson AB, Stockholm, Sweden
Tel: +46 70 6262 048, Email: dag.nielsen@ericsson.com

Abstract: What impact does the Internet have on everyday life in emerging markets? What effect does it have on people's ability to communicate, share information, conduct business, travel, learn and access healthcare? To answer these questions and gain deeper understanding of the potential benefits of Internet access, Ericsson carried out a qualitative study in Indonesia, South Africa and Rwanda. The study found real and tangible benefits arising from Internet access in emerging markets. These benefits apply across a nation's people, businesses and institutions. Access to the Internet enables a more efficient utilization of resources within businesses and institution through faster communication, faster flow of information and more efficient administration. There are, however, barriers to increased Internet uptake, which vary according to location (village, small town or rural city). This study verifies findings from earlier studies: that telecom brings substantial advantages to emerging markets and the introduction of mobile phones brings further positive development effects. As this study showed, Internet access revitalizes the development curve and brings about even more powerful progress for a nation – although at a slower rate – by opening up national and international contacts and information exchange.

1. Background

What impact does the Internet have on everyday life in emerging markets? What effect does it have on people's ability to communicate, share information, conduct business, travel, learn and access healthcare?

To answer these questions and gain deeper understanding of the potential benefits of Internet access, Ericsson carried out a qualitative study in Indonesia, South Africa and Rwanda. We gathered detailed information on the drivers for, and barriers to, Internet uptake and the development opportunities it offers through interviews and focus groups involving entrepreneurs, institutions and end-users. We were also interested to discover how people access the Internet and the role of mobile phones.

The reason for our interest in Internet access in emerging markets is the new opportunity opened up by mobile broadband for very cost-efficient access to the Internet for everyone, everywhere. Mobile broadband can help bridge the digital divide by enabling Internet access for people in villages that have been too expensive to connect to date.

By 'mobile broadband', we mean mobile network-enabled broadband access, typically provided by WCDMA/HSPA or EDGE Evolution access technologies. The most common mobile broadband devices are laptops or PCs with mobile broadband cards or USB dongles; laptops with embedded mobile broadband modules; mobile phones; and Fixed Wireless Terminals that can connect multiple users simultaneously.

2. The benefits of Internet access

The study found real and tangible benefits arising from Internet access in emerging markets. These benefits apply across a nation's people, businesses and institutions – delivering substantial progress for the country as a whole. Internet access is one of the pillars of positive development, capable of bridging the gap between developing and developed countries.

The findings of the study have been compiled into three main themes: 'Development effects'; 'Resource management effects'; and 'Networking effects'.

2.1 Development effects

Businesses

The Internet benefits entrepreneurs enormously by generating new income from both new and existing businesses.

The introduction of a homepage for marketing and email for fast communication broadens the market for existing businesses. Small entrepreneurs gain access to national and global markets and can move to a production-to-order model, rather than having to produce goods in advance. Furthermore, the Internet provides access to information, such as trends in developed markets, that helps steer product development and production processes – making micro-entrepreneurs more competitive on the national and global stage.

For some companies, like travel agencies, Internet access has become so important that it is now a prerequisite to running an efficient business.

As well as benefiting existing businesses, Internet access also opens up new business opportunities. Almost as soon as broadband is introduced in a region, new businesses offering Internet access (Internet cafés), technical support and Internet training appear – providing employment for young technically-minded people who otherwise might be unemployed.

Dewi runs a ceramic business in Malang, Indonesia. She started her business in 1991, but it was in 2005 that the business really took off. That was when a friend convinced her to get on the Internet, showed her how to use email and helped her to set up a homepage. Internet access has increased Dewi's profits by 50 per cent and enabled her to employ eight more people. Before the Internet, Dewi only did door-to-door marketing and her customers were based in her own region. By using her homepage to market her products, and email to communicate with customers and prospects, Dewi has attracted new customers from all over Indonesia as well as from Australia, France and the UK. Today, the majority of her orders come via email, which has enabled Dewi to produce to order rather than to stock. Customers can even email designs they want Dewi to produce. Dewi also researches the Internet herself for designs that western people like. When she finds something she believes will sell, Dewi produces samples which she photographs and uploads to her homepage.

Institutions

The Internet vastly improves the performance of institutions such as schools, health centers and government offices by opening up access to information and providing a channel for reaching out to citizens.

- The educational gap between village and city, rich and poor, is reduced since the Internet provides access to new and updated teaching materials.
- Healthcare is improved through instant access to information and knowledge about diagnoses, treatment and care.
- Red tape is reduced, as the Internet provides a communication and information channel between government institutions and citizens.

Doctor Joseph works as a health coordinator at a Millennium Village project in Rwanda. He is a committed fan of the Internet and started using mobile broadband even before he began working within the Millennium Village project in 2007. Joseph uses the Internet to widen and deepen his professional knowledge. For instance, he has used search engines to find information on when to prescribe, and how to dose, medicines instead of prophylaxis in connection with a worm break-out. Consequently, Internet access has improved the general quality of healthcare in the village and surrounding area.

The people

The Internet empowers people by providing access to knowledge and information that can help them learn, set up or expands a business, improve farm techniques, or find a job and, in the long run, develop their region.

In addition, when the Internet is used to reduce bureaucracy, it brings people closer to the government and gives them a greater voice. In the long term, people are likely to be more interested and involved in the development of their region and nation. Higher levels of engagement can help promote a more stable society.

Nasri works as division head of Electronic Data Administration at the Government in Malang. He is proud that his government believes in the capacity of ICT to aid regional and national development. One of his tasks has been to develop and implement an Internet- and mobile data-based service that people can use to send messages to the Government from a computer or mobile phone. The service enables citizens to respond directly to Government policies and initiatives. It is a quick and secure way to communicate with the Government, unlike letters that took a long time to be delivered, were often read by unauthorized officials and took time for the Government to answer. The Government believes the new online service will raise public trust and, in turn, make it easier for the Government to collect taxes, manage regulations and develop the region.

"Without the Internet, we would be like small fish in a small pond. We wouldn't know the same information as people in the outside world."
End-user, Indonesia

2.2 Resource management effects

Businesses and institutions

Access to the Internet enables a more efficient utilization of resources within businesses and institution through faster communication, faster flow of information and more efficient administration.

- Faster communication and information

Without the Internet, people often have to travel to deliver or collect documents. The introduction of the Internet and email reduces the need to travel, frees time that can be used to develop the business or institutional services, and speeds up the decision-making process within organizations. It leads to more competitive businesses and better services for customers and citizens.

Regional manager of one of Rwanda's major banks in Nyamata, Robert has regained two working days a week thanks to mobile broadband. At the regional office, 14 employees share three PCs, one of which was connected to the Internet via mobile broadband last year. The PCs are used to write reports on money transfers, loan repayments, etc., which are sent to the bank's headquarters in Kigali. Before the Internet, Robert used to save the reports on disc, walk to the business centre to print two hard copies and then make a six-hour round-trip to the headquarters twice a week by minibus. So in total, submitting the reports accounted for two full working days and travel costs of 8,000FRW per week. Thanks to email, Robert can spend two more days per week working in the villages, giving information to clients, solving

problems and ensuring people repay their loans. Delayed repayments have decreased from 10% to 4%, and the bank's profit has increased by 30% in just 12 months. Clients also benefit from the improvement since it has become easier to get loans in time and the interest rate has decreased.

- More efficient administration

The time-consuming manual handling and transportation of data between branches and central headquarters delays analysis, decision-making and action, and allows for data errors to arise between the different entities. Consequently, the use of email and a common database for regional and local businesses and institutions have the potential to improve decision-making and hasten action, which is based on more up-to-date data. The benefits for the people can be immense, especially in the area of healthcare.

The head of a Puskasmas (regional health centre) outside Malang in Indonesia is convinced that the Internet has the potential to improve community healthcare. Areas that can be improved are patient follow-up and general village health reports. Today, the process of keeping manual records is time-consuming, and overall analysis for the whole community is delayed because of the need to transport documents. Local data entry at the assistant Puskasmas would speed up analysis and lead to healthcare improvements since instant measures can be taken to prevent outbreaks of diseases like dengue fever.

The people

The Internet enables people to manage their everyday lives more efficiently. It gives them access to information without having to visit libraries. It enables them to send emails instead of letters, and lets them shop and make transactions without leaving home. The easy access to information of all kinds, and the reduced need to travel make peoples' lives more convenient, improves choice and increases control over prices and personal finances.

"Most of us got our jobs via the Internet, compared with some time ago when we had to buy a paper to look for jobs, travel far away to give our CVs to people we didn't know, in a place that we would probably get lost in. Now we can go to different sites with only one CV, which is a lot faster than and not as costly as when we had to pay to have it printed and faxed."
End-user, South Africa

2.3 Networking effects

Entrepreneurs, employees, villagers, city-dwellers, schoolchildren and young people can all benefit from the networks that they can create, build and maintain via the Internet. In the study there were many examples of how Internet networks have benefited people by spreading know-how and providing inspiration for business, services and personal development – as well as by providing a social 'safety net' during difficult times.

Young people in Indonesia and South Africa use online communities, forums and blogs extensively to find like-minded people to share experiences with and get inspiration from. These online networks help them keep up to date with what is going on in the world, make friends, increase their knowledge, find business opportunities, get job recommendations, and download music – and they all agree that they wouldn't like to be without them.

"For me business is really booming these days. I get offers for gigs at different places and usually the source is Internet sites like MySpace. One day maybe a producer will be interested."
End-user, Indonesia

3. Adopting the Internet

Prerequisites for uptake

Internet access offers enormous potential benefits to people in high-growth markets. There are, however, barriers to increased Internet uptake, which vary according to location (village, small town or rural city).

- In villages where infrastructure is lacking and where the levels of education and income are low, the barriers to Internet usage are quite high. There is a risk that computers and the Internet will not be used if introduced without taking local conditions into consideration.
- In small towns where the infrastructure is better and where more people are literate and can afford to use the Internet, the barriers to increased uptake are lower than in the villages.
- In rural cities where business headquarters and young people have used the Internet for many years, the challenge is to increase uptake at branches, small businesses and households. This demands technical and educational support, virus protection and information on benefits to employees and consumers.

Consequently, to stimulate Internet uptake it is important to take local conditions into account. The role of a government vision and strategy to implement and develop ICT usage among enterprise branches, small businesses and the general population cannot be exaggerated. This is clearly illustrated in Indonesia where the Government has announced its Internet vision and has stimulated Internet use to the benefit of its people.

Internet via the mobile phone

A possible route to boosting Internet uptake is to offer market-tailored and inexpensive Internet access via the mobile phone. There are billions of people using the mobile phone in emerging markets, most with limited or no access to computers. The situation creates immense potential for the mobile phone as an Internet access point. Provided that the business model is affordable for people with low disposable income, this makes the Internet accessible in places and to people who otherwise would never be able to use it.

The impact of mobile data services depends on their affordability and ability to meet the needs of users. While many users in other countries contend that mobile phone screens and buttons are too small for Internet access, mobile phone users in South Africa have no problem using their devices for Internet browsing and chatting. The success of mobile Internet in South Africa shows that usability is not an issue provided that content is suitable and the business model is feasible. It is vital that services are developed in a local context and based on thorough market research.

Mobile broadband

Everybody wants mobile broadband – as soon as they find out it exists. People in the study could see how mobile broadband could offer them Internet access, higher speeds and, in the most developed cities, mobility. However, few outside South Africa were already aware of mobile broadband and its ability to offer Internet access. Therefore, one of the challenges for service providers is to create awareness of the technology and the benefits it can provide.

Targeting high-potential segments is key to the successful marketing of mobile broadband. This study shows that the potential target groups for mobile broadband differ according on location (village, small town or rural city).

- The village: The segments most likely to adopt mobile broadband in rural villages are local government, and health and educational institutions. It is imperative for the local and regional government to have a vision and strategy for the

implementation of the Internet. Villages almost always have early adopters, such as local entrepreneurs, who will benefit from Internet access.

- The small town: Local institutions without Internet access are a major target group. There is also great potential among creative entrepreneurs looking for ways to develop their business. In addition, affluent and educated households constitute a small, but potentially profitable group.
- The rural city: Here, the target for mobile broadband is businesses and households in general.

Internet benefits for a nation

When the barriers to Internet use are dealt with, Internet access has the potential to influence a nation in several ways:

- Poverty reduction: Companies that benefit from enhanced marketing and sales opportunities increase employment and income in rural communities, bringing positive effects to the nation as a whole.
- Social stability: The Internet provides a fast channel to information and has the potential to increase trust in the community and local government, and so increase stability in society.
- Global equality: On a global level, the Internet bridges the digital divide between developed and developing nations. Nationwide access to the Internet makes a country more 'included' in the global community, and enables participation in trade and developments that might otherwise be inaccessible.

Overall, the positive development effects of the Internet at a community and regional level lead to progress for the country as a whole, with real GDP growth.

4. Conclusions

4.1 Mobile broadband has high potential

This study verifies findings from earlier studies: that telecom brings substantial advantages to emerging markets and the introduction of mobile phones brings further positive development effects. The mobile phone boosts development by enabling contact and communication across regions. However, once basic mobile phone services have been widely adopted, development tends to plateau.

As this study showed, Internet access revitalizes the development curve and brings about even more powerful progress for a nation – although at a slower rate – by opening up national and international contacts and information exchange.

Mobile broadband has high potential in emerging markets, since it brings access and speed where other solutions are unable to because of inferior or non-existent infrastructure. Furthermore, HSPA mobile broadband provides ubiquitous coverage – not disconnected islands of hotspots – with seamless fall-back to other technologies in the 3GSM family of standards (including EDGE and GPRS). The 3GSM family of standards is global and, consequently, offers huge economies of scale for systems, services and devices. Today there are already over 800 different HSPA mobile broadband devices.

However, access to computers in high-growth markets is still rare because of their relatively high cost in relation to disposable income (for consumers), revenues (for companies) or budgets (for institutions), and there are several barriers to be overcome before usage can take off. Therefore, until computer usage is more widespread, we need innovative solutions for Internet access – a situation that opens the door to the mobile phone as an Internet access point.

4.2 The mobile phone speeds up development

There are billions of people using the mobile phone in emerging markets, most with limited or no access to computers. The situation creates immense potential for the mobile phone as an Internet access point. Provided that the business model is affordable for those with low disposable income, the mobile phone makes the Internet accessible to places and people who otherwise would never be able to use it. Mobile broadband services provide a feasible Internet access alternative in rural areas and can prevent the potential slowdown in the development of emerging markets before computers are available.

References

This presentation is also available as *From voice to data. How the Internet improves life in emerging markets*. Executive summary of findings from Indonesia, South Africa and Rwanda. Available at http://www.ericsson.com/telecomexpansion/resouce/pdf/internet-improves.pdf

Other studies related to the topic of this paper are presented below:

"Assessment of M-Content Requirements in India and Uganda." (2008) Ericsson summary report, available at http://www.ericsson.com/telecomexpansion/pdf/assessment-mcontent.pdf and at http://www.ericsson.com/telecomexpansion/resouce/pdf/assessment_mcontent_requir_in_Indai_Uganda.pdf

"Gramjyoti. Rural Broadband by Ericsson." Brochure published by GSMA (2007). Available as pdf file from http://hspa.gsmworld.com/upload/papers/documents/03102008104806.pdf

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"HSPA the undisputed choice for mobile broadband." (May 2007) Ericsson whitepaper available at http://www.ericsson.com/technology/whitepapers/hspa_Rev_a.pdf

"Can mobile communications close the digital divide?" (October 2007) Ericsson whitepaper, http://www.ericsson.com/technology/whitepapers/can_mobile_communications_close_digitaldivide.pdf

Improving Home Based Care Through Mobile Phones in Malawi

Kumbukani KUNTIYA[1], Donald MAVUNDUSE[2]
[1]*Evangelical Association of Malawi, Area 3, Lilongwe,Malawi*
Tel: +265 9 8866053, kkuntiya@yahoo.com:
[2]*Tearfund UK, 100 Church Road, London, TW11 8QE, United Kingdom*
Tel: +44 20 8943 7950, Donald.Mavunduse@hotmail.com:

Abstract: Most people struggling with AIDS in rural Malawi receive care at home by families or volunteers. Malawi's health care system is inadequate and would struggle to cope if there is an increase in AIDS patients reaching hospitals. Improving home based care is therefore a viable option required to limit premature mortality for AIDS patients. The extensive coverage of mobile phone networks and the versatility of mobile phones provide an opportunity to strengthen referral system between health centres and care volunteers. The Evangelical Association of Malawi through its HIV/AIDS department supported by Tearfund UK is implementing a mobile phone pilot project aimed at improving home based care provided by volunteers in the southern part of Malawi. A mid term evaluation of the pilot reveals the need to take into account cultural and traditional realities in the community and need to be adaptable if dynamic opportunities of this technology are to be fully harnessed. This paper shares some of the findings.

1. Justification of the Project

The Evangelical Association of Malawi through its HIV/AIDS department supported by Tearfund UK is implementing a mobile phone pilot project aimed at improving home based care provided by volunteers in the southern part of Malawi. The pilot project was implemented against the following background. Malawi has been experiencing high rate of HIV/AIDS infection and prevalence now standing at 12.2%. Many rural people ill from AIDS often find hospitals are far and do not have enough doctors, nurses, beds and medicine. Home Based Care volunteers or family members provide the bulk of care for people living with AIDS. However, these primary care givers and community volunteers often lack the skills, and equipment to provide adequate care. In many cases volunteers walk long distances to take care of patients. Many volunteers are themselves poor and in many instances share the little they have with the PLWHA (People Living With HIV/AIDS). On the health delivery side, Malawi has seen a drain on its health professionals. Many rural hospitals lack adequate human resources and health outreach programmes have been curtailed due to limited resources. The scale of HIV/AIDS has put further strain on an ailing health delivery system.

Prior to the pilot, a feasibility study was carried out by Accenture Partnership Development in two potential sites served by Nkhoma hospital and St. Martin's hospital. The study found that:

- The extensive coverage of mobile phone network was confirmed.
- Existing practices of community phones meant that there was a precedent in some remote parts of Malawi
- Rural hospitals and health centre staff interviewed confirmed that lack of communication hampered referral systems especially in remote parts.

The overall study confirmed that the project was generally feasible but the following dependencies needed to be looked at: i. Community acceptance was critical especially of women using mobile phones; ii. improved mobile communication was not a silver bullet, it had to be implemented within a basket of other support to those requiring care; iii. favourable economic environment required to ensure financial viability of the project and promote motivation for care volunteers who themselves are poor.

The essence of the pilot was to see how in practice information and communication technology (ICT) could contribute to increasing the quality of service that health care workers and volunteers provide for people living with AIDS. It is posed that better equipping of the community volunteers with effective communication mode enables to access virtual support from trained staff and increase their capacity, improve the quality of community care and increase motivation through income generating capabilities.

2. Design of the Project

2.1 Objective of the Project

Overall Goal of the pilot: To contribute towards improving the level of home based care provided to poor families in rural Malawi.

Specific pilot objective: To successfully field test a 12-month mobile technology project as an effective means of strengthening referral system between rural home based care and health centers in two pilot areas of Malawi.

The specific outcomes are: a. Improved communication leading to improved quality of care for PLWHA; b Financially sustain the volunteers' use of mobile phone as an income generating activity; c. Mobile phone technological solution effectively reduces identified dependencies; d. Develop a video and print documentation for information share and recommendations for scale up after mid- term evaluation.

2.2 Project Implementation

The pilot was designed as follows:

Two mission hospitals (Nkhoma and St. Martin's) serving rural communities were selected as key pilot areas. Each project area had two main sites and each main site consisting of 5 village sites. This brings the total village sites to 20. Each village site has 5 volunteer care givers (100 volunteers in total) and each care giver oversees 10 patients (totalling 1000 patients for the pilot). The pilot was to be coordinated by a project manager seconded to EAM with support at participating hospitals as well as structures at village level. Further support for the pilot was planned to be provided by Celtel (mobile phone provider) and Tearfund's HIV/AIDS Unit in Southern Africa.

Volunteers would use the phones to contact health centres and hospitals if they needed to refer patients without having to travel the long distance to hospitals themselves by foot or paid transport. Through the same phones, health staff could offer immediate real time advice to volunteers about what to do with a patient who deteriorates or to confirm whether a doctor was available. Using the same phones, the volunteers could use the phones to raise income by allowing business and private calls to the rest of the community.

Communication infrastructure: The proposed mobile phone technology is based on GSM technology which is an open digital cellular technology suitable for the proposed project as it supports fast voice and text communication. Project proposed community phone handsets per participating village (Figure 1; fixed in one location and covering a 45 min radius of volunteers' work). The community phone on Celtel (now Zain) mobile network will allow for business calls. Health referral and support calls will use a restricted numbers (at no charge) and business/family will be open for general use at a fee. Mobile phone handsets will be made available to volunteer supervisors, health centres and hospitals participating in the pilot. The village level phones were to be solar powered.

Figure 1: Community phone handset

2.3 Organisational Structure

The organisational structure was designed to provide a comprehensive communication solution both for project management as well as to strengthen referral systems. At the village level the volunteers would cease to be isolated from the main health delivery system as is the case in many parts of Malawi. The organisational structure is depicted in Figure 2.

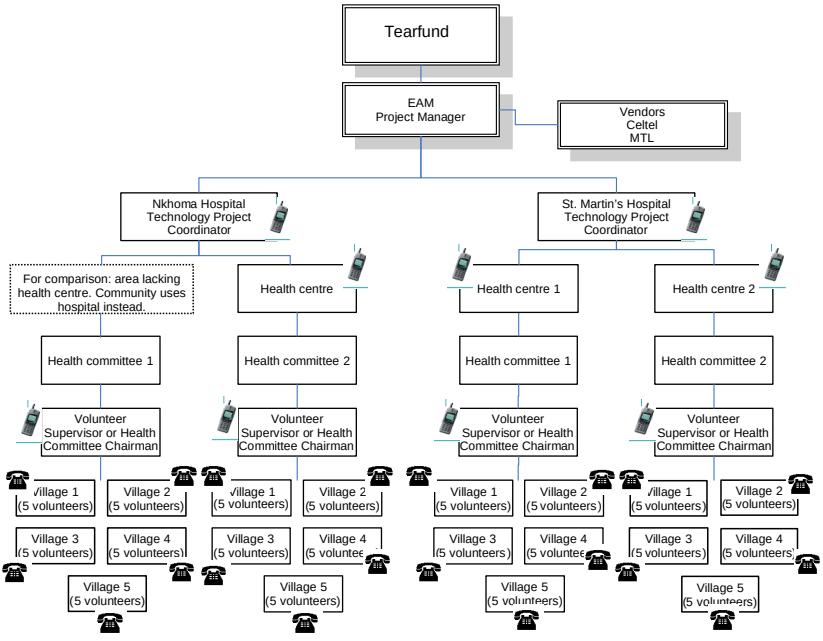

Figure 2: Structure of the Pilot

3. Highlights of the Mid Term Review

3.1 Highlights of Findings

The mid term evaluation looked at a number of dimensions of the pilot including validating possible socio, economic and technological risks identified at project design stage. For the purpose of this paper the aspects of the review dealing directly with quality of patient care as well as income generating capacity of partners have been highlighted. The results are for the St. Martin's pilot site only.

a. Has improved communication led to improved quality of care for PLWHA?
The results have been mixed. On one hand, the pilot has seen more people progressively using the phones to seek medical support. On the other hand, more calls are for business related communication rather than health related communication. Two main reasons account for this: first, there has been an increase in the number of mobile handsets in the community following government of Malawi lowering tariffs on handset imports. Secondly, families and individuals due to stigma still wait until their illness becomes critical before using the phones. In addition, the participating hospitals are fee-paying hospitals; therefore some families may hesitate to refer cases to hospitals so as to delay paying medical bills.

b Has the project been able to provide financially income to sustain the volunteers' use of mobile phone as an income generating activity?
From April to August 2008, the first half of the pilot, a total of MKw 174,841.73 (GBP 670.00) was generated by 9 sites. Table 1 below shows the trend of the usage. There has been a slight upward trend of usage except August where results show a sharp decline. This coincides with the increases in mobile handsets in the project area.

Table 1: Monthly Airtime Utilisation and Estimated Income Generated

CBO	Loc.*	Phone No.	Airtime Usage (Units)					Total	Amount Generated (MK)**	%
			April	May	June	July	Aug			
Mwalembe	N	05100377	0.35	52.58	56.23	61.33	8.49	**226.72**	**49,311.60**	**28**
Iliyoni	M	05100371	0.15	27.3	41.47	63.84	17.40	**150.16**	**32,659.80**	**19**
Mkuli	M	05100375	0.08	36.95	44.96	36.85	16.31	**135.15**	**29,395.13**	**17**
Lusalumwe	M	05100374	1.65	32.78	36.25	3.84	0.00	**74.52**	**16,208.10**	**9**
Mkadabwi	M	05100373	0.39	0.3	19.92	34.77	3.59	**58.97**	**12,825.98**	**7**
Chiwalo	N	05100372	0.39	15.8	17.15	11.56	0.14	**45.04**	**9,796.20**	**6**
Iliyoni II	M	05100379	0	0	0	38.31	1.57	**39.88**	**8,673.90**	**5**
Chikomwe	M	05100376	0.15	7.77	17.43	11.25	2.87	**39.47**	**8,584.73**	**5**
Mwanyama	N	05100378	0.09	0	0	24.65	9.22	**33.96**	**7,386.30**	**4**
Total			**3.25**	**173.48**	**233.41**	**286.40**	**59.59**	**803.87**	**174,841.73**	
Average			**0.36**	**19.28**	**25.93**	**31.82**	**6.62**	**89.32**	**19,426.86**	

*** Location: N = Nkope H/C, M = St Martin's Hospital.**
****Amount Generated varies between a markup of K70.00 and K85.00 above the cost price of K140.00/unit**

3. Wider Learning for the future

The key lessons of the pilot to date are that complimentary support for volunteers are still required for their work to be effective. In addition, low community acceptance means that increase in phone usage will be low especially without an appropriate social marketing

approach to increase profile of the phones. There is also a need to explore opportunities to provide incentives for community to use the phones for health related calls. Allowing cost free access to pre-logged hospital numbers is an option.

On the whole, the project offers valuable lessons for the next phase of the pilot.

Figure 3: A mobile phone run by the volunteers.

References:

1. Feasibility Study of Using mobile Phone Technology to improve home based care. A study for Tearfund UK and Evangelical Association of Malawi by Accenture Partnership Development, October 2007.
2. Mid-term evaluation: The Malawi Mobile Phone Technology for HBC Support Project by Philip Mandalazi, August 2008.

OMEVAC – Open Mobile Electronic Vaccine Trials, an interdisciplinary project to improve quality of vaccine trials in low-resource settings

Jørn KLUNGSØYR[1], Thorkild TYLLESKÄR[1], Bruce MACLEOD[2], Paul BAGYENDA[3], Weiqin CHEN[1], Peter WAKHOLI[3]
[1] *University of Bergen, P.O. Box, 7804, Bergen, Norway,*
Tel: +4755588560, Email: jorn.klungsoyr@cih.uib.no
[2] *University of Southern Maine, P.O. Box 9300, Portland, Maine 04104-9300*
Tel: +1207780449, Email: macleod@usm.maine.edu
[3] *Makerere University, P.O. Box 7062, Kampala, Uganda*
Tel: +256-414-540628, Email: bagyenda@cit.mak.ac.ug

Abstract: Emerging international standards and regulations will in few years require complete electronic systems for management of vaccine trials. Clinical trials conducted in low-income countries need to have the same level of quality and reliability as comparable studies conducted in high-income countries.
This will require data collection and management systems specifically designed and developed for these settings. Research data in low-resource settings are currently mostly collected on paper forms, a process which is susceptible to errors and inefficiency. The lack of control and compliancy to study protocol is a great challenge.
To solve this and related problems we will replace the paper based process with a completely digitized mobile system for conducting clinical trials based on *EpiHandy* and *R*. Researcher and field workers will use handheld computers and directly enter the collected information. This will drastically reduce the logistical challenges related to paper handling and digitization.

1. Relevance

We aim to develop a complete secure electronic system for data collection and management in vaccine trials, that handles data from source to publication using handheld computers and complying with international standards and regulations of clinical trials. It will be available at no cost including all generated software source codes and documents.
We aim at improving the quality and cost-effectiveness of vaccine trial sites and epidemiological studies through transfer of technology and usage of new and emerging mobile technologies for data collection and management.

This is an interdisciplinary action research project that combines health and information technology expertise with field studies in Africa. The partners of this application have already developed several different systems: 1) EpiHandy, a generic electronic open source and free mobile data collection and management system, that is being used for regular studies in low-income countries, 2) R, a widely used and renowned open source statistical analysis tool, and 3) an online data publishing system.

The consortium consists of Norwegian and international organizations, universities, software and hardware development groups and includes TDR/WHO (TDR is a UN-

sponsored global programme for Research and Training in Tropical Diseases), HandheldsForHealth.org (a Linux company in Bangalore India), Makerere University in Uganda, INDEPTH Network / Malaria Clinical Trial Alliance, Promise Consortium and two faculties at University of Bergen, viz. Centre for International Health and InfoMedia.

Our consortium has extensive experience in conducting clinical trials, collecting data using handheld computers for regular studies, managing, publishing and protecting research data and developing software suitable for the context and challenges found in low-income countries.

1.1 Background and status of knowledge

There is a global trend and push to replace paper based systems with electronic systems to improve cost-effectiveness. An everyday example is the upcoming requirements making all airline tickets fully electronic in only a few years. This is also a trend affecting the field of vaccine trials and medical research.

Emerging international standards and regulations will in few years require complete electronic systems for management of a clinical trial [1]. Clinical trials conducted in low-income countries need to have the same level of quality and reliability as comparable studies conducted in high-income countries and must be conducted in accordance to international regulation . This will require secure, valid, accurate, comparable, efficient and cost-effective methods of data collection and management specifically designed and developed for settings with often poorly developed infrastructure and technical facilities.

With the rising costs and probability of failure in vaccine development, innovators often focus on candidates with potential high market return. Developing products targeted at important public health needs and less common diseases prevalent in low-income countries is becoming an increasing challenge [1]. FDA (Food and Drug Administration, US) have identified a number of obstacles in transforming the recent revolution and discoveries in biomedical science into more effective, more affordable and safe medical products. These obstacles along the critical path (see figure 1) to product development include efforts needed to streamline clinical trials and include development and compliancy to international standards and regulation and complete electronic submission of study data in the final approval processes [2]. FDA is in many ways a de facto definer of standards in conduct of clinical trials, and their standards are often rapidly adopted in most other countries.

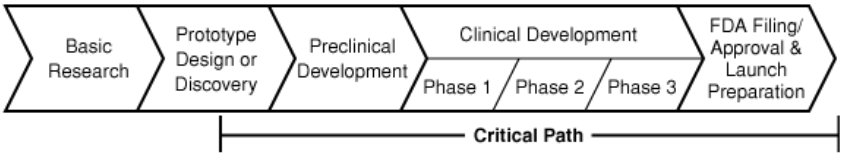

Figure 1: Critical path to product development

FDA states that the development of new medical products "*relies on the tools of the last century to evaluate this centuries' advances*" [1]. This shows the need for new and innovative tools to reduce the potential stop points along the critical pathway from basic science to more timely, affordable and predictable access to new vaccines. The costs of the clinical trial phases (including I-III) are large, calling for new tools to reduce costs and improve effectiveness in data collection, management and distribution.

This project is in line with the goal of critical path research which "is to develop new, publicly available scientific and technical tools – including … clinical trial endpoints – that make the development process itself more efficient and effective and more likely to result in

safe products that benefit patients" [1]. Furthermore FDA states that "If we do not work together to find fundamentally faster, more predictable, and less costly ways to turn good biomedical ideas into safe and effective treatments, the hoped-for benefits of the biomedical century may not come to pass, or may not be affordable." [1]

Research data in low-resource settings are currently collected on paper forms during the interview/investigation process. The papers are collected and transported to a central site where data are manually entered into a database and later analyzed. This process is susceptible to error and inefficiency. First there is no validation of data at point of collection; they are only checked for consistency when digitized. Errors found impose a resource intensive and logistically challenging process/loop of sending forms back, identifying the source, validating the data, sending the forms and finally digitizing the corrected data (see figure 2). There is often a long delay between data collection and availability of datasets ready for analysis.

Compliance to study protocol and ensuring correct linking between study subjects and the data collected at every time point is extremely important. For example, the clinical trial HIVNET 012 which tested Neveriapine, an antiretroviral drug to prevent mother-to-child transmission of HIV, was not approved as some paper forms were missing, not because the drug was judged dangerous [3, 4]. In low-resource settings official and usable identification papers like ID cards and social security numbers are lacking, this imposes a potential for mix-up of records as in the case of the HIVNET 012 study and could seriously influence the statistically analysed outcome of a study. Multi-site/country studies require 100% compliance and compatibility between protocols at the different sites in order to be able to compare and conduct pooled analyses. With more or less compatible and standardized systems this quickly becomes a great obstacle for such undertakings. It is surprising how many research projects use self-made and simple systems, e.g. based on Microsoft Access, to handle large quantities and values of data, which is an extremely risky approach.

An obstacle to cross site and country collaboration is lack of controlled and efficient access to anonymized analytical datasets and source documents for internal inspections and review process during publication. There is a lack of unambiguous verification of data sources and originality of data for a particular dataset. There are no good publicly available means of tracking a dataset related to a published article that also can clearly show versions and meta data on where, when, by whom, from whom, in what context and for what purpose it was collected.

There is a need for strict control of data sources, from point of collection and all the way to final publication, including audit trails and certificates of authenticity and origin (when, where, from, by whom etc.). The situations (or cases) call for secure, valid, accurate, comparable, efficient and cost-effective methods of data collection and management in order to produce high quality and reliable data that can be used for vaccine trials and thereby virtually any type of field research.

Recent advances in technology and software presents an opportunity to develop a system capable of solving many of the outlined obstacles and thereby preparing and enabling research institutions in low-income countries without the extreme costs related to commercial and inappropriate solutions. A number of studies in high-income countries show the improved quality, timeliness, effectiveness and usability of handhelds in clinical settings [5-7], in addition there are studies from low-income countries showing positive results of handheld computer usage in general [8, 9].

There is now a window of opportunity to prepare and enable research institutions in low-income countries for the upcoming revolution in the way clinical trials are run.

1.2 Relevance to society

This project is an action research oriented project focusing on developing new and secure methods for field data collection and fully electronic conduct of clinical trials in low-income

countries. The contributions to new knowledge will be the development of methods and tools, but also the long term improvement in quality and reliability of research conducted in low-resource settings. This can potentially make new treatments and medicines available to low-income countries that otherwise would not have been possible to fully investigate.

1.3 Environmental perspectives

The project will produce a system than can drastically reduce usage of paper, transportation and storage costs and waste problems of large volume printing in research studies. This project will as far as possible use electronic means of communication and collaboration to reduce the need of face to face meetings requiring long distance flights.

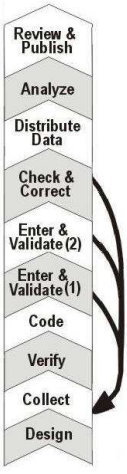

Figure 2: Data collection process

Figure 3: Simplified process by mobile data collection

2. Approaches, hypotheses and choice of method

Go for Action: This project is a multi disciplinary project that actively seeks to change the way a vaccine trial is conducted and thereby fits in the realm of Action Research (AR). AR is suitable for introduction and development of new technologies for improving processes within an organization [10]. "*Action Research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework*" [11]. The actual software development methods will be based on a mixture of existing methods with primary focus on Agile methods and Rapid Prototyping to create an iterative development which will ensure a better end product through numerous possibilities of testing and input from end users.

Go Empower: This project aims at enabling research institutions in low-income countries to conduct high quality clinical trials and research by supplying a free and open source system for complete electronic data collection and management using handheld computers for on the spot validation and utilization of existing tools for distribution, sharing and validation of datasets in the publication phase. Enabling and strengthening research institutions in low-income countries will open for new constellations and possibilities of collaboration on more equal terms than what has been possible up to now.

Go Mobile and Electronic: Our ultimate goal is to eliminate the paper based process with a completely digitized mobile system for conducting clinical trials, and thereby virtually any type of field research (figure 3 showing simplification). This project will use mobile technology to improve the quality and reliability of clinical trials and increase the speed, efficiency and cost-effectiveness of information collection and thereby also the applicability of clinical trials in low-resource settings. Researcher and field workers will use handheld computers and directly enter the collected information on electronic forms. This will drastically reduce the logistical challenges related to paper handling and digitization. The system will also support alternative methods of data collection including paper and web based forms. This could look like a contradiction, but a system of this magnitude must be capable of handling the different scenarios that are likely to exist. This will allow research sites to run different studies on the same system using different modes of data collection.

Go for International Standards: This project is based on emerging international and accepted standards for and ongoing efforts in development of data collection and management systems and collection. This interdisciplinary research project seeks to develop specifications and requirements for a system based on the EU, FDA and GCP (Good Clinical Practice) regulations, for electronic data collection and management in clinical trials and existing standards developed by HL7 (Health Level Seven – ANSI/ISO organization) and CDISC (Clinical Data Interchange Standards Consortium). The later was established by ICH (The International Conference on Harmonisation of Technical Requirements for Registration of Pharmaceuticals for Human Use). HL7 and CDISC have developed a number of standards that have now been merged into a joint initiative called BRIDG (Biomedical Research Integrated Domain Group). These standards are the foundation for future electronic submission of clinical trials. Another important standard related to data documentation is the Data Documentation Initiative (DDI) which contains data documentation for a specific dataset.

Conforming to standards is critical to ensure widespread acceptance of the system. The software requirements for electronic data in clinical trials are particularly rigorous. Key elements are: audit trail, electronic signatures, security and storage of data, review and inspections, standard operating procedures, validation and system documentation [14-17]. There is a need for a thorough review of these regulations including publications and their implications. Such a review will lay the foundation for the further development.

Go Open Source: EpiHandy is a free and open source data collection and management system (see figures and www.epihandy.com) that has been developed by this team over the last years. EpiHandy is a generic system for designing and collecting data on electronic multilingual forms. It uses handheld computers with validation of data input at the point of collection and GIS for tracking of data origin. EpiHandy is being used for ongoing studies in the Promise Consortium and several other multi country/centre studies in low-income countries. This project is not starting from scratch, but focuses on further developing EpiHandy to comply with relevant regulations and standards related to electronic data collection and management in clinical trials. The system will also be made to run on a multitude of platforms and operating systems by using established cross-platform development tools and frameworks.

Go for Security: Ensuring unambiguous and secured linkage between study subjects, protocol events and case report forms (eCRF) is a crucial part of this project. We will implement a quadruple redundant linking scheme to protect against loss of this linkage (see figure 4). All subjects, protocol items and case report forms will embed the linkage between these entities.

Go Analyse: By adapting and linking to R[12], a renowned and free open source software environment for statistical computing and graphics, we will integrate powerful data analysis tools and functions into OMEVAC. Several subprojects of R will be of particular interest including R package for Epidemiological Data and Graphics[13]. R is developed by

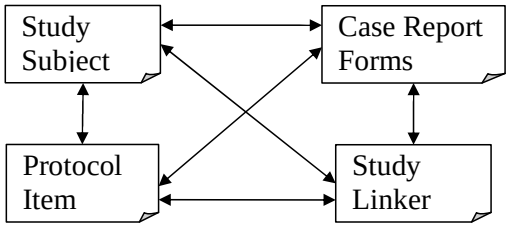

Figure 4: Linking of study objects and data

the R Foundation and supported by a high number of renowned institutions. The combination of secure mobile data collection and integrated analysis functionality will be a powerful tool for the trials sites.

Go Publish: This project will not only secure the data collection and management at site level, but also handle it all the way through to publication and secure storage over longer periods of time. By alleviating and adapting online publishing systems for data sharing and distribution, a complete and secure chain can be established to increase the trustworthiness and reliability of data collected in low-resource settings. We will setup a server that will enable free publishing, archiving and sharing of data from research projects focusing on important global health problems in low-income countries.

Go user-fee free: There exists commercial systems that can manage some parts of what is required, however these are prohibitively expensive, require extensive training and maintenance by professional system developers and are designed for settings with very good infrastructure and thereby not suitable to solve the problems described earlier.

Even if the project is aiming to solve the challenges related to data management in low-resource settings it will also be usable for similar studies in high resource settings as it solves many of the problems of conducting clinical trials in general.

The return on the investments in this project will be in the form of savings at the different sites eventually implementing the completed system.

3. System Development

The foundation of this system will be the existing large code base of EpiHandy. We will further design and develop EpiHandy to be compliant with regulations on data security and integrity in health research as described earlier The development process will be carried out using Agile and Rapid Prototyping methodologies, which are iterative software development methods with each iteration including design, development, and testing (black box testing, functional testing and user tests). This work package will involve a large number of developers from many of the project partners.

3.1 Study Protocol Management Module (SPMM)

To ensure a well conducted clinical trial, a study protocol has to be carefully designed. The protocol acts as a guide for stakeholders, participants, institutional review boards and ethics committees which approve whether the trial can be initiated. The protocol design process is one of the most crucial steps in a clinical trial as defines the why, how, when and who's who of the study. Paper based studies are prone to protocol inconsistency and might lead to errors not easily detected until late in the study and thus cause major drawbacks in both trial schedule and the validity and reliability of outcome of the results. In extreme cases, a poorly defined protocol may impose health risks to the involved subjects.

SPMM will enable research groups to collaborate on developing a study protocol that once complete can be immediately utilized in any data collection system complying to the

Trial Design Model (TDM) developed by CDISC (Clinical Data Interchange Standards Consortium). SPMM will include functions for versioning, commenting and approval processes and amendments. The system will as for the other parts not require any programming skills and should be intuitive and simple to use, but contain powerful functionalities to cater for virtually all types of study protocols.

3.2 Secure Person Identification Module (SPIM)

In low-resource settings official and usable identification papers like ID cards and social security numbers are lacking, this imposes a potential for mix-up of records. Wrong linkage by i.e. typing in the wrong ID number can be disastrous. The first step needed before starting collecting data for a case report form is to uniquely and positively find the identity of the study subject for whom data is to be collected. Through SPIM we will actively investigate potential solutions to these problems. This includes investigating usage of biometrics, imaging techniques, GIS (Geographic Information Systems) and study subject context data such as family relations, address, gender, age and more. Different algorithms and matching patterns will be developed to positively identify a study subject before collecting any piece of information. We will explore the ethical and security related issues to avoid potential misuse of sensitive information and implement techniques to prevent identity disclosure.

3.3 Data analysis by linking to R

R is a free open source language and environment for statistical computing and graphics. R provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, etc.) and graphical techniques, and is highly extensible [12]. We will create a unique linkage between EpiHandy and R. This will enable OMEVAC to utilize the powerful statistical tools and functions available in R.

3.4 Data publishing and sharing Module (DPSM)

This project will go beyond the data collection and management at site level and create a unique linkage between EpiHandy and an online data repository software. It will include functionality for publishing and sharing datasets over internet, including display of aggregated and micro level data with a number of statistical and analytical options. We will be able to establish a complete electronic chain of data management from point of collection all the way through to publishing of datasets for internal and external usage. Data access permissions are easily managed and every dataset will be uniquely identified to facilitate version control and attribution of data sources.

This feature will be an important capability to enable verification of originality of a dataset and thereby the ability to discover constructed data claiming to be from a certain study [18]. It will also make it possible to give reviewers restricted access to the datasets used in a particular paper.

3.5 System Validation and Field Testing

Technical validation of the software is a prerequisite for using the completed system in a real clinical trial. Technical validation includes code review, regression testing, testing on existing data and scenario testing. This is required in order to prove the validity, consistency, stability and security of the system prior to real life testing and deployment.

We will conduct formative evaluations of the OMEVAC system through real life field test in research sites of the PROMISE Consortium and INDEPTH/MCTA. The validation will include side by side comparison and testing with both the current paper based systems and a commercial system. The Health Technology Assessment (HTA) framework [19] will be used as a foundation for the evaluation of OMEVAC. HTA includes both qualitative and quantitative approaches and focuses on the users, technology, economy and organization of the system.

4. Project partners

Centre for International Health, University of Bergen (www.cih.uib.no) has developed a number of different systems for data collection and management in low-resource settings. This includes EpiHandy a generic survey and forms tool (www.epihandy.com), WHO Anthro 2005 a tool for child growth monitoring developed for and published under the logo of World Health Organization (WHO) (www.who.int\childgrowth\software) CIH has established and renowned master and PhD program in global health research where students can get training.

TDR, UNICEF/UNDP/World Bank/WHO - Special Programme for Research and Training in Tropical Diseases (www.who.int/tdr). TDR has extensive experience in research and clinical trials and are heavily involved in research, training and supporting research and governmental institutions in low-income countries

Promise Consortium (www.promiseresearch.org) is a consortium running clinical trials in 4 countries in Africa. The experience and expertise of the Promise Consortium act as domain experts/advisors and one of the sites will be used as the primary testing and development site.

INDEPTH Network (www.indepth-network.org) is a network of more than 35 demographic surveillance sites in 19 countries in Africa, Asia, Central America and Oceania, the network is headed from Ghana. MCTA – Malaria Clinical Trial Alliance (www.indepth-network.org/mcta/mctaindex.htm), a project of INDPETH, is actively involved in developing new vaccines against malaria. Clinical trials within an INDEPTH site has the potential giving more insight than a regular clinical trial as many of these sites have historic data at the individual level up to 30 years back.

InfoMedia, University of Bergen (Department of Information Science and Media Studies, UoB – www.infomedia.uib.no) is an academic institution at UoB. InfoMedia has been actively involved in the development and evaluation of.

Department of Computing, University of Maine, USA (http://www.usm.maine.edu/). Ass. Prof. Bruce MacLeod has been developing systems for data collection and management in low-resource settings in the past 2 decades including HRS and MobileHRS.

Faculty of Computing and IT (FCIT), Makerere University, Uganda (www.cit.ug) has been actively involved in the development of EpiHandy and several spin-off solutions. The Department of Software Development & Innovations (DSDI - www.cit.ac.ug/disd) is an establishment of the Faculty that will drive FCIT's engagement in applied software research and the application of ICT.

HandheldsForHealth.org / Encore Software (www.handheldsforhealth.org / www.ncoretech.com) is a company based in India which focuses on developing hardware and software solutions to solve common problems related to data collection and management in health services in low-income countries.

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OpenROSA, JavaROSA, GloballyMobile – Collaborations around Open Standards for Mobile Applications

Jørn KLUNGSØYR[1], Peter WAKHOLI[2], Bruce MACLEOD[3], Alberto ESCUDERO-PASCUAL[4], Neal LESH[5]

[1]*Centre for International Health, Univ. of Bergen, Norway, jorn.klungsoyr@cih.uib.no*
[2]*Faculty of Computing and ICT, Makerere Univ.,Uganda, pwakholi@cit.mak.ac.ug*
[3]*Computer Science Department, Univ. of Southern Maine, Maine, macleod@usm.maine.edu*
[4]*IT24, 126 51 Hägersten, Stockholm, Sweden, aep@it46.se*
[5]*D-Tree, Boston, USA, neal.lesh@gmail.com*

Abstract: The paper reports on three interrelated open standards and coding collaboration efforts: OpenROSA, JavaROSA and GloballyMobile. The OpenROSA consortium was established to reduce duplication of effort among the many groups working on mobile data collection systems. The goal is to foster open-source, standards-based tools for mobile data collection, aggregation, analysis, and reporting. JavaROSA is an open-source platform for data collection on mobile devices. At its core, JavaROSA is based on the XForms standard – the official W3C standard for next-generation data collection and interchange. The mission of GloballyMobile is to cooperate on mobile phone application development, testing, and implementation, while sharing plans, progress, and lessons learned, in order to promote innovation, increase efficiency, and maximize the impact of humanitarian assistance. The paper also give a brief overview of projects under the OpenROSA umbrella which uses JavaROSA as the mobile data capture solution.

1. Open Source Software Development for Social Development

Through our experience over the course of seven years, we have come to embrace the principles of open source software development for reasons of sustainability and the increased opportunities to work on larger, in particular health-centric, development efforts.

In this presentation, several authors from different but closely related initiatives present their missions. The initiatives covered are: GloballyMobile, OpenROSA, and JavaROSA, presented in section 2,3, and 4, respectively, and summarized in Figure 1.

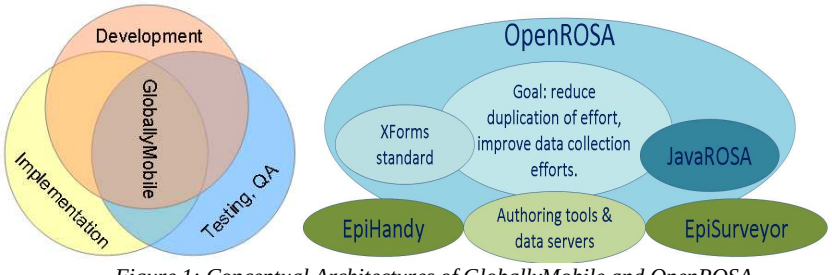

Figure 1: Conceptual Architectures of GloballyMobile and OpenROSA

2. GloballyMobile

The mission of GloballyMobile [1] is to cooperate on the development, testing, and implementation of mobile phone applications (Figure 1), including sharing plans, progress, and lessons learned, in order to promote innovation, increase efficiency, and maximize the impact of humanitarian assistance.

Members of GloballyMobile are devoted to development, testing and implementation and being truly open source through easy availability of code, documentation, testing procedures and sharing of lab resources.

GloballyMobile brings together independent groups to determine common goals to be pursued collaboratively. GloballyMobile partners will move forward with the technology available in order to avoid duplicating efforts by recoding functionalities that already exist in other applications, while simultaneously work toward the future of mobile technologies.

GloballyMobile is establishing reference implementations on integration of the technologies found in the consortium. This is done through sponsored "code sprints" every month, where 3-4 developers get together and work on a technical specific problem and by the same token, identify areas of research that no member organization has covered to date.

GloballyMobile aims to integrate as many of the existing applications as possible into this project, focusing on each application's key functionality and how these applications complement each other in the field. In the start-up phase of GloballyMobile, each member organization continues on their singleton efforts, while sharing experiences and reports to derive best practices.

GloballyMobile is making applications interoperable and usable as a part of a large project in a country where access to the Internet and to mobile network coverage might be discontinuous.

A Quality Assurance process to certify applications as "GloballyMobile Approved" is being established and includes criteria such as stability, usefulness, potential for implementation, and interoperability with other applications.

The first outcome of GloballyMobile has been the agreement on a protocol for applications to talk to each other, and agreement on using Mesh4X for asynchronous file synchronization, this can also be used across multiple devices (peer-to-peer) even when a device is not online.

A website with an up-to-date knowledgebase on mobile and SMS technologies – which will include: teaching courses, research publications, hardware recommendations, GloballyMobile product comparisons, best practices and shared public libraries – will be established at http://www.globallymobile.org.

GloballyMobile seeks to build strategic partnerships with other organizations with overlapping focus areas including MobileActive, ITU, GSMA, OpenROSA (see separate section below) and the W3C.

GloballyMobile has a great potential as being a catalyst in producing and supporting innovative ideas and systems for the improved health and lives of the population of our globe.

3. OpenROSA

Prior to the establishment of OpenROSA [2] there were a number of free and open source tools available for doing data collection on mobile devices and handheld computers (Palm, WindowsMobile, Symbian).

The OpenROSA consortium was established to reduce duplication of effort among the many groups working on mobile data collection systems. The goal is to foster open-source, standards-based tools for mobile data collection, aggregation, analysis, and reporting (Figure 1). By developing open source solutions and conforming to standards based on the XForms specification, different projects can easily share code, data, ideas and infrastructure.

Many of the consortium members are working on JavaROSA (see section 4 below), an open source J2ME codebase that conforms to the OpenROSA standards. JavaROSA is being

developed for a wide range of uses, including disease surveillance, household surveys, collection of longitudinal data for electronic medical records, guiding health workers through medical protocols at the point of care, and supporting community health workers.

OpenROSA has been successful this far based on the common need by many of the collaborating groups on "adding" a mobile data capture solution to their already existing singleton effort.

There are ongoing discussions and efforts on merging more than the mobile part of the solutions found within OpenROSA. Ongoing discussions are building on, e.g., common forms authoring tools, data management systems, etc. This seems to be a bit more problematic as most groups have a branding and funding challenge when they no longer are the sole "owners" of a solution. There are many disincentives for merging the "complete packages" due to organizational ownerships and publicity of "own solutions" in a competitive environment.

A major challenge to using mobile devices for data capture and management is the lack of standardized forms capture and handling functionality on phones. To use e.g. JavaROSA users must download the application, install it, download forms etc. Further J2ME has its limitations in targeting the wide size and functionality spectrum of mobile phones. The capability to send someone a form, have it displayed on the device, and have it sent back to a preconfigured route should ideally be a preinstalled function of any phone.

We are all acquainted with using SMS and MMS – likewise there is a need for manufacturers and service providers to come together to create a new standardized service: MXF (Mobile xForms). MXF would allow a user to accept requests to questionnaires / forms and fill them out offline, and once complete be able to submit using e.g. GPRS / SMS / MMS or other available data transmission means.

The authors have been involved in building three mobile data collection applications. These software systems include EpiHandy [3], a PDA and phone based data collection software system for surveys and research (demonstrated at the M4D conference), MobileHRS [4], a PDA based system for collecting Demographic Surveillance data, and finally JavaRosa [5], a cell phone based software system. Developing these applications generated valuable experiences on the problems, complexities, and opportunities created in this kind of software development effort.

4. JavaROSA

Through developing and supporting mobile-based data collection software for use in developing countries, we have come to embrace the principles of open source software development for reasons of sustainability and the increased opportunities to work on larger, more health-centric, development efforts.

Our latest project, collaborating with an international team of software developers who are building JavaRosa, an open source data collection forms engine for cell phones, is particularly interesting from an applications development perspective. This open source development effort has significantly changed the nature of our systems development. While we do not "own" many of the pieces of the application, we nevertheless derive considerable benefit from the software, viz. from the ongoing, daily, conversations about features and design, the focus on building from standards, and the use of open source development tools and technologies.

The development of JavaROSA was driven through the participants shared need for a forms data collection engine on a cell phone and therefore gained from the collaboration. The use of Form specification with xForms, a W3C standard, made a clear scope. The agreement on a third party standard (xForms) was a key and powerful enabler to create interoperability between the existing systems of groups involved.

The development team is truly international with daily online discussions and mailing lists and there is an infrastructure for new and existing developers with: Web site, Getting

Started, Developer documentation, Trac software for wiki, discussion groups, tickets, browse source.

JavaROSA has successfully been implemented and is being implemented in many different software solutions [6]. JavaROSA has already been tested and used in several of these and other applications, details of these evaluations will be published separately by the individual organizations. Some examples of this are:

1. GATHER, by AED Satellife (US), Dimagi (US), and Uganda MoH in Uganda
2. LimeSurvey in SouthAfrica, by Cell-Life, SouthAfrica
3. EpiSurveyour in Kenya, by DataDyne, US
4. CommCare in Tanzania/Uganda, by D-tree and University of Washington, US
5. EpiHandy in Uganda, by University of Makerere, Uganda, and University of Bergen, Norway. Through EpiHandyMobile (demonstrated at the M4D conference), which is merged into JavaROSA

5. Concluding Remarks

The establishment of OpenROSA and GloballyMobile has the potential of greatly reducing the common problem of duplication of efforts in the space of development, and in this case the space of mobile phones for development.

The example of JavaROSA shows that it is possible to collaborate across organizations, persons, countires and continents when the outcome and merrits of the outcome can be shared by the contributing organizations and persons. Lessons from JavaROSA shows that joint efforts pay off, breeds more robust solutions with better architecture due to focus on standards, better support (for devices, updates, bugfixes) and require focus on common functionality. However, collaboration increased development time, but is worth it and ”Go fast, go alone. Go long, go together!”[7] is a good summary of our experiences.

Defining standards and, where possible, collaborating on code level through open source principles can hopefully bring better solutions faster and cheaper than what has been achieved to date.

Acknowledgement

The individual authors have been involved in the creation and presentation of this paper in the following way. Lead author: Jørn Klungsøyr; GloballyMobile: Alberto Escudero-Pascual, Special thanx to Michelle at Unicef who reported from the first meeting of GloballyMobile; JavaROSA: Peter Wakholi, Bruce MacLeod, Neal Lesh; OpenROSA; Neal Lesh.

This paper is created based on documents produced through the different collaborations described here and is therefore based on input and contributions from many more persons than those listed specifically in this paper.

The lead author wants to express his gratitude to the conference General Chair, Prof. John Sören Pettersson, for his help in organizing and editing the texts included in this presentation.

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“If you want to go fast; go alone. If you want to go far; go together.”

Using Web Technologies and Mobile Phones for Social Development: W3C[1] Approach

Stephane BOYERA, Philipp HOSCHKA
World Wide Web Consortium (W3C)
Email: boyera@w3.org, ph@w3.org

Abstract: This paper presents the new initiative the World Wide Web Consortium (W3C) has launched in May 2008, Mobile Web for Social Development (MW4D). This new group explores how to use the potential of Information and Communication Technologies (ICTs) on Mobile phones as a solution to bridge the Digital Divide and provide minimal services (health, education, governance, business, etc.) to rural communities and under-privileged populations of Developing Countries. This paper presents in the first part the rationale behind the launch of the group and, in a second part, the vision and directions it is currently following, the expected schedule and its list of deliverables.

1. Introduction

Since its creation in 1994 by Web inventor Sir Tim Berners-Lee, W3C [1] has been working towards the realization of its vision of the Universal Web Access: The Web anywhere, for everyone, at anytime, on everything. In the meantime, the Web has grown exponentially to almost 1.5 billion users in 2008 [2], creating services, providing information, connecting people, creating new jobs and completely new sectors of activities.

Despite this enormous success in such a short timeframe, there are still more than 5 billions people today that are not benefiting from this Information Society created by the Web. However, the Web, and Information and Communication Technologies (ICT) in general, have been recognized as a great tool to potentially resolve the historical divides between developed and developing economies by providing an infrastructure to deploy essential services (health, education, business, government, etc.) to rural communities and under-privileged populations. That is why many actions have been engaged in the last twenty years towards bridging the so-called Digital Divide. Unfortunately, many of these actions - often focusing on telecenters – have been met with limited success so far. For example, the telecenter model has encountered many difficulties due to the local conditions (lack of electricity and lack of maintenance skills, to mention two typical barriers) and very few efforts in this area have reached long-term sustainability and continued operation.

Since 2-3 years a promising new opportunity is emerging due to the very high penetration rate of mobile telephony in developing countries. Now a minimal infrastructure (GSM networks) and minimal computing power (mobile phones) are available in the pockets (or at least in their very close environment) of billions of people, including the poorest segment of the population. Most developing countries who missed the telephony revolution due to lack of infrastructure and required investments have participated in the mobile revolution directly. Can this be repeated for the Web? Four years ago, the W3C with the mobile industry have launched the Mobile Web Initiative (see [10]) to make mobile phone users first class Web citizen, and the number of people accessing the Web from mobile phones is growing very

[1] The work presented in this paper, while driven by W3C, is part of the EU FP7 project Digital World Forum on Accessible and Inclusive ICT (see [12] for more details).

quickly. Would it be possible that, like for telephony, most Developing Countries will skip the PC-Web revolution and jump directly on the next phase, the Mobile Web?

In May 2008, W3C has launched the Mobile Web for Social Development Interest Group (MW4D [9]) to explore this direction, and this paper is presenting the vision behind this new group, its objectives, its deliverables, and its expected output..

2. Mobile Web for Social Development

Today half of the world's population is living on less than $2.5 a day [3]. This part of the population is suffering from the lack of all types of services (health, government, etc., as mentioned above) which prevents them from increasing their income.

During the last few years, the potential of simple ICT services to provide solutions in this area has been largely demonstrated. For example, in the Indian fishery sector in Kerala, an in-depth economic study (see [4]) has demonstrated that the adoption of a mobile service delivering market information (needs and prices) from different geographical areas, allowing fishermen to provide their goods to the most appropriate market, has increased the income of fishermen by 9% (integrating the price of the mobile phone/subscription), while the overall price of fish dropped by 4% for consumers, due to the elimination of unsold and therefore wasted catches. Similar experiences and results have been demonstrated in other regions and products (see e.g. grain market in Niger [5]).

Unfortunately, while these experiments are achieving impressive results, the number of these services at the global level is still very low, and the domains covered are mostly agriculture and banking only, whereas similar potential exists in health, education, government etc. In [6], we explained why the technology currently used, SMS, is clearly a limiting factor, preventing a large scale development, deployment and use of numerous applications. Indeed, while there are many reasons why SMS is widely used today (availability on all mobile phones, predictable costs, ease of use by users, free reception, to mention some of the most obvious reasons), this technology has intrinsic limitations (e.g., required literacy, lack of localization, no automatic discovery mechanism, lack of standardization, 160-character limitation) that prevents large scale low cost development and deployment of services. At the opposite, Web technologies have largely demonstrated their strengths in these specific areas, and therefore the enabling of the next generation of mobile applications based on these technologies (mobile browsing, voice technologies, mobile widgets, etc.) could be a potential solution.

The aim of the MW4D working group is to investigate and understand the characteristics of an enabling environment that would drive the adoption of this new generation of applications. This will result in the appearance of numerous services impacting positively the lives of the poorest segment of the populations in the developing world.

Successful ICT projects generally follow three steps:

1. "Someone" who is observing how a community is working/living identifies the potential of an ICT service to help this community.
2. The idea is then implemented using the technology.
3. The potential targeted users find the service accessible, affordable, usable and useful, and make the effort to learn and adopt the service.

Regarding the first step, there are different kinds of actors:

- NGO/Grass-root/non-profit organizations
- Government/Public administration
- Individual social entrepreneurs investigating how to make business in delivering social services

Each of these actors has specific challenges, and objectives, and for each a specific approach is required. As a first step, MW4D is focusing on NGO/Grass-root/non-profit organizations (see [7] MW4D focus diagram).

Regarding the second step, MW4D is conducting investigations to identify the issues, barriers, needs and challenges for potential providers of development-oriented services when developing and deploying those services, and when exploiting the potential of the mobile platform. As previously mentioned, there are multiple ways (technologies) today for developing and deploying content on mobile phone. Each of these technologies has specific domains of application, requirements (on the handset, on the operator…) and costs. MW4D is analyzing and identifying the different dimensions to consider in order to make the appropriate selection based on the specificities of the application, the context, the targeted end-user etc. The group is also investigating the gaps that still exist today, and the most promising direction to follow to resolve them. This includes specifically the education needs that would help empowering people and enabling them to develop the applications they need without relying on external expertise.

Regarding the third step, it is critical to understand the key challenges and barriers that targeted end-users (underprivileged populations of Developing Countries) have to access and use mobile services. This includes affordability, usability, illiteracy, accessibility and internationalization/localization issues. MW4D is working on the identification of these different challenges and the way to work around them or the most promising direction to explore to solve them in the future.

In terms of final objectives, the MW4D working group is chartered until the end of May 2009. By that time, it is expected that the group has developed:

1. A handbook for anyone who is willing to develop and deploy development-oriented mobile service. The handbook will describe all the current technologies that can be used for this purpose, their domain of applicability, requirements, challenges, and specific aspects to consider.
2. A roadmap that will identify the major directions to explore, or the most promising actions to launch in order to lower the barriers of providing or accessing content and services on mobile phones
3. A directory of resources related to the use of mobile phones in development (cf. the repository in reference [8])

As of October 2008, some draft documents have been already collaboratively developed [11]. MW4D, unlike most of other W3C groups, is freely open to public participation.

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Research Track

The Growth of Tanzanian Mobile Phone Sector: Triumph of Quantity, Failure of Quality?

Fredrick Japhet MTENZI[1], Bukaza Loth CHACHAGE[2], Fredrick NGUMBUKE[3]
[1] *School of Computing, Dublin Institute of Technology, Kevin Street, Dublin 8, Ireland.*
[2]*Tumaini University, P.O.Box 200, Iringa, Tanzania*
[3]*Metropolia University of Applied Sciences, Helsinki – Finland*
[1]*Email:Fred.Mtenzi@comp.dit.ie*
[2]*Email: Bukaza.Chachage@gmail.com*
[3]*Email: Fredrick.Ngumbuke@metropolia.fi*

Abstract: Tanzania's mobile communications market has enjoyed impressive growth in terms of numbers of operators and subscribers over the past few years. Currently there are six operating companies and over 10 million voice subscribers. It is expected that the number of subscribers will keep on increasing in this decade. However, the question is: Has the increase in the number of operators and subscribers resulted in improved customer services and quality? This presentation reports from a preliminary study—which used both analytical research and empirical data from interviews with operators—to find an answer to this question. The analytical and archival research provided operational statistics concerning telecommunication. The interviews focused on five main thematic areas: the use of mobile phones, future use of mobile phones, customer care, mobile phone rates and customers' rights awareness. The results from this preliminary study show that the rapid development of the Tanzanian telecommunication market has not yet resulted in improved customer services and quality.

1. Introduction

The Tanzanian mobile communications market has enjoyed impressive growth in terms of numbers of operators as well as number of subscribers over the past few years. As illustrated in Table 1, currently there are eight licensed companies, out of which six are currently operational. There are over 10 million voice subscribers [1]. The operational companies are Vodacom, Zain (Celtel), TIGO (Mobitel), Zantel, TTCL, and Benson. The first company to provide mobile phone services in Tanzania was TIGO (Mobitel). Tritel Company, which is no longer operating, was the second mobile operator. Four more operators joined later: Vodacom, Zain (Celtel), TTCL, and Benson. These operators and their subscriber bases are demonstrated in Table 2.

Tanzania is the second largest mobile communications market in East Africa with 11% penetration rate while Uganda and Kenya have 6% and 15% penetration rate respectively [3]. The rate at which Tanzanians are embracing mobile communications technology indicates that there is significant potential for future growth. On the other, landline telephone growth is insignificant over the past eight years if compared to mobile phone growth. This is due to problems with land line technology; problems such as unreliable fixed lines, common fixed lines faults, frequent connection break downs, frequent wrong bills, lack of innovative ideas, and poor maintenance services. In the past it used to take a very long time to get a fixed

Table 1: Voice Telecommunication Operators from 2000 – June 2008.

YEARS	Voice Telecom Operators	Application Services (*Internet & Other Data*)
2000	5	11
2001	6	17
2002	6	20
2003	5	22
2004	5	23
2005	5	23
2006	6	25
2007	8*	34
June – 08	8*	42

Source: Tanzania Communications Regulatory Authority (2008) [1]
* 8 licensed and 6 operational

Table 2: Number of Mobile and Fixed Phone Voice Subscribers

YEAR	BENSON	CELTEL	TIGO	TTCL Fixed	TTCL Mobile	VODACOM	ZANTEL Mobile	ZANTEL Fixed	*TOTAL* x1000
2000	-	-	56,511	173,591	-	50,000	4,007	-	**284**
2001	-	-	89,056	177,802	-	180,000	6,501	-	**453**
2002	-	120,089	160,000	161,590	-	300,000	26,770	-	**768**
2003	-	320,000	210,000	147,006	-	700,000	68,000	-	**1,445**
2004	-	504,000	303,000	148,360	-	1,050,000	85,000	-	**2,090**
2005	-	882,693	422,500	154,420	-	1,562,435	96,109	-	**3,118**
2006	-	1,516,832	760,874	150,897	6,390	2,975,580	355,246	747	**5,767**
2007	3,300	2,505,546	1,191,678	157,816	72,729	3,870,843	678,761	5,453	**8,486**
2008/ june	3,000	2,819,828	1,701,433	153,230	155,251	4,520,120	1,069,035	6,140	**10,428**

Source: Tanzania Communications Regulatory Authority (2008) [1]

telephone line installed, while today just a walk to a mobile phone shop gets one a reliable, affordable mobile phone.

The increase of voice subscribers and teledensity (Figure 1, Figure 2), could be attributed, firstly, to the affordability and ease of maintenance of mobile phones, but, secondly, to the introduction of value added services in the mobile phone services, such as caller number display, voice mail, call forwarding, call waiting, conference calls, long-distance Internet protocol (IP) telephony, and short message services (SMS). In an effort to keep up with mobile commerce worldwide, these operators are aiming at launching nation-wide wireless application protocol (WAP) services. WAP is expected to offer mobile banking, stock trading, news, weather reports, and email services to a wide audience of subscribers. However, it is one thing to have these services available and another thing to use them.

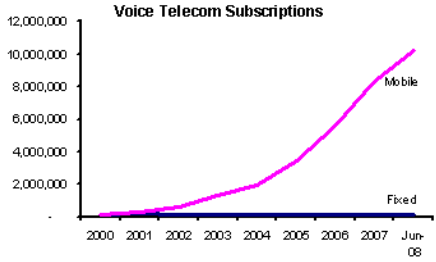

Figure 1: Voice Telecommunication Subscribers

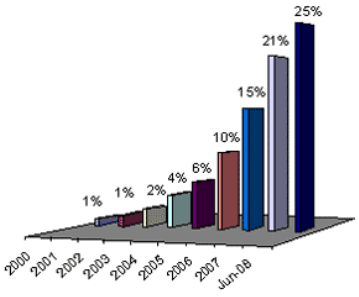

Figure 2: Teledensity in Tanzania

Source: Tanzania Communications Regulatory Authority (2008) [1]

2. Research questions

The purpose of this paper is to set a scene for a major study on mobile phone services for agricultural improvements in Tanzanian rural households. This paper describes the mobile phone situation in Tanzania by reporting a preliminary survey as well as analytical and archival research on the proliferation of mobile phone services in Tanzania. This paper attempts to answer the following question:

> *Has the increase in the number of operators and subscribers resulted in improved customer services and quality?*

To answer the question above five thematic issues were addressed: Current use of mobile phones in Tanzania, anticipated future use of mobile phones, customer care, mobile phone rates, and customer rights.

3. Methodological approach

This paper is descriptive and theoretical. The focus of this part is to reveal the attributes and dynamics of mobile phone use from operators' and regulators' view points. In this first phase, two methods were employed: Firstly, archival and analytical research, and secondly, empirical data from interviews with mobile phone operators.

The archival and analytical research provided telecommunication operational statistics.

The interviews focused on five main thematic areas as identified in the previous section. The interviews were carried out with three mobile phone representatives of the southern zone of Tanzania. As the findings discussed in section 4 show, the interviewees are well aware of subscribers' complaints. The results from the preliminary survey, however, do not portray the whole picture since subscribers were not interviewed in this phase of the study.

The interviewed company representatives were: Mobitel (TIGO) sales manager representing the southern zone of Tanzania, TTCL Ag. area regional manager (Commerce), and ZAIN (formerly Celtel) southern zone of Tanzania business development coordinator. The interviewees are key people in the southern zone of Tanzania, representing their operators. Face-to-face interviews were carried out between 17-18/11/2008. The interview data were analyzed using qualitative content analysis, and presented in tables.

4. Findings and Discussion

In this section we present, in a tabulated form, results from the three interviews and discussion of the findings. The first interviewee was TIGO's sales manager from the southern zone of Tanzania (Table 3); the second interviewee was TTCL's acting area regional

manager (Table 4); and the third interviewee was ZAIN's business development coordinator for the area (Table 5).

Table 3: Interview with TIGO Sales Manager Southern Zone of Tanzania

Thematic Issue	**Responses from the informant**
Current use of mobile phones	Customers use mobile phone for communication purposes to maintain relationships and communicating emergencies. Very little is used for business, marketing information, or weather information purposes.
Future use of mobile phones	With proper education mobile phone use will be based on development, business, economy, and productivity. The future use of mobile phones in Tanzania will move from voice to data.
Customer Care	Customers have been complaining frequently with regard to the time taken to handle customer issues or complaints, as well as to slow and low-quality network at some points. Customers lodge their complaints physically to operators and representatives' offices.
The mobile phone rates	The rates are higher than other East African Countries.
Customer rights	Majority of mobile phone subscribers in Tanzania are very ignorant. It is rare to take operators to answer for their wrong incidences. For instance, it has happened several times tat the network is disconnected without apologies. Even in the extreme situations of network unavailability customers are not seriously complaining. Customers need to lodge their complaints to the Consumer Consultative Council (CCC) and/or Tanzania Communication Regulatory Authority (TCRA). Customers' ignorance makes them not understand when they should use SMS and when they should call for cost reduction, which is one of the basic things customers have the right to know.

Table 4: Interviews with TTCL acting Area Regional Manager

Thematic Issue	**Responses from the informant**
Current use of mobile phones	Majority of mobile phone customers use mobile phone for prestige and communication purposes. It is possible to meet people who have unnecessarily many phones that may be unnecessarily expensive. In villages and schools customers use mobile phones predominantly for receiving calls and not for making calls. Very few people use mobile phones for business purposes. Less than 10% use their phone for business purposes.
Future use of mobile phones	Nothing will change unless people's attitudes change towards seeing mobile phones as tools for their own socioeconomic development.
Customer Care	Mobile phones are sold haphazardly and customer records are not properly managed. If a customer loses a phone, operators normally do not cooperate at all. While the easiest way for solving this subscribers' problem is to record properly all the IMEI serial numbers and to cooperate between operators to provide best customer services
The mobile phone rates	Customers complain that calling from Europe to Africa is sometimes cheaper than calling neighbouring African countries. But sometimes the rates are higher due to the high taxes operators are charged by the government
Customer rights	Customers do not know their rights. One customer visited their office to buy a new Subscriber Identity Module (SIM)-card for his phone simply because Zain (by then Celtel) sold it to somebody else because the customer had not used his/her phone for a month. In many incidences where technical faults lose customers' air time, operators are not sued or taken to task seriously.

Table 5: Interview with ZAIN Business Development Coordinator

Thematic Issue	Responses from the informant
Current use of mobile phones	Communication with parents and friends; less than 5% used for business, money and data transfer.
Future use of mobile phones	The merger of IT and phones will transfer power to more mobile data services than voice exchanges.
Customer Care	Generally in the industry customer care is very low. For example, if one faces a problem, the speed of getting in touch with the customer service centre or customer care representative is very slow. Even the 100 hotline number are sometimes hard to reach. Point-of-sales working hours also face several problems. During most of the holidays, weekends, and festivals, when customers need customer centre services, most of the offices are closed. The reliability of backup systems, such as automatic answering machines, is questionable. Lastly, customer care personnel do not get regular training apart from the induction training. Mobile phone operators in the near future will be identified and differentiated by the quality of their customer care services.
The mobile phone rates	Many people claim that mobile phone services in Tanzania are very expensive
Customer rights	Nobody knows anything about these matters. The government authorities in relation to the mobile phone customer rights have not done much to create rights awareness to customers.

The three informants agreed that communication with relatives and friends is the most important reason for owning a mobile phone in Tanzania. Other purposes, such as business, banking, market information, or weather forecasts, are rarely motivations for obtaining a mobile phone. Two of the informants emphasized customers' own active role and attitude change in turning their mobile phones from just tools for communication to multi-purpose tools for their various needs.

Informants acknowledged the current poor state of customer services in the mobile industry. Firstly, slow handling of issues and complaints was seen as a problem. Secondly, quality of services was considered a problem—even though many people might not actively complain about it at all. A lack of co-operation between operators was considered to hinder customers' rights.

One of the informants argued that the price of mobile phone use in Tanzania is more expensive than it is in other East African countries; another argued that people consider the prices very expensive; and the last informant attributed the high price at least partly to taxation issues. Although mobile phones have during the 2000s become very popular in Tanzania, customers' awareness about their rights is lacking. All informants argued that people are highly unaware of their rights, and do not know the procedures for filing complaints. Although Tanzanian government plays a big role in educating people about their rights concerning mobile services, it has failed to do so.

Probably the main reason for the success of mobile phone services in Tanzania is their adaptability to the local, low-income consumer markets. There is a vibrant second-hand market (as well as a black market) for SIM cards and phones. In some cases, individuals owning a mobile phone will rent it out; others offer a battery charging services. Operators' involvement in sponsoring programs such as health, disadvantaged programs, and sports are further helping to promote the use of mobile phones. People's enthusiasm on mobile phones as well as the aggressive competition in the market suggests a bright future to mobile phone markets in Tanzania.

However, the findings from interviews demonstrate that all three key informants—who are managerial position employees of large mobile phone operators—agree that customer care is functioning poorly. Specifically the informants mentioned low quality network and

improper handling of complaints. It seems that despite the large market volume, mobile phone operators in Tanzania do not offer quality services or high customer care to their subscribers. The focus of mobile phone operators is increasing their share and customer base, and customers' needs and concerns are shrugged aside with an occasional shoddy incentive package, such as per second charges and cheap days. An MBA thesis study carried out to compare the service quality of Vodacom and Celtel (Zain) came up with similar results [2].

In terms of costs the interviewees argued that it is more expensive to own and use mobile phone services in Tanzania than in other East African Countries. Although that might have been the case in the early 2000s, the situation has changed. Table 6 illustrates that, on average, since 2006 Tanzania's mobile phone operators offered the cheapest rates in East Africa.

Table 6: Average Mobile Phone Tariffs in Ushs/Minute in East Africa

Year	Uganda	Kenya	Tanzania
2000	336	425	580
2001	341	425	580
2002	356	425	500
2003	344	260	470
2004	390	260	400
2005	494	260	375
2006	410	370	315

Source: Hisali, E. (2007) Review of Sector Taxation Policies, p. 31 [3]

Conversional business wisdom would have suggested that with six operators in the market there should be competition, which in turn should end up benefiting the subscribers in terms of quality of service and cost. This appears to take longer in the Tanzanian mobile communications markets. We conjecture that the reason for this is operators' collusion and lack of government regulatory power. In addition, mobile phone operators in Tanzania have ongoing problems in terms of interconnection charges, which even the regulator has failed to arbitrate. The regulatory body has failed to oversee the introduction of new services, to ensure competitive costs and offerings, and to resolve disputes when operators overstep.

The account for high charges set by mobile phone operators are partly caused by the numerous charges they have to pay. Operators have to pay nine different taxes and duties. The first four are annual royalty fee (1% of net operating income), annual spectrum fee, excise duty on air time (5%), and corporate income tax (30%). Other taxes are value-added tax (5%), business licence fee ($10,000 plus an additional $5,000 for any additional area of operation), import duties on all operational items, tower taxes to all local authority ($3,500 for a tower per annum per local authority), and refuse collection charge ($30 per tower per month per local authority). Furthermore, the tax regime on import of high technology devices, such as mobile phones, is a major stumbling block for the sector's development. Similar tax complaints were raised in Uganda [3]. The government has failed to make a firm decision on encouraging proliferation of mobile devices by implementing favourable tax policies.

The national target for telephone density in Tanzania is six telephones per 100 people by year 2020. However, the uncontrolled development in mobile communications may lead to polarization in communications development. Most operators are present in the profitable urban areas, but poorer rural areas may be left behind in the unregulated telecommunications development. Moreover, poor quality—or even non-availability—of basic services, such as electricity, plus lack of fixed-lines telecommunications infrastructure, increase the cost of rolling out and running mobile networks in many parts of Tanzania. Equally important is the

question of why subscribers are not using mobile phones for development and business related purposes.

5. Conclusion

The growth of mobile phone services over the past few years reflects the enormous potential of Tanzania's wireless communications market. While data transfer is not very popular in this market, the wireless system plays a significant role in meeting the public's demand for quality point-to-point and point-to-multipoint-content communications.

The Tanzanian experience is an example of aggressive growth at the cost of customer satisfaction. Advanced customer care and user-friendly technologies need to be developed and adopted. The anticipation that more subscribers will use mobile data communications in the future indicates the importance of motivating content providers to supply content. Moreover, a pricing scheme enabling mobile data communications to function as a cheaper substitute for voice service is also important, at least in low-income economies where subscribers are highly sensitive to price. Consumer behaviour must also be considered within a country's cultural and political context.

The increasing competition is expected to increase supply, improve quality, and bring more competitive prices to the benefit of subscribers. This will lead to subscribers receiving timely information at reduced transaction costs for the benefit of country's economy.

Acknowledgement

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Mobile Phones and Poverty Alleviation: A Survey Study in Rural Tanzania

Hosea MPOGOLE[1], Hidaya USANGA[2], Matti TEDRE[3]
[1,2,3]*Tumaini University, P.O.Box 200, Iringa, Tanzania*
[1]*Email: hmpogole@yahoo.com*
[2]*Email: hidayau@yahoo.com*
[3]*Email: firstname.lastname@acm.org*

Abstract: Access to mobile communication has been argued to contribute to economic development. It is a common, implicit expectation that mobile phones have the power to increase growth, alleviate poverty, and bridge the perceived digital divide. Although mobile phone use is often, in the literature, associated directly with socioeconomic development, there still appears to be mixed feelings on the perceived economic benefits of mobile phones, especially among the bottom poor. This research abandons untested, implicit assumptions, and investigates how mobile phone users in the rural areas of Southern Highlands of Tanzania perceive the relationship between mobile phones and income poverty.

1. Introduction

Over the past decade mobile phone ownership and usage has expanded in Tanzania. Although mobile phone use started in major cities, the network has quickly expanded to rural areas as well, wherever the necessary infrastructure is available. Apart from the expanded mobile phone usage, there has also been an increase in the number of network providers. While in late 1990s there was only one network provider, to date there are six network providers: Tigo, Vodacom, Zain (formerly called Celtel), Tanzania Telecommunication Company Limited (TTCL), Benson, and Zantel (TCRA, 2008). Similar to other countries, increased competition among network providers has resulted in reduction of costs for mobile phone users.

It is estimated that around 10.4 million Tanzanians own a mobile phone, which gives the country a teledensity rate of about 25 per cent (TCRA, 2008). Several studies have identified a number of reasons for owning or using a mobile phone (e.g., Samuel et al., 2005; de Silva & Zainudeen, 2007; Donner, 2005; Souter et al., 2005); Chakraborty, 2005; and Sridhar & Sridhar, 2007). Some of the suggested reasons for mobile phone ownership include communication with friends and family members, maintaining relationships, emergency situations, help in job search, and business networking.

Access to telecommunication has been cited as a factor for socioeconomic development especially in rural areas (Samuel et al., 2005). It has been suggested that mobile communication increases growth, alleviates poverty, and helps in overcoming the perceived digital divide (Chakraborty, 2005). Although mobile phones cannot offer a panacea for all development problems, it has been argued that there is ample evidence that, used in the right way and for the right purpose, mobile phones can have a significant outcome in addressing specific social and economic developmental goals as well as play a key role in broader national development strategies (de Silva & Zainudeen, 2007).

Although many studies associate mobile phone usage with socioeconomic development, the real impact of mobile phone use among the poor in Tanzania is not exactly known. For example, in a study by Samuel et al. (2005), it was found that over 85 per cent of 223 people

interviewed used mobile phones for improved relationships and calling friends and family members, and about 10 per cent said that using a mobile phone was expensive. Samuel et al. (2005) found that people at all income levels were able to access mobile services either through owning or sharing a phone. Furthermore, they found that gender, age, education, and income do not seem to constitute barriers to access (Samuel et al., 2005).

According to de Silva & Zainudeen (2007), there appears to be mixed feelings about the perceived economic benefits of mobile phone use, especially among the bottom poor. For instance, about a quarter of the poorest Sri Lankans reported that direct access to mobile phones has worsened their ability to earn or save. De Silva & Zainudeen (2007) found that access to telecom is not necessarily seen as increasing the earning and cost saving potential of people using the technology—perhaps because people at the bottom poor do not use phones directly for business purposes. They found that over 80 per cent of respondents from Pakistan, India, Sri Lanka, the Philippines, and Thailand used mobile phones to keep in touch with family or friends, while less than 15 per cent used mobile phones for business purposes.

Tanzania is one of the poorest countries in Africa and in the world, with a population of 40 million people (CIA, 2008), yet Tanzania is one the top countries (in terms of percentage of population) in Africa in owning and using mobile phones. It is estimated that there are about 10.4 million mobile phone owners in Tanzania, making about 25 per cent of the total population (TCRA, 2008). This figure is, however, only an estimate since there are people who own more than one phone. Vodacom alone has 4.5 million customers. The Democratic Republic of Congo, on the other hand, which has a population of over 65 million, has about 5.9 million mobile phone owners, equivalent to 9 per cent of the total population.

Even poor people both in urban and rural areas in Tanzania strive and save in order to buy a mobile phone. Although some people use mobile phones for "beeping" (Donner, 2007), it is still surprising that even though over 40 per cent of Tanzanians live on less than a dollar per day (UNCTAD, 2007), many are able to purchase and use mobile phones. (Donner defined "beeping" as calling a number and hanging up before the recipient can pick up the call. Usually a person beeps when he/she does not have enough credit or air time.)

1.1 Problem Statement

Although many researchers (e.g. Sridhar & Sridhar, 2007; Souter et al., 2005; Chakraborty, 2005; Samuel et al., 2005; and Donner, 2005) see mobile phones in developing countries in a chiefly positive light, the impact of mobile phones on poor people in Tanzania has not been substantiated empirically. That is, there is still a gap in our knowledge on whether mobile phone ownership reduces or increases income poverty, especially among the rural poor. De Silva & Zainudeen (2007) urged for further research into this area in order to help us to understand the dynamics of the relationship between telecom access and income. They argued that telephones alone cannot be a silver bullet that will pull the hundreds of millions of poor people in the developing countries out of poverty.

This study takes a critical stance towards the impact of mobile phone ownership on income poverty among the rural poor in Southern Highlands of Tanzania. Emphasis is placed on finding out how poor people use mobile phones, on how much money do they spend on mobile phones, and whether or not they forego various development-related activities for phones. The study is aimed at substantiating whether mobile phones can be said to affect perceived income poverty in rural areas of Tanzania.

This study has five specific objectives. First, this study aims at identifying reasons among the rural poor for purchasing mobile phones. Second, this study aims at determining the sources of income among the rural poor for using and maintaining the phones. Third, this study aims at comparing people's income levels with the cost of using and maintaining mobile phones. Fourth, this study aims at determining whether the rural poor forego other activities like education, clothes, and decent meals for mobile phones. Fifth, this study aims at investigating whether mobile phone owners feel that mobile phones have increased their income.

2. Methodology

This research was conducted using questionnaires for data collection. We developed the questionnaire in two short focus group meetings with a number of ICT4D (information and communication technology for development) researchers. The questionnaire was first tested, and then administered in a number of rural villages in Iringa that were within or close to mobile phone network coverage. The sample was a convenience sample (Bernard, 1995:95). The questionnaire items consisted of questions on mobile phone usage in relation to income poverty aspects. The questionnaires were in English, but we provided assistance for those who needed help in filling up the questionnaire. We had also prepared to give the questionnaire verbally, but there was no need for that.

2.1 Questionnaire Design

The questionnaire was aimed at finding out whether or not mobile phone users feel that mobile phone ownership has a positive effect on their income. There were three types of questions in the questionnaire: closed-ended questions, attitude/perception (Likert scale) questions, and open-ended questions (see, e.g., Bernard, 1995). The questionnaire contained a demographical general information part (age, gender, marital status, occupation, and residence) and five categories of other questions, concerning 1) reasons for purchasing mobile phone, 2) sources of income for maintaining mobile phone, 3) maintenance costs, 4) other non-income benefits, and 5) the respondents' general comments about mobile phones and income poverty. In addition, there were four statements with which the respondents were required to rate their agreement on a Likert scale. The statements were:

- Having a mobile phone reduces income poverty,
- Costs of running mobile phone are comparable to benefits,
- Mobile phone reduces concentration on other activities, and
- Mobile phones make people forego other important things

Concerning demographic questions, we asked the respondents' age, gender, marital status, occupation, and area of residence. Firstly, we hypothesized that older and younger people may have different views about this study. Therefore, the age structure was considered to be important for identifying the age group that most use/own mobile phones, and for the purpose of expressing variation of opinions about mobile phone usage/ownership and poverty reduction. Secondly, as it is widely believed that more men than women own and use mobile phones in rural Tanzania, we wanted to see also whether this hypothesis turned out to be true. Thirdly, we aimed at finding out whether marital status of respondents correlated with mobile phones ownership or use in the study area. Fourthly, it is generally believed that salaried and business people utilize and own mobile phones more than unsalaried people. Therefore, we included a question about respondents' occupation. Fifthly, we wished to find out whether the respondents' geographic location and access to basic infrastructure, such as electricity, affect mobile phone ownership or use.

2.2 Participants

There are 22 villages in Iringa rural region, of which 12 villages are within mobile phone network coverage. Those villages are located along the main roads such as Morogoro road, Mbeya road, Dodoma road, and Ruaha National Park road. The visited villages were Lundamatwe, Mahenge, Tanangozi, Ifunda, Lungemba, Ihemi, Kalenga, Nzihi, Kidamali, Tungamalenga, Nduli Isimani, and Mkungugu. We selected 400 people from these villages by talking to people in the villages and asking which ones of them owned mobile phones. Of the respondents, 77.75% were male and 22.25% were female. There were 60 salarymen/women, 284 peasants, 16 businessmen/women, and 40 students.

2.3 Analysis

The questionnaire results were analyzed using two main techniques. For qualitative data we used thematic analysis, whereby respondents' opinions and ideas were categorized into themes. However, within the data there were large parts where it was difficult to perceive clear patterns. In those parts we considered grounded theory; selective coding, to be specific; to be the most appropriate tool.

Using selective coding, data were analyzed according to a number of coding procedures, which followed one another in their degree of intensity. The following procedures were used for organizing and categorizing the data:

- All recorded questionnaires were transcribed verbatim.
- Completed transcriptions were carefully analyzed according to selective coding.
- Categories were developed to reflect the responses of the respondents, and also to cover the various themes present in the questionnaires.
- Seven core categories were identified and analyzed

Simple descriptive statistics such as cross tabulation and correlation analysis were used for quantitative data. We give a detailed report of the qualitative analysis in another publication, but parts of that analysis are included here.

3. Results

The results of this study were derived from the questionnaire data using both quantitative and qualitative methods. Already in the pilot survey a number of questions were observed to be difficult and they were subsequently restructured or omitted. Hence, almost all questions were answered by all respondents.

3.1 Demographics and General Information

General information of the study sample was described in terms of age, gender, occupation, marital status, and closeness of residence to the power grid. Those aspects were considered to be important for the study, since they would provide the general characteristics of the group of respondents in this study and enable correlational analysis. Table 1 portrays the demographical data on respondents. The first column portrays categories in each area of interest; the second column indicates the number of respondents in each category; and the third column indicates the relative number of respondents in each category.

Table 1: General Information on Respondents

Age	*#*	*%*
18-25	103	25.75%
26-35	100	25%
36-45	98	24.5%
46-45	70	17.5%
56+	29	7.25%

Gender	*#*	*%*
Male	311	77.75%
Female	89	22.25%

Marital Status	*#*	*%*
Married	100	25%
Single	280	70%
Separated/Divorced	17	4.25%
Widowed	3	0.75%

Occupation	*#*	*%*
Salaried	60	15%
Peasant	284	71%
Have own business	16	4%
Student	40	10%
None	0	0%

Residence	*#*	*%*
Near to electrical	11	2.75%
Far from electrical	389	97.25%

Table 1 shows a total of four hundred (400) respondents who were surveyed during data collection process. It also shows that from each of the selected twelve villages, all selected respondents were successfully surveyed. In our sample, the largest age group of mobile phone owners was the age cohort of 18-25 years, followed by the age cohort of 26-35 years. The trend in Table 1 suggests that mobile phone owners / users are relatively young people. This result is, however, not conclusive as several kinds of sample errors can affect this result and many demographic and cultural explanations can be offered to explain this phenomenon. For example, many of our respondents were single (about 70%) and may have less family obligations than married people.

Although the study aimed at having an equal number of men and women among respondents, we were able to find much fewer females who own/use mobile phones than males who own/use mobile phones. For our sample, we finally got 311 (77.75%) men who owned/used mobile phones while we only found 89 women (22.25%). Of our respondents, 280 (70%) were single, 100 (25%) were married, 17 (4.25%) were separated/ divorced, and 3 (0.75%) were widowed.

Majority of the respondents (71%) were peasants, 15% were salaried, 10% were students, and 4% ran their own business. However, we do not have an explanation why the sample contained no unemployed people although Tanzania has a relatively high unemployment rate. Nonetheless, in our sample peasants and students—who are generally considered to have low income—were well represented. Also, according to the National Bureau of Statistics of Tanzania (NBS, 2007) there appears to be higher unemployment rate in urban areas (Dar es Salaam alone 31%, other urban areas 16%) than in rural areas where the rate is about 7%.

Majority of our respondents (97.25%) lived far from electrical power supply while only 11 (2.75%) lived near (within a few kilometres of) electrical power supply. We found out that most respondents who live far from electrical power supply walk long distances to charge the batteries of their mobile phones and spend considerable amount of time doing so—time that they could use for other activities that could improve their livelihood.

3.2 Reasons for Purchasing Mobile Phones

We found that people had purchased mobile phones for various reasons. Majority (74%) of the respondents had purchased their mobile phone for maintaining social relations. The next main motivations were keeping in contact with friends and spouse(s) (13%), business (7%), emergency situations (5%), and others reasons, such as prestige reasons (1%).

In general, the prices of respondents' mobile phones ranged between 40.000–200.000 shillings (TZS) ($33–$167; €24–€118). However, 80% of the respondents owned or used mobile phones that were priced between 50.000–100.000 TZS. Furthermore, 58% of the respondents used mobile phones for beeping and calling, 15% only for beeping, and 10% for messaging, calling, and beeping. Only 2% of the respondents used mobile phone only for sending and receiving SMS messages. As many as 57% of respondents reported perceived tangible or intangible benefits, such as substitution for transport, as well as flexibility.

3.3 Sources of Income for Using and Maintaining Mobile Phones

In addition to the price of mobile phones and reasons for obtaining them, we wished to find out the sources for the income that respondents used for airtime and for recharging batteries. In Tanzania, many people do not have electricity at their home, so they pay a small fee to other local people for recharging their mobile phones.

Table 2: Sources of Income for Using and Maintaining Mobile Phones

Source of income	*#*	*%*
Salary	60	15%
Business/Agribusiness	248	62%
Gift	112	28%

Table 2 depicts respondents' sources of funding for using and maintaining mobile phones. The study revealed that 62% of the respondents fund their mobile phone use through business or agribusiness, 28% get their airtime and recharge fees as gifts, and 15% pay their airtime from their salary. Interestingly, our results revealed that 48% of the respondents reported that they sometimes substitute important needs (e.g. education, buying food, and clothes) for mobile phone ownership/usage.

The study also charted the monthly income of respondents. Table 3 summarizes the income of respondents. With the current currency exchange rate of euro and US dollar, 50.000 TZS equals to 41$/29€, 100.000 TZS equals to 83$/59€, 200.000 TZS equals to 167$/118€, 300.000 TZS equals to 250$/176€, and 400.000 TZS equals to 333$/235€.

Table 3: Respondents' Monthly Income

Income (TZS)	#	%
50.000-100.000	210	52.5%
100.000-200.000	89	21.75%
200.000-300.000	72	18%
300.000-400.000	27	6.75%
400.000+	2	0.5%

Table 3 shows the distribution of respondents according to income classes. Table 3 indicates that most respondents (52.5%) earn an income between 50.000 and 100.000 shillings per month and one in five respondents earn an income between 100.000 and 200.000 shillings. There were only 2 (0.5%) respondents with an income of 400.000 and above.

3.4 Costs of Use and Maintenance

We were also interested in knowing how much respondents spend on their mobiles phone per month, including airtime and recharging the battery. Figure 1 illustrates the maintenance costs revealed by the study.

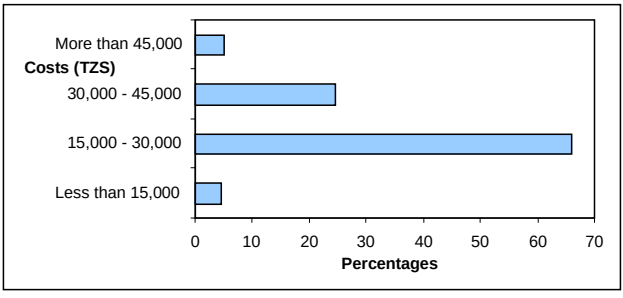

Figure 1: Monthly Cost of Mobile Phone Maintenance and Use

The questionnaire study revealed that majority of respondents (66%) spend between 15.000–30.000 TZS per month on running costs of their mobile phones, followed by 98 respondents (24.5%) who spend 30.000–45.000 TZS. Finally 18 (4.5%) use less than 15.000 TZS and 20 (5%) use more than 45.000 TS per month on running costs of their mobile phones. On top of that, majority of respondents whose expenditure ranged between 15.000–30.000 were those whose income ranged between 50.000–100.000. This is roughly 30% of their monthly income.

The questionnaire study revealed that in order to buy their airtime, respondents sometimes sacrifice other things for airtime. All of the twelve villages are near the mobile phone network coverage—usually Zain and Vodacom. As a result, the villagers, generally speaking, do not need to travel far to get network reception. However, many of the respondents reported that they often walk 3-7 kilometres in order to recharge batteries of their

mobile phones. For example, respondents from Lungemba village explained that mobile phone users/owners walk for battery recharge to Mafinga town, which is 7 kilometres away. In addition, many of them reported that they must sometimes stay in town for 3 hours waiting for their battery to be fully recharged. The respondents tended to do the trip to recharge battery 2 to 3 times per week, depending on type and use of mobile phone.

3.5 Attitudes Towards Mobile Phone Ownership and Use

The respondents' open-ended comments revealed that the growth, increased affordability, and extending coverage of mobile phones services are rapidly increasing the importance of mobile phones as a means of two-way synchronous (and asynchronous) communication. The respondents hoped that service providers' pricing models should offer affordability and choice in order to make it possible for even people from lowest-income groups to adopt mobile phones. They also emphasized that—if possible—the issues of electricity, or power grid, should be put into first consideration before extending mobile phone network coverage.

In addition, we asked the respondents to rate their agreement with a number of statements. We used a four-point Likert scale with a "no opinion" choice. In the following we present results from four claims: Firstly, that having mobile phones reduce income poverty; secondly, that the benefits of mobile phones justify their costs; thirdly, that using mobile phones reduces other important activities; and fourthly, that the cost of mobile phones make people sometimes give up other important things in their life.

Statement 1: Mobile Phone Ownership Reduces Income Poverty

As many as 79.5% of the respondents disagreed or strongly disagreed with the statement "having mobile phones reduce income poverty" (see Figure 2).

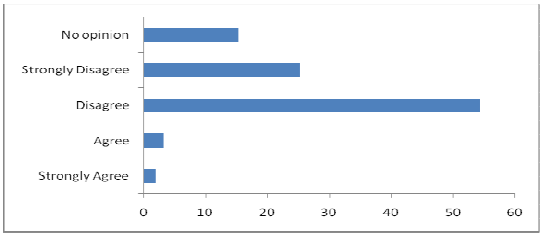

Figure 2: Mobile Phone Ownership Reduces Income Poverty

Very few respondents (5.25%) felt that mobile phones contribute positively to their income. However, given the results in Table 3 and Figure 1, this comes hardly as a surprise. That is, if the most common monthly income is 50.000–100.000 TZS and if the most common monthly spending on mobile phones is 15.000–30.000 TZS, the mobile phone-induced increase in income must be very significant to tip the balance on the positive side. However, as the mechanisms of micro-scale economy in developing countries are very different from the industrialized countries (e.g., informal economy plays an important role), this result is not directly translatable to terms and concepts of industrialized countries.

Statement 2: Costs of Using a Mobile Phone are Justified by the Benefits

As illustrated in Figure 3, 75.25% of the respondents disagreed or strongly disagreed with the statement that costs of owning and using a mobile phone are comparable to the benefits gained from the phone (see Figure 3).

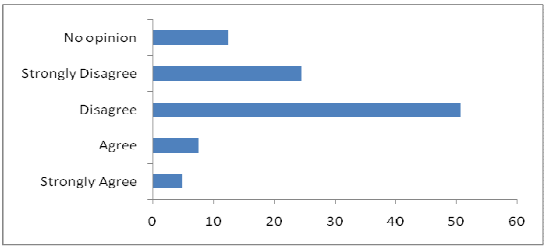

Figure 3: The Benefits of Mobile Phone Justify the Costs of Owning and Using a Mobile Phone

This result may reflect a general discontent about the pricing of phone calls and technology, or it may mirror dissatisfaction with mobile phone services, network coverage, or other aspects of the technology. In the end, no matter how people see the benefits vs. costs of using mobile phones, the fact that 25% of Tanzanian people own a mobile phone indicates that they do get *something* out of the technology.

Statement 3: Mobile Phones Reduce Concentration on Other Activities

We found out that 80% of the respondents agreed or strongly agreed with the statement that mobile phones reduce time and concentration from other activities in their life (see Figure 4).

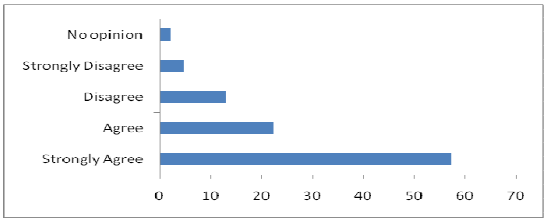

Figure 4: Mobile Phones Reduce Concentration on Other Activities

These results, however, will be analyzed further in a following study.

Statement 4: Mobile Phones Make People Forego Other Important Things

The results in Figure 5 show that 79.25% of the respondents agreed or strongly agreed that mobile phones make people forgo other important things in their life.

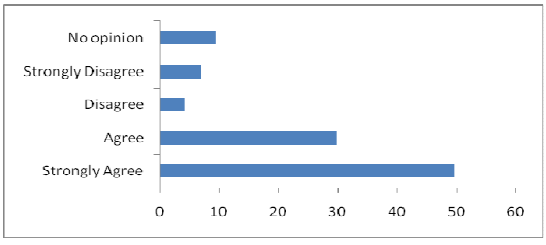

Figure 5: Mobile Phones Make People Forego Other Important Things

This response indicates that mobile phones may make people ignore things and activities in their life that would raise their income in some ways—such as clothing, balanced diet, or education. Also this result will be analyzed further in a following study.

4. Discussion

For this study we tried to find respondents from all age groups, all professions, and both genders equally. However, our final sample had a heavy bias on males and on age cohorts of 18-25 and 26-35. We consider this effect to be an implication that these are the groups with the widest diffusion of mobile phones in rural Iringa. This, however, remains a topic for further study.

According to our findings, the money for buying mobile phones comes mainly from business or agribusiness (62%), and many people get their airtime as gifts from friends or relatives. However, the cost of using mobile phones is a burden to the users/owners: mobile costs often consume more than 30% of their monthly (formal) income. Although industrialized countries and the poorest developing countries are incommensurable in terms of microeconomic phenomena, these results do not leave much room for interpretation: poor people in rural Iringa use a disproportionate share of their formal income on mobile communications. That choice is, naturally, a choice of preference, but that phenomenon requires a deeper investigation.

Of the respondents in our sample, 97.25% live far from basic infrastructure, such as the power grid. They often have to walk long distances for basic services for their mobile phones. Consequently, many income-generating economic or business activities are often postponed so as to allow visits to mobile phone services. In our sample, the most common occupations of mobile phone owners/users were peasant (71%), salaryman/woman (15%), and student (10%). Peasants and students are regarded as low-income earners, and mobile phone use could sometimes consume more than 30% of their monthly income, sometimes causing them to forgo other important things.

This study has shown that the majority of mobile phone owners and users do own/use mobile phones for mainly maintaining relationships and not for economic or business purposes. Of course this is not to say that phones *could* not be used for income-generating purposes. We have witnessed many ways of using mobile phones for gaining income: the Mama of a certain grocery stall uses a mobile phone to inform her customers when products become available, and many pushcart owners who haul goods in Iringa have written their mobile phone number at the side of their cart. However, in case studies and examples like these lies a danger. It seems that there is a widespread illusion that mobile phones create prosperity; and that illusion is created by the numerous case examples of how mobile phones have been used around the world, in many creative ways, to create income. But those case examples have been presented exactly because they are extraordinary. Our findings suggest that mobile phones do not, on a large scale, contribute positively to people's income in rural Iringa (or at least people do not perceive the financial benefits).

The international development enterprise has numerous arguments for new technologies. Anecdotally, some argue that the economy as a whole benefits from extensive communication networks. Some hypothesize that the well-off people benefit the most from cell phones but that some sort of a trickle-down effect spreads those benefits to all people of the society. Some speculate that by democratizing communication, mobile phones equalize power in a society. This study is not aimed at answering any arguments outside the narrow scope of this study. However, in future research each of those arguments should be taken under closer scrutiny. One should ask, for instance, "What are the causes and effects in the mobile phone-related phenomena?", "Is the relationship causality or correlation?", and "What kind of an effect do mobile technologies have on the income gap in developing countries?"

Our respondents' opinions on whether mobile phones decrease poverty were unambiguous: mobile phones do not alleviate poverty. It can surely be argued that mobile phones are very important for conducting economic and business activities that contribute towards development. It can also be argued that mobile phones offer many things that improve people's quality of life. But according to our respondents, in rural Tanzanian communities—especially in communities with poor infrastructure and challenging road

networks—if owning or using mobile phones actually does something to poverty on the large scale, it increases poverty instead of decreasing it.

5. Implications and Directions for Further Research

Our results are consistent with de Silva & Zainudeen's (2007) study in Sri Lanka, where the researchers found that especially among the bottom poor access to (or use of) mobile phones does not necessarily increase income or cost saving. This study appears to have significant practical and theoretical implications. Practically speaking, the ability to contact friends and relatives, as well as the ability to handle all kinds of matter over the phone, certainly makes people's lives easier. But it appears that 40 million individual phones is currently not a really viable option for Tanzania. For technology researchers and service providers the challenge is to develop useful, socially accepted, cheap solutions for communication. Theoretically speaking, for development researchers, the challenge is to understand the information exchange patterns of different people, as well as the relationship of those patterns to development. Also, it is important to understand the relationship between mobile phones and information symmetries among, for instance, smallholder farmers or small business entrepreneurs. This will determine the extent to which mobile phones reduce the information asymmetry by understanding value chains of the produce among all kinds of people in rural areas. Finally, more overall research is needed on the relationship between mobile phones and development; and that research must be able to question any and all assumptions about mobile phones and societies.

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Reflections on MobileActive08 and the M4D Landscape

Jonathan DONNER[1], Katrin VERCLAS[2], Kentaro TOYAMA[1]
[1]*Microsoft Research India, 196-36 2nd Main, Sadashivnagar, Bangalore, India 560080*
+91 80 6658 6000 jdonner@microsoft.com, kentoy@microsoft.com
[2]*MobileActive.org Tel: +1 413 687 9877, katrin@mobileactive.org*

Abstract: This paper revisits presentations at the MobileActive08 conference in Johannesburg to critically examine the current diversity of projects and approaches in mobiles for development (M4D). We identify four common choices facing individual M4D projects (intended users, technical accessibility, informational links, and market links) which collectively mark the current landscape of M4D. Discussions of M4D projects have tended to be delineated by traditional development domain (health, education, agriculture, etc). By focusing on choices that cut across domains, we highlight elements which vary across M4D projects, but which to date have not been observed to correlate with project success. We discuss these four choices in light of the broader course of the field of "information and communication technology and development" (ICTD). Further, we argue that choices made at the project level may create different M4D landscapes, with implications for the breadth and depth of the technology's impact on development.

1. Introduction

The number of users of mobile telephony in the developing world has increased dramatically, exceeding all expectations. In the past few years, we have seen a corresponding rise in enthusiasm for projects applying mobile telephony towards economic and social development. Events such as this "M4D" conference in Karlstad are a testament to the wide diversity of such activities found around the world. This brief paper revisits presentations at the MobileActive conference in Johannesburg in October 2008 (MobileActive08) in order to illustrate and critically examine this diversity of M4D projects and approaches.

Examining this diversity is helpful for various reasons. It can illustrate commonalities across traditional development verticals like health, education, and agriculture. It can disaggregate and bound our expectations about what can be accomplished though mobile development projects, and provide indications of what choices might be more likely to lead to successful outcomes. And finally, it can help us draw linkages between current efforts to deploy M4D and the broader set of ICTD initiatives of the last decade. To illustrate this diversity we identify four choices made by all M4D projects.

2. What is an M4D project?

In this paper, we do not describe the myriad ways in which the use of mobile telephones can impact social, human and economic development (Donner, 2008). Rather, we focus on the choices made by those involved in a wide variety of applied M4D projects. Each element in the compound term "M4D project" helps bound our task.

- A ***project*** is a "specific plan or design", a "planned undertaking" (Merriam-Webster, 1990). In this sense, software applications, protocols, campaigns and initiatives are all projects.
- ***Mobile*** refers to mobile telephony. For this paper, we restrict discussion to the GSM and CDMA enabled handsets and networks used by billions of people every day around the world. We exclude, for clarity's sake, wi-fi, laptops, older non-telephony PDAs, MP3 players, handheld GPS units, pagers, RFID tags, and a whole host of other technologies which, although 'mobile' in some way, are not part of the core mobile-cellular boom. Linking 'mobile' and 'project', we suggest that some projects have mobile telephony at their core; take away the mobile communication at a distance and the project is unrecognizable or impossible.
- We take a broad view of ***development,*** including improvements to social, human, and economic conditions. These changes can be brought about by people working on behalf of other people, or by communities working on behalf of themselves. Linking terms, a 'mobile development project' is a specific plan, design or set of activities, undertaken using mobile telephony, which brings about an improvement in social, human, or economic conditions.
- Even ***'4'*** has a role, signaling intentionality in the minds of those undertaking a project. It suggests an explicit or implicit theory of how mobile telephony is addressing a development need. The inclusion of the '4' helps separate projects which *happen* to bring about positive development outcomes from those *which set out to do so*. With this nod to intentionality, we'd further argue that most of those involved with M4D projects *know* they are involved in M4D projects, and that conversely, almost anyone who describes themselves as involved in an M4D project is probably correct. An analogy is the emergence of self-identified 'social entrepreneurs' who have mixed profit goals with other stated social or developmental objectives (Bornstein, 2004).

By these boundary criteria, Grameen Village Phone (Aminuzzaman, Baldersheim, & Jamil, 2003; Bayes, von Braun, & Akhter, 1999) is perhaps the single most well-known example of an M4D project. Begun in Bangladesh and replicated around the world, it was (and is) a project which sets out to use mobile phones to create livelihoods for individual microentrepreneurs. Its self-described development impacts include improved revenues and livelihoods for the phone operators, and improved access to telecommunications for underserved villages. The mobile is central to the project's identity, and there is a working model of how the use of the mobile will bring out desirable outcomes for the community.

A brief look at supporting technologies and activities adjacent to the Village Phone can illustrate important activities which are not M4D projects by our admittedly stringent criteria. For example, Grameen Telecom supplies the airtime and the network connectivity to the village phone operators, but it is mainly a commercial mobile operator, with millions of users in Bangladesh. As such it is no more an *M4D* project than was the creation of the handset or the GSM standard itself. The core technologies, tools, protocols, and services broadly available in the mobile telephony landscape clearly play a role in development, but they are not M4D projects.

Similarly, a farmer who checks prices using a village phone (and now happens to make more money) is using a mobile phone in a way which results in desirable outcomes for him and his family and employees, but he isn't involved in an organized body of work (a project) with a broader intent towards "development" beyond his immediate social and economic circles.

Finally, researchers who seek to assess and describe just how the addition of connectivity to a village changes agricultural prices or village social structures are certainly studying the role of mobile phones in economic development, and are providing the research and policy

communities a valuable service by doing so, but are not necessarily engaged in M4D *projects*.[1]

For the sake of this paper, we're looking at a relatively small set of projects—organized units of work by development practitioners, NGOs, companies, and researchers with which we are familiar with and which were represented at MobileActive08—which seek to apply mobile telephony in ways which they believe will directly improve social, economic, and human outcomes. By no means should this selection be considered definitive or comprehensive. It is, by definition, limited and should be considered a commentary rather than a definitive segmentation.

3. Viewing M4D projects as a set of choices

To reflect on the M4D landscape, we looked back over the 36 M4D projects presented at MobileActive08[2]. MobileActive08 convened a variety of stakeholders—NGOs, researchers, technology companies, operators, and donors—engaged in using mobile phones for social impact. Clearly, the presentations at the conference are neither a random nor comprehensive list of all M4D projects, but they do represent a range of 'state of the art' approaches within the emerging community of interest. As a gathering, the conference hosted 30 people in 2005, 100 in 2007, and nearly 400 in 2008—evidience itself of a growing interest and diversity of approaches in the field.

As "specific plans or designs", M4D projects are, like any projects, essentially defined by hundreds of choices, large and small, made by their participants about how to approach a problem and achieve a goal. Some such choices are relatively well-understood. For example, we are all familiar with basic domain choices—the differences between a health project or an education project—and also choices between organizational structures, e.g., between establishment as an NGO versus as a corporation. A myriad of other choices add uniqueness to any M4D project. However, given our parameters for this paper, they are not a focus of attention here. Instead, two other classes of choices require further discussion.

First, there is a set of choices which the ICTD literature has already identified as being correlated with project success[3]. Some designs, quite frankly, are more likely to succeed than others. Like other ICTD projects, successful M4D projects are likely to be evolutionary (vs. revolutionary), more aligned with existing practices, and more focused on intended outcomes (Heeks, 2002; Kuriyan & Toyama, 2007; Rogers, 2003). A more detailed list of choices which the existing ICTD literature suggests are more likely to lead to success includes:

[1] Indeed one of the authors of this paper (Donner) presented in three sessions at MobileActive, describing research about how small enterprises use mobiles, on intentional missed calls, and on the social factors influencing m-banking. Each presentation described an element of mobile use which impacts economic development, but none of them described an M4D project. By contrast, other presentations on two of the panels, by Praekelt, who found a way to insert pro-social messages into millions of please-call-me notifications, and by WIZZIT (an m-banking provider in South Africa with tens of thousands of users) did describe M4D projects.

[2] There were 58 scheduled presenters at MobileActive08, but only a subset described M4D projects. Others presented research analyses, practitioner perspectives, brainstorms, or plenary comments which were not tied to specific M4D projects. A total of 36 M4D projects were discussed. See http://mobileactive08.confabb.com/conferences/MobileActive08/sessions

[3] The 'dataset' of presentations at MobileActive08 is not a good place to assess success factors, since most presentations focused on success stories and growing, thriving projects.

- Embedding the mobile element into an otherwise ongoing development effort, versus casting the mobile service as itself the development effort or otherwise asking the technology to "lead" the effort;
- Using the mobile technology to reduce transaction costs or increase productivity of existing practices, versus introducing entirely new behaviors via the mobile;
- Requiring only basic literacy or skills from users, versus requiring additional technical knowledge or support.

Second, however, there are other fundamental choices, unique to the context of M4D projects, about which (a) the existing ICTD literature provides less of a guide and (b) we know less about their relationship to the probability of a project's success over the long term. Based on our ongoing participation in the M4D community, and on an iterative discussion of the various M4D projects presented at the conference, we have identified four of these choices which we believe confront virtually all M4D projects[4]. A careful discussion of these choices illustrates both the diversity of approaches currently at work in the field, and some difficult trade-offs many projects face.

Choice 1: Who is the intended user?

Some M4D projects choose to target broad swaths of end-users—a general public. Others are intended for niche populations of end users, such as small business owners or students. Still others target development professionals. The contrasts between projects which choose to target the general population and projects or applications targeting professionals are quite apparent. The former borrow from mass-communication paradigms and are generally consumed/used/experienced as part of users' daily lives, in diverse and uncontrolled situations. The latter are intended to support development activities by specialized users in specific roles, such as data gathering by community health workers or loan processing for microfinance lenders. In the sample of projects presented at MobileActive08, 16 targeted 'niche' populations while 20 targeted general populations.

The extremes present trade-offs, of course: mass-public approaches offer scale and breadth of impact, while targeted interventions with professionals promise depth of impact, empowering a smaller number of users to better pursue their development activities. Projects designed for niche-but-lay users, and applications for very narrowly targeted professionals in a specific field, also hold both promise and peril. Promise, because targeted applications or projects such as "agriculture prices for farmers" or "math training for high school girls", can be narrowly tailored and richly supported. Peril, because the links to sustainability and scale can be challenging, as niche and specialized users must both see the value and be able to afford the cost to sustain these specialty projects (Rogers, 2003).

Choice 2: How technically accessible is the solution?

Some projects pursue a mobile solution which offers near-universal compatibility with all handsets; others require feature or 'smart' phones or have other technical constraints. Among the MobileActive08 project sample, 18 projects were accessible to any handset; the others had hardware or application constraints requiring fancier phones. Again, the choice often involves breadth vs. depth. SMS- and voice-based interfaces are familiar to users and relatively consistent across handsets and networks, but they offer experiences of limited richness, and text and voice offer their own constraints—text requires literacy, and, in the case of some more complex SIM or multi-screen interfaces, the skills to navigate soft keys and nested hierarchies (Jones & Marsden, 2006). Voice is more intuitive, but places higher demands on back-end systems to perform tasks of voice recognition or text-to-speech

[4] This was not a formal content analysis. Rather, we used an iterative approach among the three authors to develop the categories and to assign the various projects to the categories.

encoding, and can offer limited discoverability to users seeking new functionality (Boyera, 2007). Conversely, higher-end handsets offer larger screens, photo and video, better graphics, more processing power, more memory, and sometimes better input methods, like text keyboards or a stylus; each offers increased flexibility to M4D projects, but at the cost of affordability and broad compatibility.

Similarly, there are choices about how, if at all, the application or project exchanges information over the mobile network. Voice, SMS and the USSD channels are accessible on almost any handset. Voice is relatively rich but expensive in most parts of the world– someone needs to pay for the calls. SMS, in particular, is more flexible than was first imagined. SMS servers such as the ones presented by Microsoft, UNICEF (RapidSMS), and FrontlineSMS, can allow users to asynchronously access databases, and coordinate groups. But SMS is limited to 160 characters at a time, and on a per-bit basis tend to be orders of magnitude more expensive, compared to GPRS and 3G. The USSD channel is managed by carriers and is thus not as widely available. Thus while the appeal of GPRS is clear, either to link to WAP sites or increasingly to mobile internet sites, so are its constraints; not all handsets support GPRS or data connectivity, and those that do require data plans or pre-pay data to be enabled.

Choice 3: Does the project link to other platforms or content?

Some projects are self-contained, requiring no input from other media or content sources, save perhaps a back-end database for serving content; others have more extensive interdependencies with other information and media sources such as the Web. For example, an SMS-based agricultural information system may draw content from weather resources on the internet, or a health-information system might offer dual modes of operation to its users, across mobile and PC-based channels. 26 of the 36 projects presented at MobileActive08 were self contained.

Of course, standalone projects can be valuable, and can be tailored in the short term to provide essential content or experiences to the project's users/beneficiaries. On the other hand, linking to external sources is technically and organizationally more difficult, but can offer richer experiences to users, and can create new hybrid media experiences (Jenkins, 2006) and remove barriers to information often faced by resource-constrained users (Cartier, Castells, & Qiu, 2005; Donner, in press).

Choice 4: What does the project require from manufacturers or operators?

Some projects function independently or with third-party applications; others require the cooperation of network operators, or handset manufacturers. The operators and handset manufacturers provide two points of concentration in the market landscape (Andrew & Petkov, 2003; Whalley, 2004). Operators determine which applications are pre-loaded on SIM cards, can make the USSD channel available for some purposes, can offer price discounts to certain applications, and can feature some content on GPRS home pages in 'walled garden' approaches. Handset manufacturers and the creators of mobile operating systems have a similar influence on which applications are easy to find and easy to use.

Thus, applications which ship on the handset or SIM card, or are supported and promoted by the operators may face lower hurdles to adoption; conversely, the current fragmentation of operating systems and relative difficulties of loading software may create hurdles for third-party projects and applications. In addition, interacting with corporations can be a daunting undertaking, while it's relatively easy to set up servers and downloadable services that interact directly with the user. Eight of the 36 projects presented at MobileActive08 required some level of collaboration with operators or manufacturers; the rest were independent.

4. Examples of projects

Projects with virtually all permutations of these choices were represented at MobileActive08. The appendix presents all the projects; below we illustrate the diversity of approaches by detailing six projects.

Souktel

Souktel is an SMS job-matching service in the Palestinian Territories. It is aimed at young, unemployed people in the Territories but accessible and available to anyone in the world who has a mobile phone with SMS. The technology is simple: It's an SMS-based system that allows for general use without any specialized application. It operates with a backend data service/database that is maintained by Souktel. It does not require operator involvement but as many of the projects that may generate significant SMS traffic, buy-in from the operators is very helpful to ensure reliable delivery. Souktel is not multi-media and is delivered solely through SMS messages currently, though it might benefit from a multi-modal approach in the future.

WIZZIT

WIZZIT is an application enabling mobile payments. Unlike some other systems, it is operator-independent but geographically focused on South Africa and requires collaboration with a bank. It is available on and compatible with all South African carriers. It is available on all phones utilizing USSD.

To set up a WIZZIT account, a customer needs to subscribe to the service and deposit funds into their account by going to a bank or post office. A WIZZIT account costs roughly one-third less than a traditional bank account. Rather than relying on traditional advertising, WIZZIT markets its services through so-called Wizz Kids who earn a commission by signing people up for the service.

Integration into back-end banking systems, call centre and cell phone networks, etc., is critical to the overall success of the project. Debit cards and account web access are available to customers, and cash can be obtained at ATMs and local mobile shops.

WIZZIT's choices include a focus on general users; it offers a technical solution available to virtually any mobile phone owner, ties in to bank-account databases, and works in cooperation with all three of the operators in the country.

Java Rosa

Java Rosa is one of many mobile data collection applications presented at MobileActive08. It is aimed at collecting medical data but it can be configured and used in many disciplines with configurable forms. It is in its early stages and is being tested and developed in Tanzania, for example. It is an open source project that aims to apply Xform standards as part of the Open Rosa group, an open source consortium. Java Rosa operates on Java phones. It is targeted at niche users – medical professionals or community health workers collecting health-related data. It does not require cooperation from operators nor is it dependent on a particular handset manufacturer, though as a Java-based application, it will work only on JME phones. Data is parsed through a back-end platform. It is not a multi-media project; and it is mobile only at this point, though collaborations with web-based apps are being discussed.

Ushahidi

Ushahidi is an incidence-reporting and mapping platform to which anyone can text, email, or upload on the web incidences of any sort (though the project has been focusing on incidences of violence). The platform is being rebuilt now after trials in Kenya last year. It is multi-modal with web mapping, and data entry via three channels. The project incorporates web and mapping applications, in addition to SMS. As such, it will be accessible to as many users

in the general public as possible, essential for a system that will reply on crowdsourcing information. It is operator-independent.

MyMsta (LoveLife)

MyMsta is a mobile social network developed by LoveLife, a South African NGO focused on pro-social and pro-health messages for young South Africans. MyMsta is a custom WAP platform developed by LoveLife targeted at young people under the age of 20. Users maintain their own profiles on the mobile site, can join chat groups, and access health, job, and scholarship information maintained by LoveLife. Users can also upload and download pictures and music though the site, ask questions about HIV/AIDS and sexual health, and accumulate points by solving quizzes. MyMsta functions on all four operator platforms in South Africa and is optimized for phones that run Opera Mini.

Freedom Fone

Freedom Fone is an SMS/IVR application developed in Zimbabwe and combining Asterisk and Frontline SMS, two applications, to deliver SMS and voice information and media content. It was developed in the context of accessing news of other information (such as health information, for example) but is built to deliver any kind of information content to a mobile device. It is targeted to the general public but especially suited for people with limited literacy. It combines a voice/IVR open source application (Asterisk) with an SMS-delivery application (FrontlineSMS). Users can request a call-back with information delivered by voice through an SMS, or can access voice information through a menu system. It works with all phones with voice and SMS as the lowest-common denominator and does not require operator cooperation.

5. Discussion

These choices illustrate the variability of approaches employed by M4D projects. This is in addition to the variability across development verticals, such as health, education, agriculture, governance, livelihoods and social activism (Acumen Fund, 2007). Clearly there is not one approach that fits all, nor even one dominant model of M4D project. Indeed, it is clear from the diversity of approaches that M4D is in a period of rapid growth and experimentation—a period of punctuated equilibrium (Donner, 2004; Loch & Huberman, 1999) in the ways organizations process and exchange information via mobile devices. It is equally clear that not everything will succeed; individual projects will come and go, morph and prosper.

We close with two sets of observations about the current M4D landscape, and the role of M4D projects in shaping ICTD more generally.

5.1 Choices and the current M4D landscape

Our focus on the common choices facing M4D projects has implications for our understanding of the M4D landscape.

First, we can explore the extent to which these choices can be correlated with the success of individual M4D projects. At this early experimental stage, none of the four choices which we have highlighted have 'right' answers—individual projects seem as likely to succeed with almost any configuration. That said, there are significant biases within this (admittedly non-randomly chosen sample) towards projects that required no dependency on other information sources or explicit cooperation from operators. This likely reflects the relative ease of deploying such projects, in contrast with the alternatives.

One fruitful path for future research would be to assess the relative success of M4D projects making each of the choices outlined in this paper. It is certainly possible that such

research would be able to isolate the impacts of discrete choices—finding perhaps that niche applications yield greater development impact than general applications, or that projects with operators' support outperform similar independent applications. However, it is more probable that these choices are too interdependent, and too context-specific, to be broken down so easily. In this case, we believe that future research designs could instead examine whether different *combinations* of choices are associated with success. Put another way, further research might try to isolate modalities or clusters of choices among successful M4D projects. For example, we might find one mode of 'mass' applications which work closely with operators or handset manufactures and work well on low-end phones, while another configuration might consist of projects targeting niche users, on smartphones, drawing on hybrid content, but without the engagement of operators or handset manufacturers. The identification of these clusters would improve the discussion of 'best practices' in M4D.

Secondly, although the data is not available at this stage to associate any of these four choices with the success of individual projects, we can imagine impacts on the aggregate M4D landscape. Essentially, we can describe how multiple micro-level projects might drive macro-level outcomes (Berger, Giesen, Muench, & Smelser, 1987; Huber, 1991). For example, the choices across hundreds of projects to address low-end phones, vs. mid-range-feature phones, vs. high-end smartphones will shape the degree to which the world's poor will be able to benefit directly from M4D projects. Although the proportion of feature-rich handsets in use continues to rise, tens or hundreds of millions of the current 'dumb' handsets will remain in service for a long time (Edgerton, 2007); it is important for the M4D community to remain cognizant of what phones its various target communities are likely to carry.

Similarly, on the matter of content, we are of the opinion that, at the aggregate level, it is important for the M4D community to build links between the content it generates and the broader worlds of community, national, and global content available on the internet and on other information sources. If individual projects choose to pursue "standalone" content there is of course no harm done, but as a whole, an environment with lots of applications and projects which link low-end handsets to the internet and to other media will be more diverse and probably richer than one which creates second-class information users and sources. We're intrigued by applications and projects which seek to leverage other sources and reduce differences between the info 'haves' and 'have-less' (Cartier et al., 2005).

5.2 M4D projects in the context of ICTD

Though space and scope constrain a full treatment of the linkages between M4D and ICTD, we conclude by raising some issues and further questions about the linkages which this exercise has helped bring into focus.

First, it is important to separate enthusiasm from hype (Heeks & Jagun, 2007). The introduction of mobiles cannot solve all the problems of development (not even just the ones that prior ICTs could not solve), nor are mobiles always 'better' than other ICT solutions. For example, the delivery of effective m-education via a three-inch mobile screen is at best a difficult proposition. Instead, mobile-based development interventions must function within an information landscape which includes landlines, books, blackboards, shared computers, community radio, etc. And, as the choice of whether to link to outside content illustrates, at times the best M4D projects will not replace but rather *complement* other information sources.

That said, the distinctions between M4D and ICT4D projects will continue to blur. The arrival of increasingly affordable data connectivity and increasingly affordable data-enabled handsets is bringing the mobile internet into the development arena. ICTD theory and practice addressing the developmental utility of high-end devices will 'converge' along with the devices themselves, particularly in applications for professional and niche users where the higher per-unit equipment and connectivity costs may be supportable. However, at the low and middle positions on the affordability/technology spectrum, where browsing at 3G speeds

remains prohibitively expense, theory and practice of mobile-internet use will have to account for far different use cases. The choices facing M4D projects outlined in this paper—about intended users, technical capabilities, linking to other media sources, and the nature of coordinated action with manufacturers and/or operators—will persist. Current guides to designing internet-based development projects are not sufficient for M4D projects targeted at populations whose first and only means of contact with the internet is via a mobile screen and a 10-key numeric keyboard. New approaches to M4D design (Jones & Marsden, 2006) and strategy are warranted. Yet with every M4D project, more knowledge accumulates about the appropriate choices to make; over time, these M4D 'best practices' will play an increasingly central role in ICT4D in general.

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Appendix: M4D Projects Presented at MobileActive08

Project	Description	Intended User	Technical Accessibility	Infoscape	Market-scape
DigitalIS:	Mobile Data Collection for Rural Cooperatives	Niche	Application	Web	Neither
Learning About Living	Pro-Social text Messaging	General	All	Self-Contained	Neither
M4Girls	multimedia educational content, preloaded on handsets	Niche	Feature	Self-contained	Handset
Columbia Millennium Village's	Mobile health messaging and health worker support	Niche	n/a	Self-contained	n/a
Cell Life	Patient monitoring with SMS	Niche	All	Self-contained	Operator donation/ Neither
Easy Capture/ Impact Consulting	Data collection for health information with mobiles	Niche	Application	Self-contained	Neither
Rapid SMS	SMS messaging and data collection with forms/web-back-end	Niche	Application	Web	Neither
Frontline SMS	Desktop-based SMS messaging	Niche	Application	Self-contained	Neither
The News is Coming	SMS News via SMS	General	All	Web	Neither
Freedom Fone*	SMS-audio information	General	All	Audio	Neither
MyMsta (LoveLife)*	Mobile pro-social social network	Niche	Application	Self-contained	Neither
Tradenet	Agricultural pricing information platform	Niche	All	Self-contained	Neither
Datadyne: Episurveyor	Mobile data collection	Niche	Application	Self-contained	Neither
MPedigree	SMS-verification system to authenticate drugs	General	All	Self-contained	Neither
Ushahidi*	Web and mobile incidence reporting system	General	All	Web/maps	Neither
INSTEDD: SMS Geo Chat	Incidence reporting system	General	All	Web/maps	Neither

Cont. on next page.

Project	Description	Intended User	Technical Accessibility	Infoscape	Market-scape
Souktel*	SMS job-matching service	General	All	Self-contained	Neither
Project Zumbido	SMS group text messaging service	Niche	All	Self-contained	Neither
Java Rosa*	Mobile data collection	Niche	Application /Standard	Self-contained	Neither
Isis: Sex Info	SMS sexual health information	General	All	Self-contained	Neither
Big Board	Bluetooth information system	General	Bluetooth/all	Multi-media	Neither
Praekelt: Social Txt	USSD PCM social messaging	General	Where PCMs/all	Self-contained	Operator
Praekelt: Txt Alert	SMS reminder system	General	All	Self-contained	Neither
Greenpeace Argentina	SMS/mobile activism alerts	General	All	Self-contained,	Neither
Hello Citizen	SMS news service via SMS	General	All	Self-contained	Neither
Mozambique Health Information Network	Health information for health workers via PDA/mobile data transfer	Niche	Application/ special hardware	Self-contained	Neither
Games for Life	Pro-social games	General	Application	Self-contained	Neither
WIZZIT*	Mobile banking	General	Application	Multi-modal	Bank, Operator
NDI: Mobile Election Monitoring	SMS for election monitoring	General	All	Self-contained	Neither
Streetwise	Content and news services to lean terminals via mobile network	General	Application /hardware	Multi-media	Neither
Nokia Mobile Data Collection	Mobile data collection	Niche	Application	Self-contained	Handset
Microsoft MIDAS	Mobile data collection	Niche	Application	Self-contained	Handset
Microsoft: Oxigen	Mobile banking service	General	Application	Backend	Both
Microsoft: Warana	SMS news service	General	All	Self-contained	Neither
Regional Hunger and Vulnerability Programme	Cash aid via mobile airtime	General	All	Self-contained	Neither /operator helpful
BROSDI	Agricultural price information service	Niche	All	Self-contained	Neither

* Mentioned in the text.

Ensuring Sustainable Internet Access for Development in Africa: Insights from mHealth Innovations

Adesina ILUYEMI
Centre for Healthcare Modelling and Informatics, University of Portsmouth, Portsmouth, PO1 3HE, United Kingdom
Tel: +44 023 92846784, Email: Adesina.iluyemi@port.ac.uk

Abstract: In arguing that ICT4D, from its present state of 1.0 to an emerging and future 2.0 one, Richard Heeks, called for attention to be shifted to three areas, namely: low-cost devices, telecommunications, and energy. These areas are touched upon here and argued as important for providing sustainable internet access in Africa based on empirical insights from mHealth innovations from Africa and other developing countries. These mHealth cases have shown that wireless/mobile ICTs, mobile/nomadic devices, and fibre-optics-wireless convergence are technologies to be employed for broadband internet access now and in the nearest future in Africa.

1. Introduction

According to Heeks [13], sustaining ICT innovations and digital divide reduction efforts in Africa has been hampered by the misalignment between technological concepts or designs and the reality facing local users. A major failure of ICT4D, according to Heeks [1], is the lack of evaluation of existing initiatives at the micro-level of practice for informing at the macro-level of policy and development. Heeks further stated that transiting from what he labelled the present state of ICT4D 1.0 to the emerging and future 2.0 one requires a different way of thinking. ICT4D 1.0 according to Heeks is about adopting ICT tools, especially the Internet for meeting the Millennium Development Goals (MDGs). Aggressive push of ICT4D 1.0 paradigm mostly by international bodies, informed by narrow empirical experience from DCs led to a mad rush of project and policy implementations. This paradigm was informed mostly by the implementers' western view of Internet access as argued by Heeks and has terminated with failures and without achieving any tangible sustainability whatsoever. Notwithstanding this observed failure, lessons learnt from the 1.0 paradigm is now informing how the not too clear 2.0 one should go in making ICTs to deliver on its much published promises of bridging digital divide. Transiting into ICT4D 2.0 paradigm as argued by Heeks will be how to deliver sustainable Internet access to end-users in DCs. According to him, a paradigmatic shift to user-centric access model from the unsustainable western inspired access model of the 1.0 era should be done away with. Further, he also argued that western inspired model of a fixed computer connected to a landline was costly and could not provide sustainable Internet access to users in DCs. Shaping the emerging and future 2.0 paradigm to deliver will therefore require innovative user-devices, telecommunications and energy solutions. Low-cost internet access devices (IADs) such as laptops and personal digital assistants (PDAs), terrestrial wireless networks and electricity generation are three relevant areas of innovation according to Heeks [1].

Empirical observations from case study evaluation of mHealth initiatives will be adopted as a lens into Internet access practice at the micro-level. It is hoped that analysis of this

micro-level practice will make clearer how technological innovations will unravel within the emerging ICT4D 2.0 paradigm. Hopefully, ICT4D policy at the macro-levels of international and national bodies can also be influenced. Extension on the role energy innovation will play within the ICTD4 2.0 will be provided based on practices from the mHealth cases. This issue only received a fleeting mention by Heeks.

2. mHealth Innovations are Contesting Mobile Phones and SMS

mHealth [2] involves using mobile/wireless technologies such as Bluetooth, GSM/GPRS/3G, WiFi, WiMAX and so on to transmit and exchange various eHealth data, contents and services. Usually these are accessed by health workers through devices such as mobile phones, Smartphones, Personal Digital Assistants (PDAs), Laptops and Tablet PCs, and even PCs. mHealth practices from Africa and other developing regions have demonstrated that these technologies are sustainable within the low-resource condition in these environments. Innovative deployment of these technologies has helped in improving health services to populations and delivered better health patient outcomes. Of specific concern here is how these technologies have enabled access to the web and data through the Internet and beyond ordinary SMS technology. Innovative energy sources are also being employed for powering these devices in some of these mHealth initiatives.

Empirical observations from these mHealth practices are in agreement with Heeks' three innovations proposed to define the trajectory of the ICT4D 2.0 paradigm. It is therefore my proposition here that sustainable Internet access for end-users in Africa within the paradigm of ICT4D 2.0 will involve learning from how these three innovations are being adopted. However, practice from these mHealth cases is also contesting Heeks's argument that older technologies such as mobile phones and SMS should be the platform for Internet access in DCs in the nearest future (ibid., p. 80). Rather, wireless telecommunications enabling Internet access via *powerful* portable or mobile devices as in these mHealth cases indicate that ICT4D 2.0 will be different from that of Heeks' opinion. Also, these should be seen as platforms for bridging the digital divide in Africa. Arguments in favour of this view will be pursued later on in this article. Aside from this contention, this article will also provide an extension to Heeks' argument for sustainable power generation. These mHealth cases provide proven examples of how to adopt renewable and local energy sources for powering these devices and networks.

Heeks furthermore claims (ibid., p 79) that the boundary separating the paradigmatic transition from the ICT4D 1.0 to that of 2.0 is blurred, with no definition of what 2.0 is all about. I also challenge this view. Recent global 2008 e-readiness reports [3, 4] focus on reviewing and benchmarking digital divide reduction trends also collaborate these mHealth technological innovations.

3. Telecommunication Innovations

Most 2008 global e-readiness reports highlight the influence of the rising adoption and diffusion of *wireless internet* as drivers for bridging the digital divide [3, 4]. Its influence was noted to be more profound in DCs, partly because of absent legacy fixed telecommunication infrastructures. Moreover, the reality is that digital divide reduction – which is measured by e-readiness benchmarking – is now about broadband connectivity and data exchange. This emerging trend towards broadband connectivity contrasts with Heeks' view of using SMS within the ICT4D 2.0 paradigm, but is in support of some mHealth cases in adopting wireless Internet.

A 2008 report from the Organization for Economic Cooperation and Development (OECD) on the future of internet economy [5] is also in congruence with this observation. Here, the convergence of broadband wireless/mobile and fibre-optics technologies, the next generation networks is regarded as the bedrock of future internet telecommunication infrastructure. Technology convergence, as of this OECD view, is also in agreement with

Heeks' prediction on how ICT4D 2.0 will evolve. However, according to the OECD report, this innovation is already in use in many of the western countries surveyed in the report. This observation contrasts with Heeks' opinion that western inspired technology imported to DCs was responsible for the failure of ICT4D 1.0. Practices from some mHealth cases support that the telecommunication convergence trend is already a thing of the present and not of the future.

Providing internet access through wireless telecommunication in Africa is argued here as not negotiable, as the recent explosion in GSM telecommunication suggests [24]. GSM network as employed in the mHealth case from Uganda [16] is the most widely used wireless technology in Africa. They are mostly used for voice communication, but data exchange and internet access is now being enabled through GPRS and EDGE in some of these countries. The broadband capability of these two wireless technologies has made this possible. Broadband telecommunication technologies such as WiFi and WiMAX have been used for wireless Internet access in mHealth cases from rural Zambia [25], Malawi [23] and rural South Africa [8] respectively. Economic benefits to users, such as about 100% reduction in data transmission costs brought by increased bandwidth in the Ugandan mHealth case is one of the reason why these technologies should be employed within the ICT4D 2.0 paradigm [6]. Moving from ordinary GSM, capable only of delivery SMS to these broadband capable GPRS and EDGE made this cost-savings possible to the users in this same mHealth case from Uganda. 3G wireless telecommunications has also been piloted successfully in another mHealth case from South Africa [26]. Further, broadband technologies also provide other benefits that SMS cannot provide. For instance, in a m Health case from Bangladesh [7], broad bandwidth afforded by EDGE enabled remotely located doctors to conduct real-time videoconferencing teleconsultation with distant colleagues in medical emergencies. This example for need for data transmission even in DCs, is also in contention with Heeks' argument of sticking with SMS in the new phase of ICT4D 2.0. At least, if this is not perceived as feasible for users in Africa, this will be required for businesses and enterprises in this knowledge economy. For example, e-Business and e-Commerce applications for small and medium enterprises in Africa will surely benefit from this. Because, knowledge economy is not about SMS but about access to the Internet. Likewise, digital divide reduction is about providing access to sustainable Internet access in DCs [1].

Another contention with Heeks view on the ICT4D 2.0 is that fixed and satellite telecommunication still has a major role to play in complementing these rapidly adopted terrestrial wireless ones. This contention is that, if going by the practice from cases from Malawi [23] and Tanzania [27], fixed lines will also have some roles to play in narrowing digital divide gap in Africa.

It is evident that fixed lines are making a comeback as means for providing internet access, especially for providing upstream or "first mile" window to international internet backbone or traffic in these mHealth cases. Again, this contends with Heeks' outright dismissal of fixed line roles in the ICT4D 2.0 paradigm. Broadband wireless technologies such as WiFi and WiMAX are married with fixed ones for providing "last mile" wireless internet access to the end-users. Wireless-Optical fibre convergence is being employed in these mHealth cases as Fibre-WiFi convergence in Tanzania [27]. Fibre-WiMAX convergence is being employed for wireless internet access for rural health workers in South Africa [28]. WiFi-copper convergence is also in use in mHealth in Peru [22]. Aside from this observed double marriage of wireless and fixed telecommunications, triple convergence is also evident. For instance in an mHealth case from Zambia [25], microwave, the traditional terrestrial wireless alternative to fibre-optics first mile window in Africa, is combined with fibre and WiFi to deliver wireless internet to health workers.

In contrast with Heeks' view that these innovative wireless technologies will not be available for providing internet access to rural dwellers in DCs, these mHealth practices are proving the suitability of these technologies for rural use. WiFi in particular has proven has a

cost-effective medium for providing wireless Internet to rural health workers as most of these mHealth cases concerned health workers in rural communities.

However, in agreement with Heeks' view, a marked distinction is evident between technologies for western and developing ones. For instance, WiFi are generally used for both long distance (outdoor) and short distance (indoor) connectivity in most of these mHealth cases. But a distinction is that, WiFi are usually used for indoor communications in western countries, which is in contrast to its predominant use for long-distance outdoor communication in DCs, as in these mHealth cases.

Satellite wireless technology, the usual window to international bandwidth and upstream internet access in many African countries is also converging with terrestrial wireless networks as in this rural South Africa mHealth case [8]. However, the exorbitant and prohibitive costs of satellite subscription have prompted a rethink, because it threatened the project's sustainability. Currently, attempt is at considering 3G/HSPDA as complementary or substitutive.

With a slight disagreement with but also in partial agreement to Heeks, terrestrial wireless technologies should either be seen as substitutive or complementary use to SMS and voice for DCs' end-users in this ICT4D 2.0 paradigm. This use will as such be influenced by the factor of geography and occupational status. Wireless Internet should be substitutive to SMS and voice for rural dwellers where infrastructure for supporting it is neither available nor economically viable. But for knowledge workers, such as health workers or educators, either in urban or rural areas who require access professional or educational contents, wireless Internet should be complementary.

Ensuring sustainable ICT4D 2.0 paradigm will require other innovative models beyond those identified by Heeks in his article.

Fair and concessionary wireless spectrum regulation and management will also have a say in how Internet access and efforts at bridging the digital divide are made pro-users in Africa. Special governmental consideration and legislation ensured that dedicated broadband wireless networks were built purposively for health services mHealth cases from Zambia [25] and South Africa [28]. Here, unlicensed wireless spectrum allocated by the regulator to these mHealth cases ensured that building a wide area network (WAN) was made possible. Therefore, this model can be considered for providing wireless Internet to rural users in Africa, where business case might not be seen as palatable by commercial operators. Therefore, access to future internet in Africa should be made possible through broadband wireless networks that are not encumbered by strict regulation, so as to ensure users uptake of mobile services.

Finally, recommendation made in an evaluation of an mHealth case from South Africa [28] suggests that convergence between and combination (2Cs) of telecommunication technologies might be the "killer apps" in this ICT4D 2.0 paradigm. Here, combining and converging of wireless, fixed and satellite technologies ensured that health data, even bandwidth intensive videoconferencing are made accessible to rural health workers. Again, this innovative model should be considered for bridging the digital divide in Africa. Access to health data by health workers in many of these mHealth cases are via devices that are internet-enabled and more powerful than mobile phones, that is, more powerful than the type of device backed by Heeks as relevant within the ICT4D 2.0 paradigm, as will be discussed in the following section.

4. Mobile Internet Access Devices

It is not an argument here that mobile phones will not be of relevance in the ICT4D 2.0 paradigm, but that practice from these mHealth cases challenges Heeks' stance that mobile Internet access devices (MIADs) will not be relevant in ICT4D 2.0 in the foreseeable future. MIADs are taken to include Internet-enabled mobile phones, PDAs, laptops and their hybrids.

Two 2008 global e-readiness reports [3, 4] observe the rising adoption, diffusion and gradual shift towards MIADs from traditional desktop or PC ones. MIADs are taunted future Internet access devices being pushed by the explosive parallel adoption of broadband wireless telecommunications. Although, prediction was based on adoption in western countries, emerging practice from these mHealth cases is also in support of this trend and portends that this might be sooner than expected in DCs.

Innovation in MIADs has also brought about device hybrids that combine the communication functionality of a mobile phone with the user-friendly interface of a laptop. These hybrids, miniaturized versions of laptops, are also described as ultra mobile portable laptop (UMPC), low-cost version of which was pioneered by One Laptop Per Child (OLPC) fame. Even Heeks agree that hardware innovation in this mode will have a role to play in the ICT4D 2.0 paradigm in DCs. Special mention was made by him of likely roles "Blackberry-like devices" and OLPC mutants will play in accessing Internet services in DCs. Use of MIADs and laptops by health workers in these mHealth cases is not far-fetched either mHealth cases from India Smartphone [9] and Uganda PDAs [16], South Africa [21] and Bangladesh Laptops [7] are examples. Rural health workers with minimum education and computer literacy were able to access web-based mHealth applications from their wirelessly Internet enabled PDAs. Thus, agreeing with Heeks that adult illiteracy will not be a barrier to eService adoption in the ICT4D 2.0 paradigm. Familiarity with and prior exposure to mobile phones was a reason alluded to this observed ease of adoption in the mHealth case from rural South Africa (ibid.). The health workers first contact with any form of a computing device was with mobile phones. This observation also agrees with Heeks suggestion of sticking with mobile phones as Internet access devices, at least for a foreseeable future. However, observation from the mHealth cases will suggest that functional limitations of mobile phones will hinder their usefulness for a class of users in DCs.

By not generalising users, but focus on different segments of users, a contention with Heeks' discourse, better understanding of "device–user" fit will be appropriate in the ICT4D 2.0 paradigm. User segmentation to recognise knowledge workers such as teachers or educators, health workers, students and business persons regardless of their geographic location is a point in case. Their need to access data beyond the capacity of SMS, which can only take 160 words, makes mobile phone a substitutive device for them. Smaller screen interface size and processing speed are also reasons for contending with Heeks' suggestions.

Supporting this argument, is an observation from an mHealth case, where lower cadre, minimally literate health workers equipped with basic mobile phones, made these complaints [20]. In another mHealth case from Uganda [6], demands for high performance devices were made by health workers, because their functional limitations. Their first generation PDAs, in use since 2003, were unable to meet their information processing and presentation needs at the point [10]. For example, these health workers required statistical analysis of data inputed into their devices for evidence-based decision-making at the point of care.

Moreover, small screen size was also reported as a barrier to optimal human-computer interface (HCI) engagement by health workers in another mHealth case from India [11].

A mobile phone can be used by knowledge workers for voice and SMS communications, but it cannot substitute for more appropriate devices like MIADs. Even, as such, voice over internet protocol (VoIP) over WiFi for voice communication could also make GSM voice one irrelevant in the ICT4D 2.0 paradigm as demonstrated in another mHealth case [8]. Here health workers were able to communicate with their colleagues in a cost-effective manner by circumventing the commercial GSM network.

The combination of these different limitations has influenced the proposition here, that access to the Internet for knowledge workers in Africa and other DCs should be through MIADs, especially low-cost UMPCs as being championed by OLPC. Heeks' expression of OLPC-like UMPCs/Laptops as prototype MIADs in the far future of ICT4D 2.0, also stands in contention with practice from these mHealth cases and with global trends. Laptops are used

in most of these mHealth cases, more visibly in with rural HWs in South Africa [21] and Peru [22]. So for knowledge workers in Africa, OLPC-like laptops should be the MIADs substitution to mobile phones in the ICT4D 2.O paradigm now. Now, because knowledge workers require these devices for accessing information to innovate to solve local problems and also to participate in the global knowledge economy in which they are lagging behind now. For instance, health workers in DCs need access to vast global knowledge base for tackling MDGs-related disease burdens. Also, data and information gathering such as epidemiological ones for decision-making are beyond the capacity that mobile phones can provide. Therefore, low-cost OLPC-like UMPCs for knowledge workers should be very high on the agenda of the ICT4D 2. 0 paradigm and not just mobile phones.

Case for OLPC-like MIADs is further reinforced by practical lessons from two mHealth cases [21, 22]. One of which brings into agreement with Heeks' conclusion on the reason for failure in the ICT4D 1.0 paradigm: technology inspired by western worldview was this reason. Empirical observation from this mHealth case from South Africa [12] buttress this conclusion. Here, laptops developed for western markets were reportedly prone to frequent breakdowns, without any local technical expertise to tackle these. The harsh climatic conditions such as dusts in the air and high temperatures are probably the cause of these frequent hitches. The laptops were made for western markets, where the environmental conditions are more favourable. However, innovative concept brought about by OLPC birth should be adopted to overcome these hindrances. Product innovations in intuitive user interface, wirelessly enabled-Internet capability, low-power consumption, intuitive software, hardware ruggedization et cetera, should dictate MIADs design for users in DCs. Ease of maintenance concept currently being pushed by OLPC could help in transferring technical expertise to DC users.

Device preferences from knowledge workers' perspective should also dictate the move in the ICT4D 2.0 paradigm in DCs. For example, in this same mHealth case [21], rural health workers initially equipped with a PC-based patient management application could not use it effectively because frequent power shortage hindered effective adoption. To overcome this, the application was then ported to a laptop. Eventually, this ported and adapted to a MIAD because of an organizational barrier. Adoption by the health workers soared and feedback from them revealed that portability feature of the device endeared them to it. *Device isomerism* from PC to laptop and finally to what Heeks described as Blackberry-for-development like device, further reinforces this argument for OLPC-like UMPCs for DCs' knowledge workers.

This is not to preclude any role for PCs within the ICT4D 2.0 paradigm, as they are still useful as in mHealth cases in Peru [22], where they became complementary options to failed laptops. Again this view stands in contention to Heeks' opinion on internet access devices. PC will still be relevant, but for it to be so, hardware innovation as suggested by Heeks will be required as in an mHealth case from Malawi [23] where touch-screen interface was locally built into a PC so that busy health workers can enter and recall information in a jiffy. This customized innovation also contributed these local health workers' sustainable adoption of the devices. In the aforementioned mHealth case from Uganda, portable wireless servers manufactured by a local SME was adopted as replacements for legacy, imported, more expensive, poorly performing and difficult to maintain earlier ones. This innovative effort has also resulted in creating an industrial and economic base for the manufacturing of cost-effective and functional devices, which have been employed for replicating the project elsewhere in Africa.

Increasing global trend in UMPCs adoption, inspired by OLPC commercial mutants should "commodify" them like mobile phones. This trend together with the entry of open-source driven innovation like the VIA OpenBook[1] one joining the fray, should ensure that are eventually affordable to DCs' consumers. Commercial mutations from established laptop

[1] http://www.viaopenbook.com/

original equipment manufacturers (OEMs) such as Dell, Asus, HP et cetera are already making these low-cost UMPCs more affordable, powerful and user-friendly for those in western countries. It is an irony that devices inspired by pro-poor design is now benefiting those it was not initially intended for. Failure of IS researchers to come up with innovate ideas, as suggested by Heeks, might be a reason for this lack of benefits to DCs' users. Perhaps a way to overcome this, as also suggested by Heeks ([1], p. 81), is to stimulate and encourage social enterprises partnerships between these global OEMs and local SMEs in DCs.

Finally, open-source inspired hardware and software innovations, failed to get a mention in Heeks' vision for ICT4D 2.0. Observation from most of these mHealth cases explored here suggest otherwise. Locally developed open source software was observed to have stimulated innovation in locally relevant contents. Contents that meet the needs of DCs' users were suggested by Heeks (ibid., p. 80) as important for ensuring success within the ICT4D 2.0 paradigm. Open source software low cost of development, easy access to source-codes for customization and ease of adaptation to local needs brought successes to these mHealth cases. As such, ensuring sustainable internet access in Africa could also depend on how software are available to local innovators in order to create appropriate contents and services for users. So also, any sustainable device uptake could also depend on this. Sustainable energy for powering these devices and telecommunication network to be deployed is also important for consideration, and this issue will be addressed in the next section.

5. Energy Innovations

Extending Heeks's thoughts on the importance of electric powering of the ICT devices as well as the communication infrastructure, I will here make a short note on determining how devices and telecommunication networks are powered in DCs.

Powering ICT hardware in an African environment or generally in DC environments where regular and reliable electricity is an exception could be a daunting task. Product and process innovations in making hardware energy efficient and less power hungry are global industrial trends [15]. This, together with the need for low-cost energy solutions, is in agreement with Heeks' view. Innovating hardware to be able to function with detachable batteries, either rechargeable or otherwise, are low-cost solutions for health workers in the mHealth case from Uganda [16]. For powering their PDAs this was and still is a technological masterstroke. Here, these batteries were found to be a lower cost alternative compared to PDAs with inbuilt power cells, because regular power supply is required for powering the latter. Furhter, locally sourced solar panels are also being used for recharging these batteries and other telecommunication hardware.

Moreover, WiFi routers and antennas are also being powered in an mHealth case from Peru [17]. Even bigger telecommunication hardware is already being powered by solar energy. An Indian, company-led low-cost innovation has come up with solar-powered GSM base stations for rural and village projects [18]. Implementations are already underway in Africa and India.

Other renewable energy sources like micro-wind turbines are also being deployed for power generation in an mHealth case in Tanzania [19]. Going by these examples, energy innovations for powering ICT4D 2.0 paradigm will require moving from pilots or patchy usage as in these cases for achieving scalability and impacts. Global and industrial trend in "green product" revolution should also be captured in making this sustainable. Global carbon market and trade in particular could be exploited in this regard.

Knowing that the energy-related innovations of these mHealth cases are borne out of necessity rather than a deliberate means of carbon footprints reduction, creating carbon markets around this kind of initiatives, through linkages with global carbon trade, could provide the required financial resources for ensuring scalability.

Naturally, any extension of eHealth solutions to other e-areas has to consider that for the eHealth cases there are often also other reasons to produce electricity than to drive the MIADs. For instance, health centres may use solar-powered fridges for vaccine preservation.

6. The Way Forward for the ICT4D 2.0 paradigm

Means of sustaining internet access for users in Africa have been discussed in this article based on the analysis of mHealth cases from DCs. Attempts to bridge north-south digital divide is still dominating policy makers' attention in Africa, but these mHealth cases have provided some insights into how internet access can be sustainable. These mHealth cases have shown that wireless/mobile ICTs, mobile/nomadic devices, and fibre-optics-wireless convergence are technologies to be employed for broadband internet access now and in the nearest future in Africa.

As we are transiting from the ICT4D 1.0 phase to that of 2.0, as envisaged by Heeks [1], demonstrating impacts of ICT4D initiatives and ensuring their sustainability will depend on how evaluation of micro-level practices are used for informing macro-level policy making.

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Mobility, Modernity, Development

John TRAXLER
Learning Lab, University of Wolverhampton, Telford, TF2 9NT, UK
Tel: +44 1902 518591, Email:john.traxler@wlv.ac.uk

Abstract: The idea of *development* has been crucial in focussing attention and targeting resources on excluded and marginal individuals and communities around the world. This paper argues however that this is a dangerously simplistic notion and has been born out of a modernist world-view imposed on societies now characterised by increasing mobility and postmodernity. Near-universal access to and ownership of a multitude of personal connected mobile devices, systems and technologies are gradually but unmistakably transforming our societies, transforming our ideas about identity, discourse, community, technology, knowledge, space and time. The paper introduces some of the ideas and issues.

1. Introduction

This paper grows out of the author's over-riding concern with mobility. It also grows out of his involvement in development projects using mobile devices in Sub Saharan Africa (Traxler, 2007) and in the definition and development of mobile learning globally since its inception (Kukulska-Hulme & Traxler, 2005; Traxler, 2008a), specifically in the mobile learning research communities of South Africa, North America and Western Europe (Kukulska-Hulme &Traxler, 2007).

These mobile learning research communities have had notable successes in establishing that mobile devices can take learning to people, communities and countries previously remote, geographically, socially or economically, from the usual agencies, organisations and institutions of learning. It has also established that learning itself can be enriched, enhanced and extended by the development of systems that deliver contextual, authentic, situated and personalised learning (see for example Lonsdale *et al* 2004).

The author has however been concerned that these research communities, composed of educationalists and technologists, have been pre-occupied with their own discourses and failed to recognise adequately the significance of the enormous social changes that have accompanied the increasingly pervasive and ubiquitous mobile devices, technologies and systems in their societies. He has argued that much of the thinking in these communities, for example around methodology, has been rooted in modernism and that this accounts for some of the shortcomings, for example in developing appropriate and credible evaluation (Traxler, 2008b).

He has since also argued that the rhetoric of e-learning, specifically the concept of the *digital divide*, is a modernist concept and thus increasingly unhelpful where the impact of mobile devices, systems and technologies is accompanied by a transformation of many societies to a potentially and at least partially postmodern state (Traxler, 2008c). This current paper tentatively extends this line of argument and asks similarly whether *development* is also a modernist concept and thus increasingly inappropriate as mobile devices, systems and technologies become ubiquitous and universal. It may now be inappropriate in the North once characterised as *modern*; it may be inappropriate in the South only ever characterised as partially *modern*.

2. Is Development Modern?

Development is not a straightforward concept. It contains a complex mix of teleology, objectivity and causality and these themes hint at an essentially modernist perspective (Butler, 2002). At a recent e-learning conference in Africa, there was much talk of 'unexpected consequences', of 'objectively verifiable indicators', of 'leap-frogging', of 'multi-causality' and much else that revealed a modernist mindset.

Development has been characterised by a succession of dichotomies, initially underdeveloped / developed then developing/developed, followed by non-industrialised / industrialised, traditional / modern, poor / rich and most recently South / North (see Sundén &Wicander, 2006 for a lengthier explanation). Hoping to understand the world in this way is another modernist trait.

Some of the literature treats development as an artefact of the relationships between society and technology. This might be manifest in the 'diffusion of innovations' (Rogers, 2003) literature in which lack of development is merely the outcome of some innovation not having yet 'trickled down'; other approaches see lack of development as a purely technical problem, perhaps the outcome of defects in the supply chain, needing a merely technical (or management) fix. This tendency to analyse from a technical perspective, to take the approach that things are improving and that knowledge, science and technology will be instrumental in progress is also modernist.

It has philosophical foundations that include logical positivism, empiricism and rationality. These are held together by overarching beliefs that enquiry will reveal the essence of the natural, physical and social worlds and this essence can be described objectively by sets of symbols, ideally mathematics but perhaps by language. As Mitchell points out:

> Modern technological innovations, such as the steam engine, the railroad, electricity, and medicine, fostered in Western secular thought a strong sense of optimism. "Much of the extravagant hope generated by the Enlightenment project derived from a trust in the virtually limitless expansion of new knowledge of – and thus enhanced power over – nature" (Marx, 1994, p. 239). Driving this sense of confidence in technology were the mounting breakthroughs in knowledge and discoveries. "The expected result was to be a steady, continuous, cumulative improvement in all conditions of life".
>
> As modern perspectives gave way to postmodern perspectives, optimism for technology faded as well.
>
> Late in the twentieth century, attitudes toward technology had changed considerably.
>
> Mitchell (2003:240)

Modernism is being described here as giving way, in the North at least, to postmodernism. This is not an easy concept to define competently, not least because its many manifestations may only be linked as reactions to modernism, and to a range of cultural and intellectual movements growing out of a century of global warfare and the perceived inadequacy of the dominant *isms* of the preceding two centuries. Butler (2002) gives some insight into the problem of definition, saying of postmodernists, "They have a distinct way of seeing the world as a whole, and use a set of philosophical ideas that not only support an aesthetic but also analyse a 'late capitalist' cultural condition of 'postmodernity'. This condition is supposed to affect us all at a more fundamental level, through the influence of that huge growth in media communications by electronic means ... And yet, ... most information is to be mistrusted, as being more of a contribution to the manipulative image-making of those in power than to the advancement of knowledge. The postmodernist attitude is therefore one of suspicion ....." (2002:3) and later, "one central theme is ... 'realism lost' " (2002:110). The suspicion and the loss are about a faith that words, words such as *development*, really do describe (rather than construct) reality.

3. Mobility and Modernity

This paper takes up these themes by asserting that mobility, the social changes associated with personal mobile devices becoming ubiquitous, pervasive and universal, accompanies changes taking societies from possible and partial modernity to postmodernity where the language of *development* is too naïve, too simple. The second part of this paper argues that this universal access to and ownership of mobile devices, systems and technologies are progressively but unmistakably transforming our societies. They are transforming our ideas about identity, discourse, community, technology, knowledge, space and time, in ways that suggest a transition to postmodernity, where conceptualising progress, exclusion and disadvantage around binary divisions and linear purposive trajectories is no longer adequate or helpful.

The ownership of mobile devices is nearly universal in many of the world's societies. In the North, we see the relentless marketing and take-up of each new gadget, network, system and connectivity. We hear statistics of music CDs dying out in the face of mp3 downloads; of cameras outnumbered by camera-phones, of nations where mobile phone ownership exceeds saturation and carries on growing and of nations sending a billion SMS texts in any normal week. The ITU says, "the greatest impact of mobile communications on access to communication services - in other words, increasing the number of people who are in reach of a telephone connection of any kind - can be seen in developing countries" (200: 4). This means that mobile devices will not merely replicate or reproduce existing inequalities, for example, geographical or social inequalities; they will transform the South too but in equally complex but different ways. Much of the literature of mobilities comes of course from the North and explores the minutiae of social interactions within small homogeneous group. Some authors however take a more global and inclusive perspective (Donner, 2008; Plant, 2000).

Further analysis suggests that these technologies have led in under a decade to new forms of commerce, employment, crime, artistic expression, political organisation and to new artefacts, commodities, resources and economic assets that did not previously exist, forms with no recognisable antecedents before perhaps the 1990s. It is possible to catalogue examples of each of these categories but our point here is that mobile devices characterise societies now in motion (not just literally).

These societies are changing profoundly; they are in fact becoming partially but recognisably postmodern societies. Evidence of this emergent postmodernity includes the following observations.

Mobile devices and technologies are eroding established notions of time as a common structure. These seem to be largely European notions. Kathryn Banks (2006) for example says, "... second half of the sixteenth century in Geneva, there arose a new Protestant apprehension of time, which was encapsulated in the valorization of punctuality" whilst time zones grew out of the need to timetable the Victorian British railway system. Now in their place, we see the 'approx-meeting' and the 'multi-meeting' (Plant, 2000), 'socially negotiated time' (Sørensen *et al*, 2002) and the 'microcoordination of everyday life' alongside the 'softening of schedules' (Ling, 2004) afforded by mobile devices.

These devices are also eroding physical place as a predominant attribute of space. It is being diluted by "absent presence" (Gergen, 2002), the phenomenon of physically co-located groups all connected online elsewhere and "simultaneity of place" (Plant, 2002) created by mobile phones, a physical space and a virtual space of conversational interaction, and an extension of physical space, through the creation and juxtaposition of a mobile "social space".

They are reconfiguring the relationships between spaces, public ones and private ones, and the ways in which these are penetrated by mobile virtual spaces. This is documented in the literature of mobilities (for example Katz & Aakhus, 2002; Ling, 2004; and Brown *et al*., 2004). This is accompanied by what goes on in those spaces. Cooper (2002) says that the private "is no longer conceivable as what goes on, discreetly, in the life of the individual

away from the public domain, or as subsequently represented in individual consciousness", Sheller and Urry (2003) argue "that massive changes are occurring in the nature of both public and private life and especially of the relations between them." and Bull (2005) says "The use of these mobile sound technologies informs us about how users attempt to 'inhabit' the spaces within which they move. The use of these technologies appears to bind the disparate threads of much urban movement together, both 'filling' the spaces 'in-between' communication or meetings and structuring the spaces thus occupied." Earlier work came to similar conclusions, "the Walkman disturbed the boundaries between the public and private worlds" (Du Gay *et al*., 1997: 115).

This is accompanied by a growing dislocation of time and place, in which "everything arrives without any need to depart" (Virilio, 2000:20). "Closer to what is far away than to what is just beside us, we are becoming progressively detached from ourselves" (Virilio, 2000:83). Owing to "the tendency to previsit locations, through one medium or another; to actually arrive somewhere is no longer surprising in the way that it was ....it is becoming replaced by prevision. Thus according to this logic, the mobile would be one more technique by which the world became unsurprising." (Cooper, 2002:26)

These technologies are redefining discourse and conversation. Goffman (1971), for example, noted the phenomenon of 'civil inattention', where in certain situations it is customary not only to not speak to others but to avoid looking directly at others. This management of gaze is a way in which the boundary between public and private is negotiated and is now often a characteristic of creating a private space for mobile phone conversations in public settings. 'Enforced eavesdropping' is the corollary. A similar concept is the 'tie-sign', keeping a face-to-face encounter live and 'in play' whilst servicing an interruption caused by a mobile phone call. The recipient of the call is obliged to "play out collusive gestures of impatience, derogation, and exasperation" according to Goffman. Murtagh (2002) describes a wide set of non-verbal actions and interactions with the mobile phone in public, and these are part of a wider transformation of discourse and social interaction as society engages with mobile technologies. 'Missed calls' (Donner, 2007) are a global phenomenon.

Mobile devices are creating communities and groupings, sometimes transient and virtual ones, arguably at the expense of existing and traditional ones (captured in Howard Rheingold's (2003) defining book). With these groupings come new norms, expectations, ethics and etiquettes (see Ling (1997, 2004) for one discussion of ethics in a mobile context) and shifting ideas about the self and identity. Geser (2004:11) points out that, "the cell phone helps to stay permanently within the closed social field of familiar others: thus reinforcing a unified, coherent individual identity."

Mobile devices, as the media and containers of knowledge and information, are creating new and highly individualised ontologies, 'just-in-time/just-for-me' – consumer choice turned into a 'neo-liberal nightmare', and fragmented users in a 'fragmented society' (to use Bauman's (2001) phrase in an accurate but narrower sense than he intended).

In areas of the North with better connectivity, mobile technologies are converging with social software, accelerating the growth of user-generated content and decentralising and fracturing the production, storage, consumption and control of ideas and information. The growth of citizen-journalism (Owen, 2005) is one global example, the recent migration of Wikipedia, Google and YouTube into mobile devices being others. Mobile technologies facilitate the generation of new knowledge, intruding a new dimension into the debate and dichotomy between utilitarian and liberal views of education, fragmenting or challenging the modernist notion of education as a grand narrative. Postmodernism's 'incredulity at meta [grand] narratives' (Lyotard, 1999) is important here in challenging this idea of a widely, if not universally, accepted canon that is education.

Mobile technologies deliver knowledge and information in ways that challenge formal learning, its institutions and its professionals, specifically in their hegemonic roles as gate-keepers to disadvantaged individuals and communities to learning and technology

Mobile technologies provide increased levels of surveillance and oversight, even in the course of delivering and supporting communication and connectivity. Many of the authors above cite Lyons (2001) and Foucauld (1977) in this respect, giving substance to the postmodern suspicion and mistrust.

These are examples of a widespread and far-reaching change taking place slowly but not imperceptibly across our societies. They undermine the old certainties of knowledge, thought and language that have underpinned the ideas and practices of *development* emanating from the North.

4. What Next?

The idea of development has constructed a world understood in terms of polarities and of opposites, of purpose, causality and teleology whilst mobile devices are associated with societies each adapting and adopting their own languages and discourse, rather more fragmented and rather more complex. We feel that these ideas deserve greater exploration in the context of development.

Sadly, however, these are probably the observations of a confused modernist, perhaps a troubled critical realist at best, trying in part to make sense of the experiences of working away from the structured confines of metropolitan Western Europe. They suffer from 'essentialising', that is tendency to behave as though there is some meaningful durable entity behind the terms being used, specifically 'mobile devices, systems and technologies'. They sadly suffer too from privileging a particular viewpoint, namely development conceptualised as a North/South issue, rather than for example as a young/old or urban/rural issue and from the engineering, problem-solving analysis. They also suffer from the author's residual faith and optimism in society, knowledge, technology and learning.

No doubt, there are other defects but we can still however ask whether the observations have any consequences for researchers and practitioners. There is clearly a need for a greater critical and self-critical awareness of the attitudes, expectations and world-views that underpin the concept of development and for an exploration of how these map onto societies in both the North and in the South. If an argument that links mobility and postmodernity is at least partially credible then the response must be more that revisions to techniques and methods, rather an exploration of the research practices growing out of postmodernism – see Denzin and Lincoln (2005) for one of the most authoritative accounts of these themes alongside their existing practices.

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"Upwardly Mobile": the Potential to Deliver Social Protection by Cellphone – Lessons from Lesotho

Katharine VINCENT, Nicholas FREELAND
Regional Hunger and Vulnerability Programme, 3rd floor North Park, 20 Girton Road, Parktown, Johannesburg, 2193, South Africa
Tel: +27 72 196 4525, Email: katharine@rhvp.org/nicholas@rhvp.org

Abstract: Social protection has risen on the development agenda as a way of providing sustainable poverty relief, using mechanisms such as cash transfers. However, recognition of the difficulties involved in delivering cash to remote, rural locations has led to the development of alternative delivery systems using technology such as cellphones. This paper summarizes the concepts and debates behind cash transfers as a form of social protection. It then outlines a pilot project in Lesotho where cellphones were provided to women's farming groups, and explains some of the advantages and disadvantages highlighted in the evaluation. It concludes that there is great potential for the use of mobile technology to deliver social protection, but that active partnerships between governments and private sector partners will be required.

1. Introduction

Social protection programmes are increasingly being developed to reduce poverty throughout Africa. A key component of such programmes is cash transfers to recipients, such as old age pensions, child support grants, and disability payments. Whilst there is growing evidence supporting the use of cash, ensuring effective delivery to recipients in often remote and inaccessible areas can be problematic. Cash transfers have typically been delivered through government departments and NGOs, often in conjunction with payment outlets such as post offices. But delivery systems are prone to problems, such as cash-in-transit heists and corruption. Identifying more effective delivery mechanisms is thus imperative to reduce leakages and improve the effectiveness of both cash and other forms of transfers within social protection programmes.

The Regional Hunger and Vulnerability Programme (RHVP[1]) is building evidence on innovative approaches to develop better, more dynamic ways of tackling both acute hunger and chronic vulnerability. This paper reports the findings of a pilot project where cellphones were distributed to women's farming groups in three communities in rural Lesotho: Maliele (St Michaels), Nyakasoba and Semonkong. These findings have informed studies that RHVP has subsequently undertaken on innovative delivery systems for social pensions in Malawi,

[1] RHVP is a regional programme for southern Africa funded by the British Department for International Development and AusAID (the Australian Government's overseas aid program) that seeks to address the problem of chronic vulnerability in the region by promoting a shift from reactive emergency food aid to longer term institutionalised social protection using innovative approaches. In the first phase of the programme (2005-08) RHVP focused on the six countries most acutely affected by the 2002-03 food crisis, namely Lesotho, Malawi, Mozambique, Swaziland, Zambia and Zimbabwe. In the second phase of the programme (2008-10) the geographical focus has been expanded to cover all fourteen Southern African Development Community member countries.

for the old-age grant in Swaziland and for the PSA (food subsidy cash transfer) programme in Mozambique.

2. Social protection: the emergence of the paradigm

Social protection has rapidly emerged as a dominant policy agenda in support of efforts to achieve sustainable poverty reduction in Africa, Asia and Latin America. Social protection is predicated upon the notion that poor people can be active agents in making the choices necessary to improve their wellbeing when given the chance. This marks a paradigm shift within development discourses.

The traditional development discourse is based on the idea that the poor are the problem. Under neo-liberal ideologies and the Washington Consensus, it was believed that development would be brought about by economic growth at a macro-level, which would in turn trickle down to the poor at the grassroots, thereby reducing poverty. Macro-level economic growth was promoted by the lending policies of multilateral institutions such as the World Bank and International Monetary Fund, with donors providing emergency assistance to the poor in the case of crisis. However, after many years the persistently high statistics of chronic poverty in Africa show that the model is not working, and thus prompted a re-think towards pro-poor development.

Pro-poor development recognises that macro-level economic growth does not necessarily filter down to the poorest at the grassroots, and instead advocates initiatives that are specifically targeted at this level. Fundamentally this represents a shift in paradigm: from viewing the poor as a problem to the solution. Under this paradigm it is recognised that if comprehensive social protection is provided to the poor it will help to generate economic growth at the grassroots level, in turn reducing poverty (and in turn the cost of providing the social protection). In addition, by attempting to address the causes of chronic vulnerability, social protection reduces the occurrence of crisis situations where reactive emergency aid is required from donors.

Social protection can be defined as all initiatives that provide income or consumption transfers to the poor, protect the vulnerable against livelihood risks, and enhance the social status and rights of socially excluded and marginalised people (Devereux and Sabates-Wheeler, 2007). This broad definition allows for the fact that different categories of people require different forms of social protection. Among those requiring social protection are the chronically poor, including rural landless and orphans; those who are economically at risk, such as people living with HIV and AIDS, internally displaced persons and refugees; and the socially vulnerable, including ethnic minorities, people living with disabilities, and child-headed households. But to protect their livelihoods each of these groups needs different forms of social protection: social transfers (e.g. disability or child grants), social services (home-based care, education, healthcare), and social transformation (broader policy and legislation changes to ensure rights to vulnerable groups). The more typical notion of social insurance, including contributory pensions and maternity leave, are also encompassed within the notion of social protection, although clearly only available to those able to pay.

Arguably the area of social protection that is most immediately relevant to pro-poor development is social transfers. Social transfers are non-contributory, predictable and on-budget transfers to recipients. They can take various forms: cash, vouchers, food, agricultural inputs, medicines, and school fee or health care waivers. There are already a number of social transfer programmes in operation in southern Africa: for example Swaziland and Lesotho have non-contributory social pension schemes that provide cash transfers to elderly citizens; Malawi has an input subsidy programme that provides subsidised fertiliser and seed to vulnerable but viable farmers; and Zimbabwe has a Basic Education Assistance Module that provides school fee waivers[2]. Many countries also provide antiretrovirals (ARVs) to

[2] For more information on these and a range of other social transfer programmes operating in southern Africa see http://www.wahenga.net/index.php/evidence/case_study_briefs/

people living with HIV and AIDS. Particular attention has been paid to the role of cash transfers in promoting pro-poor development.

3. Cash transfers as a form of social protection

Predictable transfers of cash to vulnerable groups are raising increasing interest amongst donors, NGOs and national governments in southern Africa, with a number of pilot projects and national programmes having been implemented (for more information see www.wahenga.net). Providing recipients with regular and predictable transfers of cash gives them the flexibility to plan their expenditure to meet immediate basic consumption needs as well as providing the opportunity for investment in productive activities. There is now a growing body of evidence to show that cash transfers are effective in ameliorating vulnerability and chronic poverty (Barrientos and DeJong, 2006; Farrington and Slater, 2006), and have wider positive impacts within recipient households and communities (Davies and Davey, 2007).

The impact of cash transfers begins with the recipient, and then expands to the household, wider community, and eventually the country, meaning that many more people can actually be said to be beneficiaries of cash transfers than just those people who receive them. It is possible to summarise these impacts at various levels.[3] At the micro-level, cash transfers promote self-esteem, status and empowerment amongst vulnerable people, enabling them to be active members of their households and communities, rather than burdens. A Lesotho pensioner describes "before we were treated as if we were dead. Now people respect me" (Save the Children UK/HelpAge International/IDS, 2005). Similarly, a male disability grant recipient in Langa, South Africa explains "this disability grant is very helpful because I can buy food and medicines if necessary. I also became a decent person – I now have insurance and accounts" (Surender et al, 2007).

At the level of the household, there is plentiful evidence to show that cash transfers improve food security and nutrition. Typically a large proportion of a cash transfer is spent on food: the evaluation of Malawi's Food And Cash Transfers (FACT) showed that 75.5% of the transfer was typically spent on groceries (Devereux et al, 2006). In Lesotho the number of old age pensioners reporting that they never went hungry increased from 19% before the pension to 48% after it was introduced (Croome and Nyanguru, 2007). As well as increasing the volume of food available, cash transfers lead to an increase in the variety of foods consumed within the household: in Zambia 12% more households consumed proteins every day and 35% consumed oil every day if they received a transfer, compared with those households that didn't (MCDSS/GTZ, 2007). But in addition to this, there is morphometric data to show that receipt of the child support grant in South Africa increases the height of children who receive it by 3.5cm if it is received in their first year and for two of the first three years, and the old age pension increases the height of girls in the household by over 2cm (Aguero et al, 2007). There are gendered differences in the sharing of pensions (Burns et al, 2005), with a greater proportion of women's pensions being spent on food (Case and Deaton, 1998), and women's pensions showing particular improvement in the height and weight of girls (Duflo, 2003).

But household benefits are not limited to food security and nutrition. There is also evidence to show that receiving a cash transfer improves access to healthcare and education. Whilst improved nutritional status assists improved health status of household members, cash transferred to households allows recipients to afford treatment. In Zambia, for example, incidence of illnesses reduced from 42.8% to 35%; and incidence of partial sightedness reduced from 7.2% to 3.3%, potentially due to the fact that beneficiary households could

[3] This section is based on the brief "The impact of cash transfers: theory and evidence from southern Africa" prepared by Katharine Vincent and John Rook for RHVP. The document is available online at http://www.wahenga.net/uploads/documents/focus/The_Impact_Cash_Transfers.pdf

afford minor eye surgery (MCDSS/GTZ, 2007). Cash transfers also play an important role in access to education, both by providing households with the means to pay school fees, but also to purchase peripheral requirements associated with attending school, such as uniforms, books and stationery. Education is accepted as a critical means of reducing inter-generational poverty and promoting development. In Namibia, interviews with a grade 12 class found that participation of 14 out of 16 learners was solely due to their grandparents receiving a pension (Devereux, 2001). Using data from the national household survey in 2000 in South Africa, models show that household receipt of an old age pension is associated with a 20% to 25% reduction in the school non-attendance gap, and receipt of a child support grant is associated with a 25% reduction in the non-attendance gap (Samson et al, 2004).

Receipt of cash transfers also provides small amounts of capital for investment in productive activities, giving recipients the opportunity to not only protect but also improve their economic well-being. In the Kalomo social cash transfer scheme in Zambia 29% of transferred income with invested, either in purchases of livestock, farming inputs, or informal enterprise (MCDSS/PWAS/GTZ, 2005). A recipient of the child support grant in Mdantsane, South Africa explains "I sell sweets and biscuits so that I don't run out of paraffin. I buy them from the child support grant money. I do this so that when the child support grant runs out, we are not in darkness" (Surender et al, 2007).

The net effect of these individual and household benefits is a decrease in poverty. At its most rudimentary this is measured in reductions in the poverty headcount: in South Africa, for example, this would be 5% higher without the old age pension (40% compared with 35%) (Case and Deaton, 1998). Similarly in Mozambique the GAPVU cash transfer programme was estimated to have contributed to a reduction in headcount poverty by 6%, and reductions in the poverty gap and poverty severity by 27% and 44% respectively (Datt et al, 1997). All of this evidence suggests that cash transfers have a positive role to play in development.

4. Delivering cash transfers: what role for mobiles?

Despite the positive evidence for the impact of cash transfers, there are difficulties with delivering this mechanism of social protection. Vulnerable people are often disproportionately concentrated in remote and inaccessible areas, and getting cash to the recipients can be challenging, especially in poor countries with weak administrative capacities and severe deficits in rural infrastructure. Cash transfers have traditionally been delivered through a pull mechanism, where recipients are "pulled" to a set location – typically a government office or payment outlet such as a post office – at a set time to collect their transfer. But the liquidity of cash compared with other transfers, such as agricultural inputs or food, means that the resource can easily be used by anyone, and thus there is high risk of loss throughout the process of delivery, adding to costs. Staff costs, either from employing new personnel or the opportunity costs of diverting existing staff from their routine tasks, are high, and there are further 'leakages' and risks through 'cash in transit' heists and corruption (see, for example, Vincent and Freeland, 2008). This can result in delivery costs representing a disproportionately high percentage of programme budgets. Identifying more effective delivery mechanisms is thus an important policy need.

Information and communication technologies offer new opportunities for delivering social protection (Devereux and Vincent, submitted). A variety of such innovative delivery mechanisms have been proposed and piloted to increase the effectiveness of cash transfer programmes in southern Africa. The costs and benefits depend upon specific local conditions such as rural infrastructure, population density (or conversely, the dispersion of recipients), the technological capabilities of recipients, and installation and operating costs. These technologies are aimed at reducing the risk to implementing agencies when transporting and distributing transfers, ensuring efficient distribution to recipients, and reducing the management load on donors and implementers. Relevant technologies include smart cards, mobile ATMs, GPS devices and biometrics.

Cellphones also offer a useful mechanism for delivering social protection. A number of highly publicised schemes have recently begun which use cellphones to transfer cash from user to user. The M-PESA scheme in Kenya, for example, run by Vodafone (in conjunction with local operator Safaricom) registered 111,000 users within the first three months, and transferred nearly $6million, with an average transaction value of $45. Zain (formerly Celtel) is about to launch similar cash transfer services across the fourteen countries it covers in Africa. Cellphones have not yet been trialled as a delivery mechanism for social protection, but they clearly offer lots of potential and have been mooted as a more innovative mechanism than smartcards (Pearson and Kilfoil, 2007).

5. Pilot project in Lesotho

In 2006 ten cellphones were distributed amongst three women's farming groups in different agro-ecological zones in Lesotho: one went to a chicken farming group in Maliele (St Michael's) (the lowlands); four went to a pig farming group in Nyakosoba (in the foothills); and five went to a seed potato and vegetable farming group in Semonkong (the highlands). The cellphones were Siemens handsets and training was provided by the Maseru-based provider (Vodacom Lesotho). Recognising the lack of exposure to mobile telephony amongst the target users, joint monitoring committees were established, comprising a teacher in the community and a young student, together with the members of each farming group. As it is beyond the scope of RHVP to provide a regular cash transfer, each handset was pre-loaded with ZAR500 (approx $40) of airtime, and the intention was that the recipients would use ZAR100 of this for group communication, and then sell the remaining ZAR400 (as airtime or SMS) to other community members, such that the enterprise becomes self-sustaining. A follow-up evaluation was conducted in May 2007, nine months into the project, in order to look at the opportunities and challenges.

6. Results from the follow-up evaluation May 2007

6.1 Opportunities offered by cellphone delivery in Lesotho

The evaluation highlighted several opportunities offered by the provision of cellphones in Lesotho.

The most overwhelming advantage relates to how an increase in communication led to a drop in travel times experienced by the women in the farming groups. Lesotho is a mountainous country and outside of the capital, Maseru, transport infrastructure can be poor, meaning that disproportionately long times are often spent travelling short distances. In the highland location of Semonkong, for example, women would typically make a four hour round trip to the Bishop Allard Vocational School where impromptu meetings are held concerning the marketing of produce. After cellphones had been distributed, it was possible for the women to call ahead to the market and obtain pricing information, and then to communicate with each other, removing the need for physical travel.

A number of women also provided stories of how access to communications had eased their lives in other ways, for example in the case of a medical emergency it was possible to call a doctor and obtain advice rather than getting a sick patient to a clinic.

Some women in Semonkong had also started selling airtime, as had been intended at the start of the project.

6.2 Challenges posed by cellphone delivery in Lesotho

That said, there were also a number of challenges that arose in the use of cellphones amongst the women's farming groups. As vulnerable groups who are typically characterised by low incomes and high levels of poverty, previous ownership of cellphones amongst the recipients was typically low, and thus many of the women had poor technological capacity. Despite the

initial training provided by the service providers, many of the women initially had difficulty in using the technology. One older lady recounted how she had been shown how to use multiple functions, but then had to seek assistance from the teacher within the joint monitoring committee, who showed her again how to switch it on ("the green button") and off ("the red button").

The provision of a valuable commodity to vulnerable groups also raised concerns that it would inadvertently increase the vulnerability of the recipients. Although there had been no incidents of cellphone theft amongst the recipients, the women were all familiar with incidences of cellphone theft within their social circles, with one lady explaining how her daughter's phone had been stolen at a party attended only by family and friends. Electricity availability for battery charging was also problematic: not all rural areas in Lesotho are connected to mains electricity, and so sometimes women had to take their cellphones to innovative local entrepreneurs with solar-powered charging systems, for which they paid a nominal figure.

Perhaps the biggest failure of this project was the assumption that women would be able to sell airtime, making the venture self-sustaining. The cost of cellphone calls in Lesotho is prohibitively expensive at ZAR1.60-ZAR2.90 (US¢18-30) per minute (much higher than equivalent charges for calls from a land-line) and so there was little demand for purchasing calling availability. As a result, the women's farming groups were forced to finance the calls they used through alternative means.

7. Conclusion

This pilot project was very small scale and only reflects true social protection programmes in a very limited way: however it does offer valuable lessons on the provision of cellphones to vulnerable groups similar to those that are likely to be targeted by social protection programmes. The ancillary benefits of providing cellphones, in terms of improved communications, are clear, and link mobile telephony to wider development impacts. The challenges of using cellphones to deliver social protection, in terms of impeded technological capacity of recipients, and risk of increasing their vulnerability through theft remain.

RHVP has used the information generated by this small pilot in Lesotho to inform the studies on innovative delivery systems for social transfers that it has subsequently undertaken for Governments in southern Africa. Swaziland, for example, had a high profile political crisis concerning the delivery of its national non-contributory social pension, known as the Old Age Grant. Introduced in 2004, Swazi Post and Telecommunications initially took responsibility for disbursing payments through its post office branches, but suffered from administrative problems resulting in delayed payments. Parliamentarians took up the cause in government, and eventually the whole of cabinet was recessed until an effective solution was found, which ended up being government taking back responsibility for delivery through the Department of Social Welfare. As this was not a sustainable solution in the long term, given resource constraints, the government then put out a tender for a private sector partner to participate in delivery, and considered the use of innovative technologies such as cellphones. Similarly in Malawi interest in a potential social pension prompted a feasibility study to be undertaken, which included provision and costing of potential innovative delivery, including the use of cellphones; and in Mozambique the Ministry for Women and Social Action is currently looking to expand its *Programa de Subsidio de Alimentos* (Food Subsidy Programme, which is actually a cash transfer to vulnerable groups), and is also considering the use of cellphones for delivery, amongst other options.

In this pilot project the initial capital costs were covered by RHVP, whereas in a pilot or national social protection programme there would clearly need to be some provision to procure and distribute handsets to those programme recipients who are not already in possession of them. Clearly this could be a costly procedure: although retail prices of cellphones are now falling, and new and modern handsets are available in many southern African countries for less than $20 apiece. The potential savings through reduced costs

(administration and leakage) of each transfer would be likely to offset this, although to provide this evidence is a catch-22 situation: project implementers are unlikely to trial cellphones as a mechanism of delivery until there is such evidence, yet until trials take place there will be no such evidence.

There is also considerable scope for imaginative partnerships between Government and private sector: the readiness of Vodacom Lesotho to support this pilot testifies that there is untapped enthusiasm for mobile telephony service providers to be partners in delivering public services and transfers. Likewise the preliminary studies in Swaziland, Malawi and Mozambique have shown cellphone operators to be enthusiastic about the potential of partnership: they see the commercial advantages of increased markets and further increases in coverage – while at the same time appreciating the public relations benefits in terms of corporate social responsibility and progress towards universal service obligations.

Indeed, there might even be potential for the GSM operators to turn this situation to their advantage. In Africa, mobile handsets and airtime are often heavily taxed as a luxury, and national governments frequently impose extra demands on operators in terms of their corporate social responsibility and universal service obligations. How much better would it be for the operators to free themselves of this burden, by acting in enlightened self-interest, and taking the opportunity to establish public-private partnerships with governments to manage a national social fund (part of which could be funded direct through – reduced – taxation on mobile phone usage), and then to deliver social transfers through their own networks on behalf of governments. In fact, a similar idea could even be taken to international scale: in the same vein as earlier proposals for taxes on globalisation, such as the "Tobin" tax on cross-border currency trading, or the more recently-proposed Currency Transaction Tax (0.005% on every foreign currency transaction, which it is estimated could generate $30 billion a year for development), GSM operators in the North could impose a "social tax" on mobile telephony. With estimated annual revenues of over $900 billion, a 3% tax could match the CTT's $30 billion annually, which could be distributed as social transfers, again through the cellular networks, in the poorer countries of the South. On this basis, the term "GSM", which many people in Africa already assume to stand for "God Sends Mobiles", could eventually come to designate the operators' role as "Global Social Moderators"!

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Experiences on Mobile-ATM Deployment in a Developing Country

Amila KARUNANAYAKE[1], Kausn De ZOYSA[1], Sead MUFTIC[2], Feng ZHANG[2]
[1]*University of Colombo School of Computing, Colombo, Sri Lanka.*
a.karunanayake@gmail.com, kasun@ucsc.cmb.ac.lk
[2]*Departments of Computer and System Sciences,*
Royal Institute of Technology, Stockholm, Sweden.
sead@dsv.su.se, fengz@dsv.su.se

Abstract: Mobile-Commerce is the latest concept of enabling the financial transactions on mobile phones and hand-held devices. With the rapid development of the society, the M-Commerce applications play a vital role. Mobile-ATM is one such application, enabling the banking services on mobile phones. Even though users have a poor computer literacy, they will be able to use the Mobile-ATM system easily. This kind of application is very useful, especially in rural areas, where accessing financial and banking services is a critical issue due to the distance barriers. Hence this paper discusses the social, economical and technical impact of the Mobile-ATM system, which is developed by the authors. Moreover the paper points out the essential value added services provided by our system with respect to financial transactions services such as security and confidentiality. Although the Mobile-ATM is technically feasible and practically deployed, it is important to have community acceptance. This paper discusses the community acceptance of this system and related issues.

1. Introduction

As a result of industrial revolution and globalization, commercial transactions have rapidly increased. However people realized that exchanging a large amount of money is a risky task. As a solution they started using banking facilities for doing money transactions. At present banks provide attractive facilities for more effective money transactions. However, many problems related to bank transactions are still remaining. In developing countries these problems have become worse.

During last two decades researchers have applied information and communication technology concepts to solve banking problems. They introduced E-Commerce and M-Commerce concepts as an alternative to traditional methods. Examples of such solutions are ATM services and credit card/debit card services.

Implementing and using IT-based solutions in developing countries is a big challenge due to poor communication and IT infrastructure. Remarkably, in most of the developing countries like Sri Lanka, mobile telecommunication sector archived a rapid expansion [1] in recent years. Therefore the mobile communication infrastructure can be used as a good deployment platform for the electronic based banking and financial systems.

Mobile banking (M-banking) is one of the newest approaches to the provision of financial services through wireless network, which has been made possible by the widespread adoption of mobile phones even in developing countries. It involves the use of a mobile phone or another mobile device to perform various financial transactions either directly with the recipient (micro-payments) or indirectly, via a client's bank account. The functional capabilities of mobile telephony have been rapid, and have extended usage well beyond the

classical applications (telephone calls and short messaging). There is mounting evidence of positive financial, economic and social impact of those technologies all over the world.

Additionally mobile based solutions can achieve more coverage. On the other hand one of the most important concerns with such transactions is their security. The mobile networks are based on use of poorly secured wireless protocols [2]. Therefore these reasons make mobile financial applications even more vulnerable to fraud and illegal use than similar transactions performed over open networks. Therefore, one of the main prerequisites for successful, large scale and broad deployment of mobile financial services applications is their security.

There are number of commercial systems available for enabling the banking services on mobile devices. Most of these systems are focused on introducing new smart technology in to the banking services. Mobile-ATM [5] is one such system, which is successfully deployed in Sri Lanka. Instead of introducing smart technology to banking services, Mobile-ATM system thinks in a different way. It utilizes some valuable features of mobile networks to address the barriers of accessing banking services in rural areas.

This paper is organized as follows: the next section will discuss the M-Commerce concept and briefly raise security and social requirements. Thereafter the paper describes the Mobile-ATM system and related deployment issues. The latter part of the paper reports from our evaluation methods and results concerning both technical aspects and social.

2. M-Commerce

Currently researches on mobile technology are introducing new services to fulfill the growing demand of mobility. One of the attractive services developed in recent years is providing mobile-based banking and financial services. This type of applications/services includes buying over mobile phone, purchasing and redemption of ticket and reward schemes, travel and weather information and writing contracts on the move. This type of mobile applications is categorized as M-Commerce [10] applications. There is a significant growing demand on deploying banking and financial services over mobile networks.

2.1 Strengths and Limitations

The M-Commerce applications are very useful for mobile users in a variety of ways. Any user with a mobile phone can access M-Commerce applications in real time at any place. Also, mobile devices provide security to a certain extent compared to online transaction systems [2]. Furthermore the mobile systems can be expanded to provide local information services by localizing registered users within a specific area with the help of the mobile network operators or positioning techniques such as GIS/GPS. However, there are limitations of mobile devices, as most devices are equipped with limited memory/display and limited processing power. In addition the communication through the air links introduces additional security threats (e.g. eavesdropping).

In fact, M-Commerce applications have the potential to address a major service gap in developing countries that is critical to their social and economic development. However, the success of M-Commerce applications depends on the security of the underlying technologies and the community acceptance of the system.

2.2 Security requirements

Most of the M-Commerce systems are based on the GSM network infrastructure and security features provided by the GSM network. However, using the security features provided by the GSM network is not sufficient for the M-Commerce applications [4].

In M-commerce applications, each party that participates for a particular transaction does not meet each other physically. However, in financial transactions trust should somehow be established between each party [9]. General cryptography concepts can be used to accomplish

the trust between each participant. There are five types of features that are needed for establishing trust:

- *Authentication:* Authentication is the process of proving user identification. One party which involves in transaction needs to make sure that counterparty is the one he interested to communicate with.
- *Integrity:* Assuring the receiver that the received message has not been altered in any way from the original message.
- *Confidentiality:* Ensuring that no one else can read the message except the intended receiver.
- *Non-repudiation:* A mechanism that ensures to prevent that the counter party later on rolls back the transaction.
- *Availability:* System Availability is whether (or how often) a system is available for use by its intended users. This is an integral component of security.

2.3 Social requirements

The Mobile-ATM system targets the rural community [5] in developing countries. So, there are several constraints in developing community acceptable solutions. The poor computer literacy stands against the successfully deployment of such projects. Therefore the mobile user interface should guide users to perform transactions with very simple help statements.

Moreover the existing M-Banking systems use only electronic financial materials (like electronic coins) for the transaction [10]. In most of the developing countries, only very few facilities exist to perform transactions using electronic financial materials. Meanwhile the survey which was conducted shows that most of the people in rural areas do not like to use electronic coins. Therefore M-Banking systems for developing countries should be capable to use actual notes and coins as the transaction medium. Therefore our system should be able to deal with the actual coins and notes.

3. Mobile-ATM

Mobile-ATM is a simple M-Commerce application, which provides ATM services. The traditional ATM network [7] can be replaced by the Mobile-ATM system. The key components of the anticipated system are Bank, Customer and the Mobile-ATM agent. Roles of these components will be discussed later in this paper. Both Mobile-ATM agent and the customer should have mobile phones, suitably modified to perform the functions of the Mobile-ATM. The bank has Mobile-ATM server as the front-end, connected to the bank's back-end transaction management system.

3.1 System Architecture

Transactions of the deployed Mobile-ATM system take place are explained below. In order to perform a transaction, a customer with a mobile phone should come to the Mobile-ATM agent, who has another mobile phone. Figure 1 illustrates the overall system design.

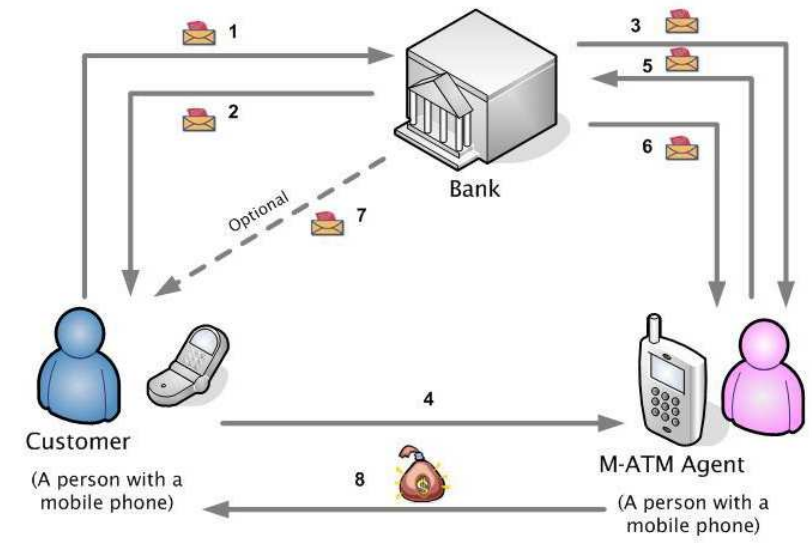


Figure 1: High level architecture of Mobile-ATM

1. A customer goes to a Mobile-ATM agent's place and sends a secure SMS to the bank (withdrawal request) with Mobile-ATM agent's (Mobile-ATM) phone number, requested amount.
2. The bank verifies customer's account and sends an authorized SMS message to the customer together with a confirmation number (a random number).
3. At the same time the bank sends a payment authorization SMS to the Mobile-ATM agent (Mobile-ATM) together with a transaction number (a random number which is different from the confirmation number).
4. The customer tells the confirmation number to the Mobile-ATM agent (Mobile-ATM).
5. The Mobile-ATM agent (Mobile-ATM) sends a confirmation SMS to the bank together with the transaction and the confirmation number.
6. The bank transfers the amount from the customer's account to the Mobile-ATM agent's (Mobile-ATM's) account and sends a transaction confirmation SMS to the Mobile-ATM agent.
7. The bank also sends a transaction confirmation SMS to the customer.
8. The Mobile-ATM agent hands in the money to the customer.

Two random numbers are used in any particular transaction to provide non reputability. Moreover it is a good evidence to confirm that the transaction has been fully completed.

3.2 System Roles

The operation of the system can basically be divided into three parts based on the actors in the system:

- *Customer:* A customer can be a person who needs to perform an ATM transaction. He has a bank account and mobile phone. Special program should be installed in customer's mobile phone to operate Mobile-ATM functions.
- *Mobile-ATM Agent:* Like the customer, Mobile-ATM agent should have a bank account and a mobile phone. This mobile phone is also modified to perform functions of the Mobile-ATM in a secured manner. He is an authorized person to perform Mobile-ATM transactions by the bank. Mobile-ATM agent keeps money with his hand and interest to hand over to the customers when there is a request.
- *Bank Organization:* Bank should have Mobile-ATM servers to deal with transactions between customers and Mobile-ATM. The Mobile-ATM servers should be directly connected to the bank's databases. In addition to that, bank maintains the bank accounts of the customer and the Mobile-ATM agent.

3.3 System Deployment

At the customer side there should be a special mobile application which is suitable to operate the Mobile-ATM functions. This application would require customer's PIN number for authenticate purposes. In addition it requires Mobile-ATM agent's mobile phone number and the amount of money to be withdrawn. Finally, application at customer's side sends secure SMS message which includes the Mobile-ATM mobile number, the amount of money to withdraw and customers account number to the bank.

At Mobile-ATM agent's side there should be a mobile application, which is capable of receiving secured SMS messages from the bank. As well as it should be capable of sending transaction number, confirmation number and customer's mobile phone number to bank securely. This application also requires agent's PIN number for authenticate purposes.

Mobile-ATM server is providing registration and authentication services for the Mobile ATM. Furthermore the Mobile-ATM servers are responsible for generating two random numbers (confirmation number and transaction number) for every transaction. There is an algorithmic relationship between the confirmation number and the transaction number. Random number generation program will not generate the same number for another transaction. After the 5th step, in section 3.1, Mobile-ATM servers should be able to identify the two numbers, which belong to the same transaction.

3.4 Security Issues

Since the transaction happens mainly through SMS, security issues related to SMS should be considered by the Mobile-ATM application [3]. Normally in GSM networks, sender and receiver of an SMS is identified by its IMSI [6], which cannot be forged without breaking the GSM/UTM security mechanisms by an attacker [8]. Therefore these SMS messages can be used for authentication (at least towards the network). However, this kind of protection is only available in GSM network and there is no end-to-end security. Therefore either the network operator and its infrastructure must be trusted or an external authentication protocol must be deployed [4]. It is not convenient to trust the network operator and its infrastructure in the context of applications like Mobile-ATM. Therefore, Mobile-ATM provides end-to-end security mechanism instead of depending on the GSM network security.

3.5 Security Architecture – Customer side security

Customer side security is provided based on the symmetric key cryptography. Here we make an assumption that the bank is a trusted entity.

Customer has to enter his PIN number in to the customer side application and the application itself gets the customer mobile phone number and application ID to generate a secure Hash Code. The generated hash code is used as the key for the AES encryption algorithm to encrypt the customer related information at the client side. This information includes the Mobile-ATM agent's phone number, and the amount to be withdrawn. Then, this

encrypted version of information is sent to the relevant Bank. According to the assumption mentioned above, the bank generates a Hash Code using Customer PIN number, Phone number and Application id and keeps it in bank's database, and uses the generated hash key to attempt decrypting the received encrypted message from the customer. If this is successful, it means that the hash key stored in bank database is equal to the hash key generated by the customer. Therefore bank can authenticate the customer. Also encrypted version of the customer message provides the integrity and the confidentiality of the customer information.

3.6 Security Architecture – Mobile-ATM agent security

MOBILE-ATM agent is an authorized person by the bank. The same security architecture described in section 3.5 has been applied here.

At the step 5 of figure 1 the Mobile-ATM agent encrypts the confirmation number (which has been obtained from the customer) and the transaction number. Calculated hash code from Mobile-ATM agent's PIN and application ID is used to generate the encryption key. Then the bank can authenticate the Mobile-ATM agent. This message also provides the integrity and confidentiality of data.

At steps 6 and 7 of figure 1, the bank sends the confirmation note that indicates whether the transaction was completed or rejected. These two messages are encrypted by bank. If these messages are successfully decrypted on the receiving sides, both the customer and the Mobile-ATM agent can verify that the confirmation notes come from the bank. The transaction completes at this stage.

4. Evaluation

So far, we have discussed about the technical designs and the special issues of the Mobile-ATM system. This section introduces a detailed technical evaluation and a small user study evaluation. As mention in section 2.3, Mobile-ATM mainly targets for the rural area community. Hence, we believe real world evaluation has more advantages instead of evaluating the system in a lab environment. Therefore, for the evaluation purposes, we have been deployed the Mobile-ATM system in a rural bank, which has a rural customer community.

4.1 Technical Evaluation

The technical evaluation focuses on evaluating the system performances and the scalability. The performance of the deployed Mobile-ATM system has been measured by the time taking to complete a particular transaction. The completion time of a particular transaction consists of the time needed to feed the data to the application, the throughput SMS delivery time and time taken by core banking system to complete the transition. But the time taken to feed the data to the application depends on the computer literacy of the user. Therefore we remove that factor to extract correct measurements about the system performances. For a particular transaction, mainly there are two situations where users should feed data to the application, the withdrawal request and the agent's request. Hence, we have to divide time measurements into two parts.

1. Time period starting from customer sending the withdrawal request and ending with receiving both confirmation SMS and transaction SMS. (T1)
2. Time period starting from agent sending confirmation and transaction numbers and ending with receiving the transaction completion SMS. (T2)

According to Table 1, standard deviation values of T1, T2 and Total are relatively small in comparison to the mean values. That means the spreading of T1, T2 and Total time is in a short time interval. For example, the bulk of the total completion times for transactions are

found between 84s and 104s. Hence we can conclude that the system is stable for most of the transactions.

Table 1: In-network performances

	T1(s)	T2(s)	Total(s)
Mean	49.677s	44.34s	94.021s
Standard deviation	8.216s	7.311s	10.534s

Moreover, we take the first 20 transaction measurements at a location of very high GSM signal strength (at around 250 meters distance from the base station). The latter 20 observations are measured at a location of average GSM signal strength (around 4 Km away from the base station). When these observations interpret in figure 2, we cannot see considerable variation of the total time among first 20 measurements and latter 20 measurements. Thus we conclude that the GSM signal strength does not affect the system performances to a great extent. Hence, the system can be used in rural areas, which has low signal strength.

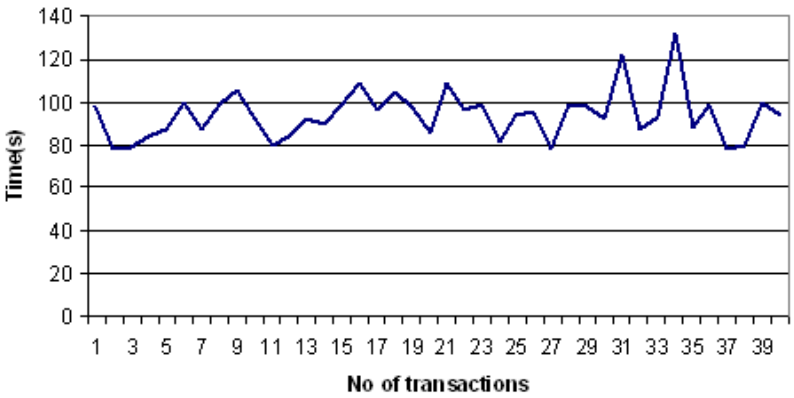


Figure 2: Transaction performances time

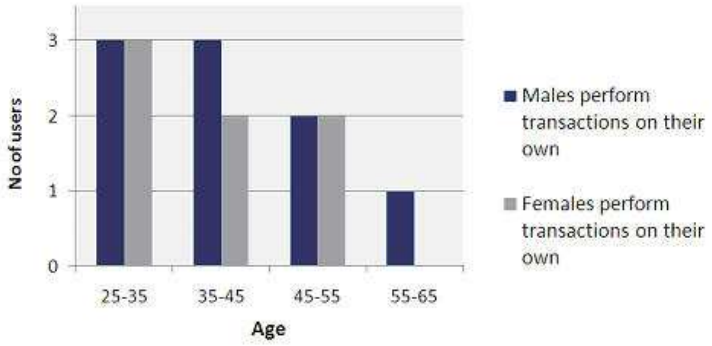
4.2 Sociological analysis: A quick pilot study

As well as introducing a new technology to a social problem, analyzing the social impact of the deployed system is vital. Through a thorough analysis of the social impact, researchers can apply their theoretical proposals in real world problems. When we planned the Mobile-ATM system, we considered that user should have capability to operate a mobile phone. Hence we perform an analysis to test the social factors like age, level of education and sex affect on the usage of system.

Figure 3 illustrates the results of the analysis. The sample take such a way that 6 people are between 25 years to 35, 6 people between 35 to 45 years, and so on. Also from a particular age group there are equal number of males and females. Figure 3 shows that old people cannot do the Mobile-ATM transactions on their own (Mobile-ATM agent has done the customers duty according to the customer's instructions.). Possibly, females are weaker in doing transactions on their own even if it is impossible to draw any final conclusions from

our small sample. So age and possibly sex are two major social factors which stand against the popularity of Mobile-ATM system in rural community.

The above analysis is a quick pilot study that indicates some sociological factors such as differences between age groups and sex which should be investigated more thoroughly but which we have used as a temporary guide for the design of your system.



Figur3: Users perform transactions on their own

4.3 Privacy Problem

Another important consideration that we take from users by oral discussions is the privacy of the transactions. Most of the users think privacy is a big issue when they deal with the Mobile-ATM agents. In a real world scenario, the agent is a villager. Most of the customers said, they do not like the agent ask the purpose of money withdrawal. Most probably these situations not occur if customers do their transactions with bank or ATM. Hence the privacy of the transaction is another issue when we deploy the system for practical usage.

5. Conclusions

One of the distinguished features of the Mobile-ATM system which makes it different from any other similar system is its security. The Mobile-ATM system provides all the basic security features describe in section 2.2.

Without having any additional cost on the infrastructure, the existing mobile networks can be used to deploy this system. Since most of the people have the knowledge to use mobile phones, customers can familiarize with the system easily.

We have been thinking “out of box” on how to use the mobile technology in a new fashion, instead of using the mobile technology to attract the customers for banking services. According to section 1, the effort taken to bring the Mobile-ATM system into success is acceptance by the rural community in developing countries. Although our evaluation is mainly positive, still there are some barriers standing against the popularity of our Mobile-ATM system.

However, we are confident that this application addresses a major service gap in developing countries that is critical to their social and economic development.

Acknowledgments

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Using eduPhone for Self-Service Healthcare in Developing Countries

Shafiq Shamsur RAZZAQ, Md. Abu SAYED
Master of Electronic Government
Swedish Business School, Örebro University
SE - 701 82 Örebro, Sweden
Tel: +46 19 30 30 00
Email:ssrrazib@gmail.com;asayed86@yahoo.com

Abstract: Rural development in developing countries draws much on the ability of people to be access quick services and advice on day-to-day issues and problems. The need for providing healthcare information to the rural people is of paramount important nowadays in order for them to improve their health status and understanding on the relevant issues. This paper reports on the effectiveness, usability, and feasibility of the "eduPhone", a system for delivering everyday situated learning such as healthcare advice/service to people with lacking of access to such services through a field test with rural people in Bangladesh. The proposed eduPhone uses mobile telephony combined with an automated interactive voice response (IVR) system and hence draws on existing, available, and relatively cheap infrastructure. The improvement of users' learning and *t*-test analysis show the effectiveness of the eduPhone system. The interview and observation results show that the users' acceptance is 100%, as showed by the fact that participants' find it expedient to understand the learning content and to use the eduPhone system that reflects the usability of the eduPhone system from end-users. Thus, the positive factors of effectiveness and usability indicate the feasibility of the eduPhone system in rural area of the developing countries.

1. Introduction

Incorporating Information & Communication Technology for Development (ICT4D) requires multi-faceted planning and intervention. Enabling people to find their own best usage in daily life situations is the biggest challenge at the very onset. For instance, the developing countries lag far behind in delivering healthcare information regularly and effectively to its rural masses due to lack of adequate resources and proper infrastructure. Most people in the rural areas do not have knowledge of common diseases like diarrhea, arsenic poisoning, cholera, dengue fever, skin disease and so on WHO(2004). They lack awareness and knowledge on how to treat these diseases. People from the rural areas usually have to travel a long way to avail the facilities. Like in Bangladesh, child mortality rate for children under five years of age due to diarrhea disease is 20% and a physician per 1000 population is 0.26 WHO(2004). In this backdrop, the need for delivering quick healthcare services in the form of healthcare information to the rural people is imperative. There is no denying that formal education is necessary to understand health issues and foster behaviour change. However, there is also growing need to address everyday situations requiring knowledge and learning that exist i.e. knowledge at the time and point where it is urgent. The prevailing healthcare situation and availability of mobile phones motivate us to draw up the research question, "Is it possible to deliver healthcare knowledge in rural areas of developing countries using existing mobile

phone networks and applications?" Here, the focus is to address real life problems in rural areas.

In this paper, we have proposed a system called 'eduPhone' for providing healthcare information to people living in rural areas of the most developing countries and/or with lack of access to adequate healthcare services. The eduPhone system uses mobile phone in combination with an automated interactive voice response system. Moreover, this paper reports the effectiveness, usability and feasibility of the eduPhone system by conducting a field test. The remainder of the paper is organized as follows: Introduction followed by Section 2 focusing on the motivation behind this research work and literature review. Then, Section-3 explains the method of study; Section-4 describes the design of proposed eduPhone system. Section-5 demonstrates the empirical study and section-6 presents the results and data analysis. Lastly, Section-7 attempts to draws some conclusions.

2. Motivation of Research and Literature Study

The use of ICT and e-learning platforms provide alternative channels to improve the quality of education and expand its reach to broader audiences. However, lack of Internet access and bandwidth pos the main barrier to spread e-learning in most developing countries. To overcome this situation, experts have been exploring the potential of m-learning. Research shows that mobile devices such as PDAs, mobile phones have the power to make learning even more widely available and easily accessible to rural people than current e-learning tools Brown(2005). Again for high mobility, mobile learning process is more apparent as some socio-cultural activities than a learning process based on textbooks and classroom learning Peter(2004).

There is a large and growing body of evidence demonstrating that healthcare service intervention around mobile phone could be very innovative, interesting and immensely successful as well. Starting from SMS based reminder service for asthma patients to improve how they manage asthma Neville(2002) to telemedical wound care using enhanced multimedia applications of mobile phones Ralph(2005). In Uganda, Personal Digital Assistants (PDA) was used for telemedical purposes AED-SATELLIFE(2004). In India, mobile phone was used to spread HIV awareness. In this project, popular regional content is converted into engaging m-learning material for under-privileged and semi-literate people Traxler(2005). 'Healthnet' an evaluated a project led by 'On Cue', a small company based in Cape Town, South Africa, which sent SMS messages to patients via mobile telephones, reminding them to take their tuberculosis (TB) medication at pre-determined times Bridges.org(2005). Another project named 'School Empowerment Programme Kenya' used bulk SMS text messaging as in-service training to primary school teachers and local support cadres across rural and urban areas Traxler(2005). In Nicaragua, the use of interactive radio instruction (IRI) for primary education was introduced. After that, it was introduced in Thailand and Kenya with some modifications and the result was satisfactory. It was found that 'IRI project reports significant student achievement at reduced costs in those countries Eastmond(2006). However, to use IRI system the participants have to be self-motivated and there is no way to repeat the lesson for particular students. In Uganda Output-Based Aid project uses the data and communication capacity of the mobile phones to support a new voucher-based programme for the treatment of sexually transmitted illnesses (STIs) in East Africa Berkeley(2008). However, use of Smartphone is expensive and inaccessible by the rural people of the developing countries. The examples show that different techniques have been used by different countries suited to their local needs. However, they all have two things in common -pre-determined time and expensive technologies where most of the developing countries are looking for low-cost ICT based solution.

World Bank estimates that 77% of the world's population is within the reach of mobile phone network Kenny(2007). It is often more convenient for people in developing countries, such as Bangladesh, to gain access to mobile features than the Internet through fixed and often costly infrastructure. By September 2008, Bangladesh had reached 45.9 million mobile

phone subscribers where total population is 153.3 million BTRC(2008); World Bank(2005). However, there are 0.45 million Internet users and 1.2 million fixed phone lines in Bangladesh Group(2008); Barta(2008). In Uganda, by September 2006 the number of mobile phone subscribers reached at 2.24 million compared to 0.011 million Internet users and 0.12 million fixed phone lines FAO(2006). On the other hand, Kenya has 5.6 million mobile phone subscribers, and only 0.2 million Kenyan households have electricity Technology(2008). Afghanistan has 0.02 fixed-line phones and 2 million mobile phone subscribers Strategic Digital Outreach(2006). Study shows that villagers who can not afford mobile phones are now buying mobile phone services from small phone-call shops. In Bangladesh, the Village Phone Lady Foundation(2008) has already been recognized as a solid business model for reaching rural populations. It is also acknowledged as a sustainable development tool by governments and development agencies such as the World Bank, the United Nations, the International Finance Corporation, and the USAID. The overall scenario in the developing world suggests that mobile technology could offer tremendous potential to reach out to the millions of people in developing countries.

3. Method

3.1 Choice of method and instruments

Empirical testing with potential users is considered the best way to find problems related to user tasks and experiences Riihiaho(2000). In order to fulfil the study goal, we have chosen field test with actual target participants to examine the proposed eduPhone system. The field test of eduPhone also focuses on the front end, the automated response system, as this is most critical for success. If this can be designed successfully it would lead to quick access, timely and appropriate treatment, and costs-effectiveness. We have examined the effectiveness, usability and feasibility of the eduPhone system by the following attributes.

Effectiveness was measured by:

1. A pre-test and a post-test of user knowledge.
2. A post-test interview on users' views on how learning was supported, or not.

Objective usability was examined by using different contents in the same design to measure the performance of participants:

1. Errors
2. Time to complete a task
3. Completion of task
4. Repetition of task
5. Navigation path through the system

Subjective usability was measured by observation and post-operation interviews soliciting user opinions. Feasibility for the target population was estimated by the success factors of effectiveness and usability as well as technological availability.

3.2 Choice of contents and selection of participants

For the field test, we have selected two different contents to examine the learning effect and usability of the system. The idea behind selecting the two contents was to investigate improvement of user performance based on subjective and objective usability. We have chosen diarrhea and arsenic poisoning related diseases as the learning contents. Diarrhea is common disease in most rural areas while the arsenic-poisoning related diseases still remain a less-known issue among them, notwithstanding the fact that it is major threat now. The idea was to explore and examine how they manage to interpret common and 'uncommon' diseases. For the field test, we had Bangladeshi village people as targeted participants who were selected by random sampling method. However, we have set the minimum age of 10 for

the participants. A total of 60 participants from two locations in Bangladesh were tested to measure usability and feasibility assessment of the system. The idea was to examine the level of healthcare knowledge in remote village and village beside town.

3.3 Tasks of user and observer

During testing, each user followed these sequences and tasks:

1. Performing a pre-test (Paper based for diarrhea)
2. Operating the system (Using mobile phone for diarrhea)
3. Performing a post-test (Paper based for diarrhea)
4. Performing a pre-test (Paper based for arsenic related diseases)
5. Operating the system (Using mobile phone for arsenic related diseases)
6. Performing a post-test (Paper based for arsenic related diseases)
7. Interview (By Observer)

The role of the pre-test was to measure the current level of knowledge of each user. The post-test was conducted to indicate how much, if anything, the user has learned from using the system. It is to be noted that the pre-test questions were also included in the post-test questions. The post-test questions were more elaborate than the pre-test ones to reflect how the user had understood different parts of the information provided by the system. We have also used participant observation technique Preece(2002). At the end, the interview sessions helped getting additional information about the feasibility and usability of the system. The interview format was semi-structured where orderly categorized, dichotomous, and open-ended questions were included.

4. Design of eduPhone System

During design phase of eduPhone system, our primary concern was how to deliver healthcare information effectively using existing infrastructure to ordinary rural people of developing countries, here in this case Bangladesh. In addition, the system was designed in a way that it could be easily accessible and the content easily understandable to enable users in absorbing necessary information. Therefore, we have considered the eduPhone system as a front end, an automated response system to deliver basic information about health issues. Exiting mobile network and ordinary/simple mobile phone sets were used to access eduPhone system.

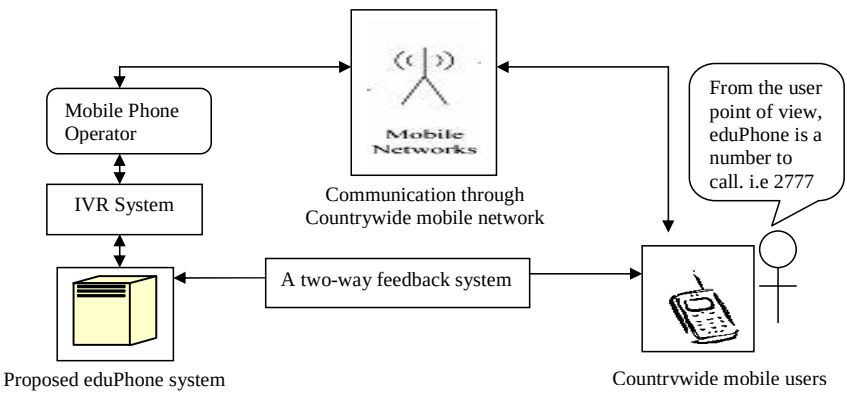

Figure 1: Communication model of eduPhone system

From the user point of view, the eduPhone is a number to call when in need of medical advice/service. For example, to access the healthcare service, a user has to call a number, i.e. 2777, which is then transferred by the mobile phone operator to the eduPhone system using

an Interactive Voice Response (IVR) system. After that, the user gets connected to a pre-recorded voice message with instructions. Then the user has to press certain numeric keys to get required information from system. Figure 1 shows the communication model of the eduPhone system. It should be noted that the eduPhone does not require users to be able to read or write, hence it is also possible to use in areas where the literacy rate is low. Thus, this low-cost system can cover a wide number of people which otherwise was not possible in the past. The system design phase was determined by three major components: accessibility, navigation, and content.

Accessibility: Our target group is rural areas do not have access to expensive modern technologies like Internet and 3g mobile network. Again, Marsden says that "Identify a small, coherent set of functions users really want and deliver them in a simple, direct way." Jones(2006). Therefore, the mobile phone was chosen as a convenient yet low-cost medium to access the proposed system. The user can easily access desired information from the system by simple by calling a specific number and pressing different buttons. More importantly, the proposed eduPhone system is completely time independent i.e., the user can access the system 24 hours a day, 7 days in a week.

Navigation: One of the oldest hypertext usability principles is to visualize the structure of the information space to help users understand where they can go. Usability Guru Nielsen says that "usability is a quality attribute that assesses how easy user interfaces are to use'" Nielsen(2002).Therefore, we have empathized on designing navigation path of the eduPhone system. We have designed the navigation path in a way that the user can navigate the system easily. We have followed hierarchy approach to design the navigation path Louis and Peter(2006). When users call for the service, the system first introduces the users as to what kind of information is available and how it can be accessed. One of the system goals was to present order of the menu to facilitate easy access of information from the 'not to techno-savvy' end-users.

Content: The content design was largely determined by the cost factor, taking into consideration the poor economic status of the target users. The contents were packaged in a way that requires fewer amounts of airtime charges to access necessary information. The information provided was short yet to the point leading the users to a specific situations e.g. diarrhoea treatment, arsenic poisoning, AIDS precautions etc. As mentioned earlier, we have selected diarrhoea and arsenic poisoning diseases as being our test cases. The first content was about emergency diarrhoea diagnosis and treatment in particular focusing on child care. The second one was about symptoms of arsenic poisoning related diseases and its treatment. The contents were designed by us in consultation with qualified public health professionals.

5. Empirical Study

According to our plan, we have conducted a field test of eduPhone system in Bangladesh. Participants were mostly uneducated rural people. The goal of this field test was to investigate effectiveness, usability, and feasibility of the system in rural areas.

For the field test, first we went to a village, some 350 km from the Dhaka city (Capital of Bangladesh), called Singdar in Natore district. This is a remote village and people are not much aware of healthcare information. Most of them are illiterate and many are suffering from diseases like diarrhea, arsenic related diseases, and other common diseases like fever etc. We went from door to door for our interviewees. Also, we talked to the farmers who were then working in the field. Our study reveals that although people know a little about these diseases, most of them are not aware of the symptoms and how to treatment these diseases. They usually prefer going to a doctor for any medical complications – big or small. However, qualified doctors are not available in many rural areas in Bangladesh. Our next location was a village on the outskirts of near Dhaka city called Delpara, Narayangonj district. The reason behind choosing this place was people living near Dhaka city seem to be more aware of healthcare information and they get better healthcare facilities than rural areas. Here the interviewees were mostly day labours and illiterate people. We also took interviews

of housewives and domestic maid servants. People in this place have better knowledge than first village we visited, due to social campaigns and availability of local healthcare facilities. Compared to the people in Singdar, Natore, people here have more access to TV, and they know more about diarrhea and arsenic related diseases. However, the basic knowledge level is not satisfactory as yet. In both the villages, most of the people have access to mobile phones, at one phone in each family. Moreover, people can buy mobile phone services from local phone shops.

At the beginning of the system testing session, we explained the test scenario to the test participants. The following scenario we presented to the participants:

> DIARRHEA: You live in a rural area where you don't have access to medical services in the vicinity of your home or locality. But then you have access to mobile phone – either you or your family members own one or you can still access mobile phone through a village phone lady. From your friend/ village phone lady, you have come to know that you can get healthcare service/advice through mobile phones. Let us assume that, you have a 5 year old child and the child one day starts to have watery stools more than 3 times a day coupled with vomiting. You already know that these are the symptoms of diarrhea but you do not know how to treat this. Therefore, you pick up the mobile phone and dial a mobile number i.e. 2777 to get necessary information.
>
> ARSENIC-RELATED DISEASE: You live in an arsenic contaminated polluted area where you regularly drink water from a deep tube well marked 'read' (arsenic contaminated). Meanwhile, you have been informed by your friend/ village phone lady that you can get healthcare service/advice through mobile phone. After a few days, you have found skin lesions and loss of feeling/numbness in the hands and legs. And you know these are the symptoms of arsenic poisoning. Therefore, you pick the phone and dial 2777 to get necessary information.

Figure 2: eduPhone test participants at Singdar, Natore.

After explaining the scenario, we briefed them about how to get connected and use the system. Figure 2 demonstrates the test participants using eduPhone system. Then we asked a few questions to fill up each user's profile. Then a paper based pre-test was conducted to check the knowledge level of the user about diarrhea. This was required to see if there was any change between the pre-test and post-test knowledge level. After that, the participant used mobile phone to listen to information about diarrhea. However, we had to help some of the new users to get connect to the system. During system operation, we observed the participants and took notes on how they reacted to the system including their facial expressions. Soon after that, a paper based post test was conducted to see if there was any

change in the knowledge level of participant before and after using the system. The same procedure was followed in case of arsenic-related diseases.

In the end, each participant was interviewed based on a common questionnaire. It needs to be mentioned that all questions for pre-test, post-test and interviews were multiple choice questions (MCQs) and if they answered other than the preset options we took note of that as well.

5. Result and Analysis

In this section we present and examine the results on testing samples, user learning, usability, and feasibility of eduPhone system.

5.1 Test samples

During field test, 60 people participated to test the eduPhone system where 67% participants were male, and 33% were female. In addition, 50% participants had primary school education. 82% participants had experience of using mobile phones and 7 % participants had experience of using a mobile phone at least once a week.

5.2 User Learning

The pre-test results show that 35% participants had no knowledge about diarrhea and 60% participants had no knowledge about arsenic before using the system. After using the system, 92% of the participants had improved knowledge about diarrhea and the use of oral saline. Furthermore, 100% of the participants have been able to improve their knowledge about arsenic poisoning after using the system. From table 1, the average diarrhea knowledge score of pre-test was 39% and of post-test 84%. So, the improvement for diarrhea was 115%. For arsenic, average score of pre-test was 20% and post-test was 86%. Thus, the improvement for arsenic was 330%. It is to be noted that improvement of learning is a key success factor in order to validate the eduPhone system. In order to determine the improvement of learning, we have also conducted a *t*-test investigation on pre-test and post-test results of all the participants.

Table 1: Pre-test and Post-test Average Marks (N = 60)

Scenario	DIARRHEA		ARSENIC	
Pre/Post	Pre-test (Max = 4)	Post-test (Max = 8)	Pre-test (Max = 4)	Post-test (Max = 8)
Average	1.55 (39%)	6.73 (84%)	0.8 (20%)	6.88 (86%)

We have performed the *t*-test analysis separately on paired pre-test and post-test data of the Diarrhea and Arsenic scenarios. The *t*-test investigation shows that the two-tailed *p* value is less than 0.0001 for both the Diarrhea and the Arsenic scenario. The *p* value is a probability with a value ranging from 0-1 for observing the given sample result under an assumption that the null hypothesis is true. By conventional criteria, this difference is considered extremely statistically significant. So the outcome of the post-test demonstrates well the user learning.

5.3 Usability of eduPhone system

Quantifying users' performance is a dominant theme in usability testing Preece(2002). Measuring users' performance and satisfaction indicates the usability of a system. Due to the limitation for getting the system log file, it was not possible to present and analyze the objective usability data. But we have measured participants' behaviour through observation and interview data. About 98% of the participants had positive facial expressions. Only two participants were a little nervous when they started using our system as it was for the first

time they used a mobile phone. As we had observed, the level of comfort increased by 37% when they heard arsenic related contents. One of the reasons could be, already getting used to the system by the diarrhoea test prior to arsenic related test.

Again, the opinions expressed by the participants also reflect the importance of usability of the system i.e. if people think a system is hard to use and hence don't use it, who is to say they are wrong? To learn about users' satisfaction we did semi-structured interviews with every user individually after they had used the system. During interview session, most of the participants were very open to accepting such an innovative system although they had never used such systems like eduPhone. For them, it was quite a new experience. After using the system, we have asked them 'Do you agree mobile phone is a good medium to transfer knowledge?' to all the participants. From figure 3, about 97% of the participants agreed that mobile phone was a good medium to transfer knowledge where 60% of the participants shared their strong argument for mobile phone.

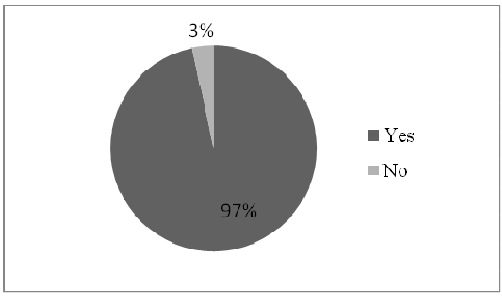

Figure 3: Participants' opinion regarding 'Do you agree mobile phone is a good medium to transfer knowledge?'

Most participants' expressed that due to availability and quick assess, mobile was a good medium to transfer knowledge, especially in rural areas. After that, the user friendliness of the eduPhone System was also investigated. Figure 4 shows, 97% of the participants found it comfortable to operate the system. They also confirmed that the learning contents had increased their level of knowledge (which corresponds to the post-test results). They all shared positive vibes about the system as 97% of participants thought that it was easy to use eduPhone System. However, the remaining 3% of the participants found it difficult to operate.

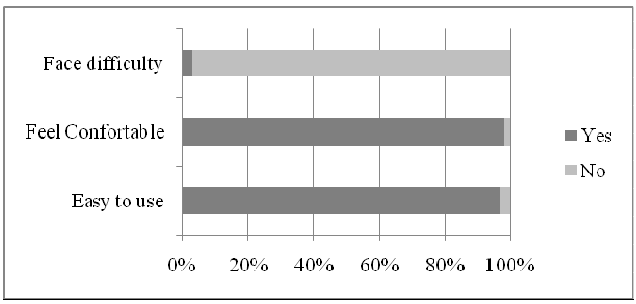

Figure 4: Participants' opinion regarding user friendliness of eduPhone system.

5.4 Feasibility assessment

A feasibility study could provide a thorough examination of all issues and an assessment of probability of success of the proposed eduPhone System.

The use of mobile phone and mobile network is a key success factor for the eduPhone system. Bangladesh has reached 45.9 million mobile phone subscribers at the end of September, 2008 where the country's mobile operators added another .5 million new subscribers in September 2008 BTRC(2008). It indicates the acceptability and practicality of mobile phone usage in our day to day life. Our study also shows that majority of the testing population have access to mobile phones at least once a week and every family has at least one mobile phone. Therefore, communication medium like mobile phone is a practical choice to reach out to a large number of targeted rural people where systems like the eduPhone system could be incorporated. Moreover, 24 hours access availability would cater to emergency situations when people desperately seek healthcare service/ advice. The results and analysis of sample population's post-test have shown the improvement of learning among users that reflects the quick learning ability of the sample population due to easily understandable learning content. The usability investigation, i.e. interview and observation, has shown that eduPhone system is an effective system for rural people due to user friendliness and structured learning content. Regardless of the fact that the sample population did not have any previous exposure to a system like eduPhone, their performance was quite commendable. The interview results showed that the users' acceptance was 100%, as indicated by the fact that the participants were able to learn by using the eduPhone system.

Thus, these positive findings and factors indicate the feasibility of the eduPhone system in rural areas of Bangladesh and possibly in other countries too, of course.

6. Conclusions

In this study, we tried to explore the effectiveness, usability, and feasibility of the proposed eduPhone system that offers potential to foster situated learning such as healthcare advice/service to the people living in poor socio-economic conditions who lack access to healthcare services. The study concludes that there is a growing demand for delivering effective and quick healthcare advice/service to the rural people. Moreover, this system can help rural people to access healthcare information regularly and effectively. The post-test results and *t*-test analysis shows the effectiveness of the eduPhone system. The majority of the participants expressed that due to availability and quick access, mobile phone could be a good medium to transfer knowledge in rural areas. Every test participants expressed their positive attitude towards the eduPhone system that indicates that such system offer usability.

In conclusion, we consider that our proposed eduPhone system could help villagers to access the healthcare advice/service at a low cost in any emergency situation. Moreover, it can promote self-learning in rural areas of developing countries to solve every day problems.

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Sustainable Rural IS Implementation Process for Developing Countries: Agriculture Market Information Services (AMIS) in Bangladesh

M. Sirajul ISLAM[1], Suha ALAWADHI[2]
[1] *Swedish Business School, Örebro University, SE -701 82, Örebro, Sweden*
Tel: + 46 733 74 46 94, +880-1817-048388, Email: siraj2k@yahoo.com
[2]*Kuwait University, P.O.Box* 5969, 13060 *Safat, Kuwait*
Tel: +965 2498 4845, Email: s.alawadhi@ku.edu.kw

Abstract: The implementation of rural Information Services (IS) faces a number of challenges in most developing countries. These challenges include access and ownership of technology, imbalance in availability of resources, and technological skills. Via an analysis of the literature, this study tries to investigate the digital divide found between poor and rich people, the status of information and communication technology (ICT) as well as market information services in Bangladesh, as one of developing countries and from which many lessons can be learned. Empirical investigation also uncovers the association between the adoption of technology and satisfaction, technology preferences regarding supply and demand and the barriers to accessing technology. Based on the findings, a conceptual integrative framework for implementing a rural IS in developing countries is proposed.

1. Introduction

Rural areas of developing countries are dominated by conventional agricultural and fishing activities, having scarcity of common urban facilities such as access to education, health and sanitation, reliable electricity and water supply, access roads, regular transport, modern technology and technical personnel, and difficult topographical and climatic conditions (ITU, 2008). The gap in accessibility of information and communication technology (ICT), perceived and quantified, popularly known as 'digital divide', among the rural people in developing countries and between developed and developing countries is very much evident (OECD, 2000). Here accessibility refers to physical access to technology and ownership, imbalance in resources and adequate skills to participate in digital systems effectively. The first level of the digital divide, i.e. ownership of technologies, has now moved to a second level with the dramatic improvement of devices and the availability of modern ICTs. This second level has resulted from the following factors: mass connectivity, online skills, autonomy and freedom of access, and computer-use support (Brian et al., 2006). On the other hand, some argue that such a divide is an economic and social handicap of a community or nation which could be overcome over time due to the transient nature of technology, without any substantive public policy initiatives and spending (Compaine, 2001).

However, despite arguments over the definition of 'digital divide', and even whether it exists or not, substantial quantitative trends are being seen in terms of the adoption of modern ICTs, especially of wireless technologies by people considered to be underprivileged. This is a kind of bridging the divide through the transient nature of technology. According to the Economist (2005), "Rather than trying to close the divide for the sake of it, the more sensible

goal is to determine how best to use technology to promote bottom-up development. And the answer to that question turns out to be remarkably clear: by promoting the spread not of PCs and the internet, but of mobile phones. Plenty of evidence suggests that the mobile phone is the technology with the greatest impact on development." WISR (2007) reports that mobile communications have grown most rapidly in developing countries where the number of mobile cellular subscribers rose from just 12 million in 1995 to over 1.15 billion in 2005, at a compound growth rate of 58 per cent per year.

Appropriate use of ICT in agricultural operations helps to realize 'digital opportunities' by enhancing productivity by value addition, reducing urban and rural inequalities, learning to use relevant technology and make decision, generating more income and linking with the various channels and parties of markets to access effective market Information Services in order to get to know who to deal with, where to sell, at what price, and when. However, reaping the fruits of ICT in the rural areas of developing countries, especially by less privileged people, is still out of their reach compared to urban areas. The main reasons for this inequality are lack of awareness and illiteracy, lack of commitment, and knowledge-base and sources of funding by governments and related agencies (Nattaradol, 2002), which ultimately mean that such efforts cannot be sustained.

This paper will try to look at the context of the digital divide in the rural settings of developing economies and analyse the major challenges faced while adopting both conventional and modern agricultural Information Services. Based on a literature review and empirical investigations, this study proposes a conceptually integrative and sustainable rural IS implementation process for developing countries.

2. Methods

This study is based on ongoing research into mobile phone-based agricultural market Information Services in Bangladesh. For this paper, the authors have used parts of the questionnaires designed for a survey (by the first author as field researcher) during the same months (November – February) in 2006 and 2007 respectively. In the first survey in 2006, 1050 respondents (farmers, wholesalers and retailers, with 350 in each category) were surveyed in 13 out of 64 districts of Bangladesh (Islam and Grönlund, 2007), while in the second survey in 2007, 420 farmers were surveyed in 50 villages (out of 87,362) of 13 districts through structured and open-ended questionnaires. Observation, interviews and face-to-face conversation with the survey participants were also conducted. In addition to these surveys, an extensive literature review was conducted of literature available on the net.

The paper begins with an analysis of the ICT inclusion and market IS in Bangladesh, followed by a discussion of ICT adoption in rural market services in Bangladesh with reference to some global initiatives. The survey focused on the adoption of modern technology and associated degree of satisfaction, choice of mobile phone network, preferences regarding access devices, and understanding of access barriers for rural people in Bangladesh as a case from which much can be learnt. Finally, based on the analysis and findings, the authors propose a conceptual framework for implementing a rural Information Services.

3. ICT inclusion and rural market information services in Bangladesh

3.1 Status of ICT inclusion

Bangladesh is considered representative of a developing economy. According to UNCTAD's ICT Diffusion Index of 2005 (UNCTAD, 2006), Bangladesh ranked 171st out of the world's 181 countries, being placed at the bottom of all South Asian countries, while the Maldives was placed at the top of South Asian countries, ranking 72nd in the world overall. However, despite its disappointing status in the region, the rate of penetration of cellular mobile phones

has been increasing remarkably over the last few years. Various literatures and field surveys (ITU, 2008; D. Net, 2005; World Bank, 2008; BTRC, 2008; PBC, 2007) show that while the rate of PC penetration is less than 3%, Internet penetration is less than one-tenth of that. However, the growth of cellular phone subscriptions in comparison to traditional fixed phones (PSTN) is remarkable. In December 2007, there was about one mobile phone per four persons, compared with about one per seven persons in 2006; if this trend continues, it is expected that the rate of penetration will be about one per three persons by 2009. Therefore, this astounding growth rate of wireless digital diffusion brings new hope of bridging the digital divide in Bangladesh, and similarly in other developing economies.

3.2 Rationality to use effective market information service

Rural Bangladesh shares one of the common characteristics of developing economies where there is an absence of efficient and effective channels in the marketing services to ensure a smooth functioning of demand and supply and thus fair price setting. A survey by the first author found that 'dishonest' traders (or middlemen) have commonly become market players able to manipulate the price of rural commodities to the detriment of both farmers and consumers. Opposing this view, some studies argue that in general "traders do make a small profit or even losses. Clearly, unless they make a reasonable profit, traders will not take the risk of continuing in business, to the disadvantage of both consumers and farmers" (FAO, 2007).

Table 1 indicates that the selling price of beans fluctuated inconsistently in the urban area and that urban retailers extracting a significantly higher margin (e.g. about 150% higher than the initial selling price in the peak season). It also shows that the price of beans increased with involvement of the intermediaries in the supply chain. Here the role of the retailers, i.e. of those in the final stage in the supply chain, seems to be more suspect than that of other intermediaries. It is, therefore, suggested that farmers should be empowered to be retailers by providing them with access to and logistics for the markets and that they should have more bargaining power vis-à-vis the first-tier middlemen (well known as 'syndicates') by providing them with market information along with other factors of empowerment in an imperfect, unregulated market structure.

Table 1: Change of selling price of country beans in the value chain (US $1 = Tk.68 Feb. 2008)

Final selling price (Tk.)	***Minimum no. involved***	***Players***	***Region***
10	*1*	*Farmers*	*Rural*
12	*2*	*Farmers, Faria/Bepari*	*Rural*
14	*3*	*Farmers, Bepari, Retailers*	*Rural*
18-20	*1-3*	*Rural wholesalers, Mahajan, Government*	*Peri-urban, Urban*
24-25	*5*	*Faria, Rural wholesalers, Mahajan, Urban wholesalers, Urban retailers*	*Urban*

As the economy of Bangladesh is heavily dependent on agricultural activities, the growth of agriculture depends on the growth of rural development. "But as there are many small farmers and less than perfect information for stakeholders in the sector, the market is volatile to manipulation and uninformed actions. Farmers' participation in market and transport management is so poor that most of the time they are being forced to sell their products to local middlemen at dumped prices. Under these circumstances, experts opine that this deprivation on part of the growers may greatly be reduced if they would have been empowered with information" (Islam & Grönlund, 2007).

3.3 Rural market Information Services: Some global initiatives and Bangladesh

"When you look at the digital divide, the biggest gap is in agriculture where there is a low literacy rate" (B2BpriceNow, 2003). To counter this, there are some initiatives being taken across the globe to reduce such a gap by adopting modern ICT-based systems in place of traditional channels, such as radio and print. Many such initiatives have been successful. For example, farmers of UNFAO's Farmer Information Network (FARMNets) generated around 12% more profits in selling cotton in Mexico and 40% less cost when disseminating market information through electronic means in Chile. Such Information Services enhance the bargaining power of farmers vis-à-vis local buyers and link organized groups of farmers to various service agencies (FAO, 1997). In the case of the Philippines, "if there is one good example where the digital divide is successfully being bridged, it would be the agriculture sector where farmers have been trading their produce in an electronic market place via the internet and their mobile phones" (B2BpriceNow, 2003). Some of the major initiatives in developing countries have used the mobile phone and its Short Messaging Systems (SMS) feature as one of the main channels for the dissemination of market price information, especially in rural areas, as in the Xam Marsé ("know your market") of Senegal, CAMIS of Cambodia, Farmprice of Zambia, KACE-MILS of Kenya, TradeNet of Ghana, FoodNet of Uganda and RESIMAO/WAMISNet of West Africa. The use of the mobile phones by the fishermen of Kerala (Jensen, 2007) of South India in their daily business is one of the most noteworthy examples of effective mass application of cellular phones that helps to improve the livelihood of the rural community.

As our survey found, rural agriculture Information Services in Bangladesh are dominated by conventional dissemination channels, such as word-of-mouth, price boards, newspaper and sometimes radio. These are kinds of non-interactive Information Services which suffer from a lack of update, fail to provide market opportunities elsewhere and demand a greater physical presence to ensure authenticity.

On the part of the government, there have been some initiatives to disseminate agricultural product price information primarily to empower the farmers and the other primary stakeholders so that they can be benefited. As its first such initiative, the Department of Agricultural Marketing (DAM) of the Ministry of Agriculture of Bangladesh, with the assistance of the Food and Agricultural Organization of the United Nations (FAO), launched a web-based market information services (www.dambd.org) in June 2002. After the project was phased out, the same department launched an interactive but otherwise similar web-based Information Servics (www.dam.gov.bd) in 2006 which has been in place until now but was found to be ineffective as the rate of Internet penetration in rural areas is extremely low at only 0.09%. A study by Islam and Grönlund (2007) revealed that only 1.43% of farmers had heard of DAM's initiative, only 0.09% of whom had used website.

4. Findings of the survey

Understanding the access barriers, our survey was carried to examine the status of ICT inclusion and accessibility by the farmers, the association between satisfaction and technology and preference for technologies for accessing the channels of disseminations. The findings should help decision makers to offer feasible digital solutions to rural people who have been wider suffering a gap in digital accessibility of information in comparison to urban people.

4.1 Adoption of modern technology and satisfaction

The longitudinal survey first carried out in 2006 showed that the proportion of farmers using a computer is very low (3%), increasing to 16% of farmers who have heard about the Internet. The survey shows that only farmers with a high rate of literacy are likely to use a computer. The level of satisfaction by farmers with the profits they receive is about 20% lower than the average level of satisfaction by wholesalers and retailers. A test of significance

($\chi 2$) indicates that in the case of farmers there is no association between having a mobile phone and level of satisfaction; another way of saying this is that in the present context (e.g. lack of awareness and access to authentic information) owning a mobile phone does not make a contribution towards motivating farmers to earn higher profits. However, in the case of the other two stakeholders, i.e. wholesalers and retailers, it shows a positive association.

4.2 Choice of network and access devices

The survey found that 87% of mobile handset owners in rural areas have been keen on the Nokia brand while the rest preferred Siemens, Motorola, Alcatel, Phillips and Ericsson. Therefore, it seems that Nokia is in a good position to achieve its vision of connecting all the people of the world (Pedersen, 2006) by providing affordable universal access through mobile phones especially designed for developing countries. Among the variety of handsets in use in Bangladesh, 50% of Nokia owners have the N1100 model while 11% and 10% use the N1600 and N1110 respectively. The major reasons for this preference is, first, its affordable price (US $32 – 60) and, second, easy accessibility and some other useful features such as a built-in flashlight, which seems to be especially useful in rural Bangladesh where a shortage of the supply of electricity is acute. The black and white display of the Nokia 1100 model with its 96 x 65 pixels of resolution allows the user to customize the display with a selectable font size and up to 4 lines of text. This model has a long-lasting battery which gives the user a talk time of between 2 hours and 4 hours 30 minutes, and a standby time of up to 400 hours. However, although this model (and the range of models available) is SMS enabled, it has no WAP functionality as this would increase its price. Presently, Nokia has been adapting the native (Bangla) language in their range of low price models.

4.3 Understanding the access barriers

Knowledge of how to send text-based messages (by the Short Message Service, SMS) is still poor but has improved from only 8% in 2006 to 20% in 2007. Only 10% of all users have also used Value Added Services (VAS) and of those about 50% know how to use General Packet Radio Services (GPRS). It is noteworthy that according to the survey the SMS-based information service has failed to reach about 80% of the farmers, which has, thereby, created a new kind of 'digital feature divide'. The main reason for this divide is clearly a lack of alphanumeric literacy. As the interface of the mobile phone includes both numbers and letters, rudimentary literacy and numeracy are required to understand its features. This is a problem, especially where structured learning and levels of literacy and numeracy are low (Chipchase, 2007). This also suggests that rather than SMS, there should have been some other mobile phone-based mode of dissemination channel that could attract the people without formal education but who have a need to access some crucial content, such as agricultural price information. The possible solution in this case would be to adopt a voice message system or to employ human agents (e.g. in a call centre). According to the *Indian Express*, "Voice SMS helps address illiterate sections of the population who are otherwise locked out of value-added services. It eliminates linguistic barriers and thus has tremendous scope in rural areas. Unlike text messaging where one needs to know the exact language that the handset supports, a Voice SMS enables the listener to listen to the exact voice of the messenger offering the same cost-effective model as a text message, which is to say that it is free of cost for the recipient" (Talwar, 2007).

5. Towards a sustainable rural IS implementation framework

Heeks (2003) in his study finds that only 15% of rural IS projects are successful and this figure is even more disappointing in the case of developing countries. One of the big issues for rural IS is sustainability. Although some of the systems show success initially, later they have been found ineffective and institutionally unviable (Furuholt et al., 2008). According to Dhankar (2003), "India has 28 States and 7 Union Territories. Almost all of them have their

own system of providing market information to the farmers. However, these prevailing systems are mostly based on conventional methods due to which communication of information to target groups usually gets delayed losing its relevance. The system is also limited to collecting data on market arrivals and prices on transactions in the regulated market yards and disseminating through various media like radio, newspapers, blackboard display and public address system at market places". A study by Rhodes (2004) finds that the main reasons for failures of rural ICT in Africa are lack of connectivity, low tele-density, limited Internet access, scant ICT and computer education, limited literacy and minimal human and technological networks. In both cases, the situations represent most of the AMISs in the developing countries.

However, the more we can understand and identify the reasons for failures, the more we can ensure the probability of a project's success. The "significance of the development of sustainability implies that the ICT project process needs to be receptive to critical factors that play a role in promoting the sustainability of an ICT project in rural areas" (Pade et al., 2006). Heeks and Bhatnagar, as reported in Furuholt and Wahid (2008), identified ten such factors: information, technical, people, management, process, culture, structure, strategy, politics and environment. Furuholt and Wahid (2008) summarized these factors in three categories: management (of supply side), infrastructure and human factors (of demand side) though these can also be explained within the context of a gap between realities and design. While measuring the success or failure of a project, the concept of a reality-design gap (Heeks, 2003) is widely used. Based on our survey of the literature about information service projects especially in developing economies, this paper identifies several factors in Table 2, categorized under each part of Heeks' model of reality-design gap.

Table 2: Factors under the reality and design of IS project

Reality factors		***Design factors***
Need and goal	*GAP*	*Capacity building* *System and access tool design* *Process and content development* *Promotion and motivation* *Implementation and evaluation*
Infrastructure and capacity		

5.1 Need and goal factors

A clear vision, mission, goals, benefits, strategies and priorities (Bhatnagar, 2002; Ndou, 2004; WPCFR, 2002) are the pre-requisites for success of any project. However, it has been observed that most of the IS initiatives in developing countries simply replicate the theories and experiences of developed countries (Chen et al. 2006), and with their strategies separated from the implementation process (Rhodes, 2004). As a consequence, many result in failure as they do not meet local needs and address questions of sustainability. Different treatments are needed if they are to consider (local) social and technical issues (Islam and Grönlund, 2007; Rhodes, 2004). For an initiative to be effective, there must have been due consideration given to the social and economic context in which the project is implemented (Grönlund et al., 2005), because, "a good understanding of local needs, the best use of available resources, and effective joining-up with local partners are a good basis from which to start" (IDEA, 2008).

5.2 ICT Infrastructure

The first requirement for making an IS project sustainable in the long-term is to make the required technological infrastructure available in such a manner that the primary demand side stakeholders can have equal access to it (Dada, 2005). Other key elements of the success or failure of an IS project are: financial (flow of funds) (Dada, 2005), legislative (policy issues), human (skills, capabilities, education, learning), data systems and institutional infrastructures

(Othman and Rahmat, 2006). There have been many examples (e.g. b2bpricenow.com in the Philippines) that show how a project can be successfully run and expanded over time, primarily by being in good partnership and collaboration with public and private communities and networks (Ndou, 2004; B2BpriceNow, 2003). Above all, strong leadership and political commitment (Kaaya, 2006) must be there to make any initiative effective and the supply side "should clearly understand the importance of leadership, strong and sustained commitment, adequate training of the staff, consistent evaluation and monitoring of the performance, and institutionalization of the initiative" (Kumar and Best 2006).

5.3 Systems and access tools design

Islam and Grönlund's (2007) study shows that DAM's web-based AMIS for the farmers of Bangladesh failed because it did not address the access barriers of its main intended users. "One of the fundamental issues associated with barriers is the … gap between those with full access to electronic information and those without it due to such factors as socio-economic conditions, language barriers, physical situations, age, education, and so on" (Chipchase, 2007; Kaaya, 2006). Our survey shows that technology access barriers on the part of users have been found broadly in three areas: Behavioural, techno- and alpha-numeric skills, and affordability and availability of devices. Therefore, rather than depending upon the single access channel, the designers should consider alternative solutions and multi-channel access to services (De', 2006; Ndou, 2004; Othman and Rahmat, 2006).

Evidence shows that many projects in Africa were not sustained because they used English as medium of accessing content in place of considering the intended users' native language (Kaaya, 2006). In general, achieving the primary objectives will fail if the users do not have the ability to use the technology and to access useful information and services (Dada, 2005). Therefore, "multiple systems with different designs and localized objectives would help in the overall design of systems across large populations. This would help towards understanding diverse requirements of the people" (De', 2006).

5.4 Promotion and motivations

Promotion of the existence of a service and motivating the people on both the supply and demand sides are critical for realizing the objectives of a project and its widespread public adoption (Ndou, 2004; Othman and Rahmat, 2006). Educating the targeted beneficiaries is also part of promotion, because the "system would fail if the government did not take an active role in educating citizens about the value" (Kamar, 2007) of an IS initiative being undertaken.

5.5 Implementation and evaluation

"The implementation of IS and IT is more than putting the technology to use. It can be understood as encompassing the whole diffusion process" (Furuholt and Rvik, 2006). A proper implementation process is one of the vital, difficult and time-consuming tasks in any IS project. Even a well-designed service system may fail if it is not implemented properly and carefully (Blurtit, 2007; O'Brien, 2003). The implementation process involves acquisition, testing and piloting, documentation, training, installation and conversion activities to transform the services and make them operational for the targeted users (O'Brien, 2003). It is generally suggested that if the concept of a project is new in nature, it should first be tested in a small pilot tailored to a specific context (Ndou, 2004). Furthermore, it has been observed in most of the cases in the developing countries that projects are undertaken with inadequate preparation and thorough appraisals (Blurtit, 2007). Therefore, to make a project efficient, productive and above all sustainable, there must be a phase of project evaluation in the process.

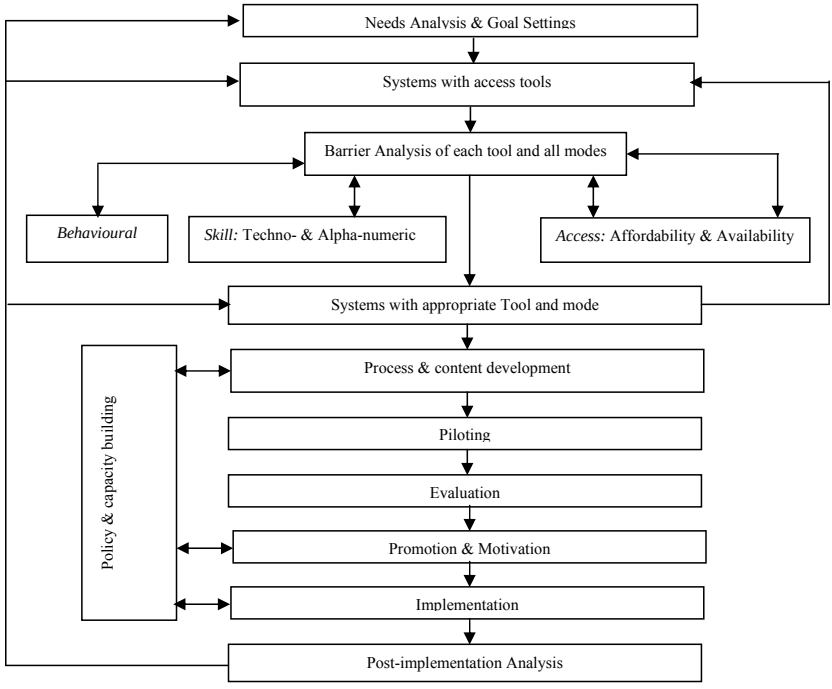

Figure 1: Rural IS implementation process (Source: current authors)

5.6 Sustainability and the proposed framework

"Most projects prove to be unsustainable in the long-run because they have not been accompanied by, or fail to generate the broader economic and social changes that would lead to sustainable demand for ICT resources in rural development" (Pade et al., 2006). Sustainability is a part of the development process that addresses the need of the present generation without compromising the needs of the future (Pade et al., 2006). It is a "key for the effective contribution of ICT to rural development, and for that reason needs to be understood and applied to the rural ICT project process" (Pade et al., 2006). South African cases of rural ICT also stress the need for sustainability to ensure effectiveness and community involvement and that it can be characterized by support from supply and demand sides, appropriate training, demand-driven needs, local ownership, entrepreneurship development, etc. (Pade et al., 2006). One of the biggest challenges is how to address these issues through a suitable framework (Mathur et al, 2005) that can be replicated and maintained in other rural environments (Pade et al., 2006). In fact, our literature survey shows that there is so far no holistic rural IS implementation framework, although there have been several frameworks for an e-government implementation process which indirectly address rural IS projects. Mathur and Sagarika (2005) argue that such a model should have three sub-frameworks: Implementation (6C model), Resource (PPP model) and Technology (ICT architecture model). However, these three models suffer from their isolation from the total implementation process and are not suitable when addressing any of the phases individually instead of holistically. UNESCO (2005) in its action plan on e-government describes the need

to define national level vision till the implementation. It also emphasizes on the infrastructure and capacity building issues giving less importance on access barrier agenda.

Based on the above analysis and findings, a framework on rural IS implementation process has been proposed in Figure 1. In it's first step (starting from the top), to address the need of those currently without ICT, there must be an understanding that people only accept change when there is an absolute need for it or have a personal interest in it, as any attempt to impose something (e.g. new technology) would find resistance (Smyth, 2005). The needs analysis is followed by the goal settings. The action of the process starts with a goal that is identified by the needs analysis of the targeted primary stakeholders so that it will satisfy the 'objects' (i.e. the objectives of the subjects, in common parlance). Here, for instance, the primary goal is to improve the bargaining power of rural people, especially the farmers ('subjects') by having them better informed – since they are currently deprived of easy access to information because of socio-economic and cultural realities (corresponding to desire as object) – via some time- and space-sensitive means (automatic operation) like mobile phones. In the next steps, the process is directed towards testing the usefulness of the initially presumed tools (artefacts) for the proposed system, which in this case may be websites, mobile phones or even FM/community radios. The barrier analysis undertaken during this step would broadly be behavioural or motivational, geared towards accepting the tool and corresponding mode (if any), alphanumeric and technical skills and access to technology or systems in terms of affordability and availability, which are subjected to an exploration for transforming and matching internalities in the real world through externalization. However, to make the situation more attuned to human activities, which is a precondition for the acceptance of a project, the artefacts should be more human-centric and appropriate across time and space. Therefore, the interoperability test may further be narrowed down to checking the feasibility of the mode of access (if there is any, e.g. in case of a mobile phone, this could be SMS, MMS, or IVR, i.e., Interactive Voice Response) to the tool finally chosen. In our empirical study, we found that IVR, voice or call-centre based (instead of text messaging) rural Information Services accessed by mobile phone is the most feasible tool for ensuring the sustainable use of an IS.

Furthermore, the implementation process shows that content development is the crucial part in terms of disseminating quality information, which is measured by time, content, form and presentation. For instance, providing price information for all agricultural produce may seem unnecessary; instead, farmers' priorities should be taken into consideration and the necessary process identified accordingly (whether push or pull) to disseminate the information in an understandable format (e.g. Bengali in terms of native language). Simultaneously, the policy and capacity building activities should be backed up by maintaining all efforts, which in this case means technical and non-technical support from governments and NGOs, mobile phone operators and other concerned stakeholders. In this example, the non-technical support could be funding, staffing and promoting new ideas to both supply and demand sides, and monitoring and analysing systems within the context of development for making it self-sustaining and effective over time. As IT is a cultural entity, it is influenced by economic and political actions and subsequently determines the likely impact of the systems (Kvasny, 2001). Finally, it can be concluded that the ever-changing trends of technology, with corresponding tools, may provoke the need for further analysis, which in turn will narrow the deprivation gap and strengthen the well-being of society in the long run.

6. Conclusion

The proposed implementation process is generic in nature and needs to be tested by empirical works. Therefore there is a scope of further research on this area in order to make it more sustainable. The success of IS implementation in rural areas, where most of the underprivileged people are found, requires serious effort and support by both supply and demand sides. To maintain the success and sustainability of such IS, the community should be involved in the design and implementation of the services to reflect the ever-changing

needs of the people in parallel with the changing trends of technology, or it will fail. The necessary resources must also be available for poor people to access the service. In addition, raising awareness among poor people about the potentials of such service is another aspect of successful and sustainable systems. Last but not least, regular monitoring and evaluation of IS are essential to achieving the required results.

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Mobile Diffusion and Development: Issues and Challenges of M-Government with India in Perspective

Kavita KARAN [1], Michele Cheng Hoon KHOO[2]
[1] *Nanyang Technological University, 31 Nanyang Link Singapore 637718*
Tel: (65) 6790 4570, Email: TKavita@ntu.edu.sg
[2] *Nanyang Technological University, 31 Nanyang Link Singapore 637718*
Tel: (65) 6790 4182, Email: michele_khoo@pmail.ntu.edu.sg

Abstract: Mobile telephony has emerged as the new frontier where governments around the world are making themselves more accessible through the remote delivery of government services and faster rate of data transfer. In developing countries, the lower cost of mobile technology as compared to Internet has allowed for the expansion of mobile government or m-government services to the poorer segments of the population. From a literature review on m-government, including the various strategies required and successive practices across the world, we build five parameters for a framework for evaluation of m-government services. These include *Infrastructural Investment, Regulatory and Political environment, Awareness and Acceptance, Security and Privacy, and Equitable Acceptance*. Using these factors, we review the m-government initiatives in selected countries both in the West, Asia and India. This paper provides an updated review of the current mobile government initiatives, including: m-government's facilitation of development; the issues and challenges in India; and, finally, proposes some strategies that can be adopted by India.

1. Introduction

Internet has enabled complete transformative changes in societies all over the world. According to Warkentin et al. (2002), governments are embarking on e-initiatives to improve the process and delivery of government services, transactions as well as communications with citizens and businesses. They recognize the potential of ICTs to bring about changes and increase efficiency and effectiveness in the public sector (Layne & Lee, 2001; Karan, 2004). Mobile telephony, on the other hand, can reach areas where there are infrastructure constraints for internet service or where wired phone service is not a viable option. Mobile telephony has emerged as the new frontier where governments are making themselves more accessible through the remote delivery of government services. These are subsets of the successful e-government strategies adopted by governments around the world.

What are the reasons for governments to embark on e-government initiatives? According to Heeks (2000), there are three main factors. First, the current level of expenditure on public services do not produce the desired level of efficiency and effectiveness due to wastage, delays, mismanagement and poor organization and management skills. Second, the revival of neo-liberalistic thoughts that emphasizes the importance of market competition, and the need for governments to adopt business mindsets. Third, governments are increasingly becoming aware of the tremendous potential of the rapidly developing IT sectors. Many countries around the world have been successfully using e-government tactics in delivering citizen services, feedback mechanisms, and there are greater levels of transparency and efficiency in

the transactions and levels of satisfaction among the citizens. However, though Internet is readily available in most countries, the people are either unable or unwilling to access public services over the Internet. As Fountain (2001) argued, the technology of the Internet does not mean the same thing to different governments and their people. Besides infrastructural constrains, there are also the concerns of digital divide and issues of inequalities amongst the people.

Hence, innovative efforts are being devised to deliver services through cheaper and easily accessible technology, of which the mobile systems are a great innovation. Using such wireless technology opens up new channels where governments can deliver services to the citizens through a more efficient and lower cost model (Ghyasi and Kushchu, 2004; Hossan et al., 2006). Through the review of studies done on m-government, we are proposing the following parameters of a framework for evaluation of m-government services: *Infrastructural Investment, Regulatory and Political environment, Awareness and Acceptance, Security and Privacy and equitable acceptance* (Sandy and MacMillan, 2005; Chandrasekhar, 2007; Karan, 2004). Using these critical success factors, through an in-depth case study, this study will review the m-government initiatives in selected countries in the West, Asia and India.

2. India – A move toward mobile telephony

India is on the threshold of mobile revolution. In a recent report, it is estimated that a large part of India's revenue comes from mobile data usage. According to Pyramid Research by 2012, India will be the fourth largest market for mobile data revenue in excess of USD14 billion, which is huge compared to USD 2.2 billion for all of 2007 (Pyramid Research, 2008). The government is planning to set up a 256 Kbit/s broadband service that encourages a majority of Indians to get enough data services from their mobile phones. Early 2008, one of the world's leading IT research and advisory company, Gartner Inc., predicted that India will have 6.9 million mobile and fixed Worldwide Interoperability for Microwave Access (WiMAX) connections by the end of 2011 (Lewis, 2008). At present, most states in the country are successfully delivering government-to-citizen services through e-government networks and are gradually using mobile channels, a move towards m-government. It is estimated that in the Government of India approximately 50%–60% of government services can be delivered via mobile channel through the m-government for mobile-enabled development (Chandrashekar, 2007). The Society for Promotion of e-Governance (SPeG) a non profit organization is also facilitating the various government agencies and helping them initiate mobile government projects in India. To date, the country has established various successful networks including *Nicnet* for connecting state and central Government offices; *Ernet* to connect Educational and Research institutions; *Railnet* to connect Railway networks and *Airline network* to connect the air ticket reservation and its services. Such initiatives are operationalized with minimum network bandwidth to ensure infrastructure longevity for at least ten to fifteen years (Ghosh & Arora, 2005).

Over the past decade India has seen a tremendous boom in cellular phone users. Today companies in India see the cellular phone as an advertising medium just like the radio, television and the internet. In the Telecom Regulatory Authority of India (TRAI) report released on Jan 1, 2008, Internet subscribers increased to 9.63 million at the end of September 2007. This means a higher proliferation of Internet across India and with the wireless market grown by 13% with an addition of 24.15 million subscribers in quarter ending September 2007, there is a substantive increase in the mobile phone users. The net savvy generation also increased the Broadband subscribers to 2.67 million at the end of September 2007. People are looking for higher speeds for better content and online advertisements. The subscriber base for wireless services has increased from 184.92 million in June 2007 to 209.07 million in September 2007, whereas subscriber base of wireline service has decreased from 40.09 million in June 2007 to 39.58 million in September 2007. According to Kurrup (2008), it is estimated that today one in four Indians owns a mobile

phone and that by 2020, every employed adult in the country would have one. However, it is true that network coverage and mobile penetration are still limited in some of the remote rural areas (Adler and Uppal, 2008).

3. Objectives of Research and the Methodology for the study

The objectives of this research are to examine the strategies of mobile usage by governments across the world and evaluate the factors facilitating development, particularly in moving from e-government to m-government. Through the factors identified, and from examples from around the world, we study India as a case with the challenges faced by the country and propose a framework, which the Indian government could consider in their mobile government applications. Secondly, we felt that this framework is a holistic roundup of the issues surrounding the successful implementation of m-government initiatives that are relevant to India. It is mooted after detailed review of past and present research on m-government projects around the world. Thirdly, this framework and analysis would serve as a reference point for most of the developing nations in their adaptation and use in implementing m-services.

A case study method was used (Reinard, 2001; Wimmer and Dominick, 2006). The framework was developed from the literature review across the countries around the world. Sandy and MacMillan (2005) on examining the available literature on m-government conclude that there are six factors critical to any m-government success. These include: Cost, Business re-engineering, Education, Acceptance, Security and Access. Further studies in other countries added to the factors that influenced the success of m-services and the study was built on the framework of five factors; see above (cf. also Welch and Wong, 2001; Trimi and Hong, 2008; Shin, 2007; Kushchu and Kuscu, 2004; Sandy and MacMillan, 2005; Gupta, Dasgupta and Gupta, 2008). The framework with the five factors will be applied to analyze the m-government initiatives in India.

4. E-Government to M-Government

What is the difference between electronic government (e-government) and mobile government (m-government)? Simply put, mobile government is one of the manifestations of electronic-government. It also appears as the natural move from the e-government efforts, where citizen services are being delivered through the computer networks building epistemic societies and easing the lives of individuals particularly among the people in rural areas (Hossan et al., 2006; Karan, 2004). According to Zálešák (2003), m-government is a subset of e-government but with the unique feature of allowing freedom of mobile access to services and information at any time and from any place. It goes beyond just provision of information via mobile phones to the citizens, but includes more complex utilization of all wireless-based devices and platforms including mobile phones, PDAs and the ubiquitous Blackberry.

Governments in Asia are beginning to see the tangible gains in using mobile government applications. According to Business News & Technology News (2008), global mobile phone subscribers were 3.1 billion in 2007 and are expected to reach 4.5 billion in 2012. In Asia, the industrialized countries, such as Japan, South Korea, Hong Kong, Taiwan, and Singapore, have some of the highest penetration rates of mobile phones in the world, and every country in the region has mobile telephone usage exceeding Internet use. This gap is in fact even more pronounced in developing countries. With pre-paid mobile services, poor economies are also able to reap the benefits of mobile communication technologies as governments are able to tap on the mobile channel to communicate with the people. For example, in the Philippines, more than half the government departments use mobile channels to deliver services to the citizens (Smith, 2005).

According to Zálešák (2003), government's mobile services contribute in two general ways. First, mobile services allow for the easy sending of information to citizens through Short Message Services (SMS) directly to their mobile phones. The second way is almost

transparent to the citizens as it involves the streamlining of government processes and making them easily available to the citizens. For developing countries, with limited ICT or Internet penetration, mobile services present interesting opportunities for the government in both investment and technological points of view as this does not require extensive infrastructure or hardware, and, equally important, the issue of training in the use of this technology is circumvented as it is easy to manage mobile phones.

5. M-Government Applications, Strategies and Best Practices

In this section, we will discuss some of the m-government applications around the world, and specifically in Asia, learning from their successes and challenges of the various m-government applications within these countries. The tacit assumptions of most m-government initiatives is grounded largely within the power-knowledge framework linking technology to development and the need for the undeveloped to play catch-up with the developed. This is essentially the essence of modernization theory (Schelkle et al., eds., 2000).

This paper does not seek to critique the process of technological development per se as there are indeed many positive contributions that the various electronic and mobile government initiatives have brought to people. Rather, we want to understand the factors that contribute to the success of such initiatives and discuss how that could be applied to India's emerging m-government initiatives.

5.1. Infrastructural Investment

For developing countries, one of the main hurdles in jumping into the bandwagon of m-government is perhaps the cost of infrastructure development. Managing this factor is indeed critical for the success and failure of any m-government project. Granted that not all e-government or m-government initiatives entail huge financial investments, most of the projects do require a certain portion of the nation's budget. Researchers such as Rahul and Sen (2004) have shown that with the appropriate business model, these projects can be successful and self-sustaining. To move forward and garner more private sector support and participation, it is proposed that the government leverage on the advantages of public private partnership (PPP) to move towards providing mobile services to its citizens.

To date, though the Indian government is portrayed as a main driver of infocom development in India, it is unfortunately unable to motivate many private operators to join in the broadband bandwagon. This is largely due to the low PC penetration in the country resulting in low demand for broadband usage. Though the PC penetration rate is very low in India, the mobile penetration rate is extremely high. According to a report published by Paul Budde Communication Pty Ltd (2007), a research company, the Ministry of Communications and Information Technology (MCIT) of India is targeting 250 million telephone subscribers by end-2007 and 500 million by 2010. The government recognizes the great potential of telecommunication industry in helping the country to move forward. Besides telephone subscribership, the country is also seeing a mobile market boom, with annual growth rate approaching 90 percent in 2007. Overall, India with total revenue of US 22.4 billion in 2006 for the telecommunication market (ibid.) is an indication that there is much room for the private sectors to come in and play a pivotal role together with the government in developing m-government initiatives.

Public Private Partnership (PPP)

Hall and Soskice (2001) suggest that one of the main purposes of privatization of public services is to establish a possible comparative advantage though cost effectiveness. Governments are increasingly working with the private sector to jointly develop the required infrastructure and the subsequent management of nation-wide technology services. M-Taiwan is an example of the "*Build and Operate*" model where PPP allows the government to invest only a minimal sum to get the required infrastructure and the subsequent maintenance and

delivery of services. The entry of the private sector encourages efficiency and value-added services with profits as a strong motivator. It is a win-win situation for all parties – government will be able to deliver the required services; the private companies are able to generate profit and the citizens are able to gain wider mobility and access to information and services.

There are similar costs sharing initiatives in Singapore where industry players have been playing active roles in many government's IT projects. The Infocomm Development Authority (IDA) of Singapore reported that in 2007, about S$730 million worth of ICT tenders were called with a total of S$2.12 billion committed on 654 contracts. Overall, the Singapore government will be spending a total of S$1.14 billion (US$833 million) from 2008 to 2009 on new infocomm projects. One of the more ambitious projects is that the country will be building a broadband network to deliver high speed connectivity to all homes as well as offer wireless broadband network throughout Singapore. Though the IDA is overseeing the project, the network rolling out is executed through a PPP. This move will not only create the required public service broadband network at a much reduced cost to the government, but will also spur the growth of the related sectors such as broadcasting and digital media.

One of the recent PPP project in India as announced in 2008, is a $2-billion PPP to provide broadband and internet connectivity in India's rural areas. $1.5 billion for the project would be generated from the private sector and the balance would be funded from government sources. It is felt that the concept of PPP is important for the Indian government to further develop the mobile technology in the country, including broadband and mobile communication especially in the rural areas, as they do need private sector's contribution to bring the country to the next level of m-government.

Common Service Centers

The Common Services Centers (CSC) are part of India's National e-Governance Plan (NeGP) developed by the government in 2006 to launch e-governance nation-wide. CSCs promise to deliver cost effective and high quality video, voice and data on education, health, government services as well as entertainment to the end users. Importantly, such centers are able to introduce web-enabled government services to the rural areas of India such as service application forms, payment services and certificates. The CSC scheme is a good example of how the private sector can become a partner of the government in the development of the rural sections. As discussed earlier, PPP is a viable option when implementing m-government services. Under the PPP model of CSC, there are currently three-tier structure where the first tier is the Village Level Entrepreneur (VLE); the second tier is the Service Center Agency (SCA) which takes care of around 500 to 1000 CSCs and finally at the top of the structure will be the State Designated Agency (SDA) which is selected by the State government to oversee the implementation of the scheme at the state level.

Drivers of Growth for Mobile Services

Mobile Device penetration – one of the key drivers for the growth of m-government in India is the high level of mobile penetration in the country. As discussed above, mobile subscribership will reach 500 million by 2010. As with other developing countries, India's rural residents often perceive mobile phones as a valuable resource and are inclined to share its usage with family members and even friends at no cost at all. According to a LIRNEasia (2007) study, 80 percent of poor Indian households in which at least one member owns a mobile phone, close to half of them share their phones with family members and even non-family members.

Mobile Internet Services – One of the key to the success of m-government is the implementation of services that are relevant and useful for the needs of the end-users. These services are sometimes called hybrid services. One such example is the DakNet service by United Villages, Inc. to bring Internet connectivity to isolated rural villages in India. Villages are fitted with WiFi kiosks that villages can use to search for jobs and even make travel

arrangements. The implementation process is customized to suit the localized needs of the people. There are many mobile access points (MAPs) which are small base stations mounted on buses or motorcycles. When these vehicles pass through the villages, the kiosks, which have been storing information from the user's offline, will connect to the MAPs and the messages will be uploaded and downloaded accordingly. As the routes that are plied by these vehicles are mostly through the villages, most messages are delivered with 6 hours. DakNet hopes to expand to more than 50,000 villages by 2011.

Mobile Payment models – One of the promising services for mobile-phone initiatives is m-commerce. M-commerce would be important to India as in the country, as a small percentage of the population currently has a bank account. Some of the banks in India have already introduced mobile banking to their customers. For example, ICICI Bank and ABN Amro Bank have services where customers can check account balances, transfer funds and even pay bills. Telcoms such as Airtel has also partnered with VISA and the banks to promote mobile bill payment and prepaid phone top-up services. Subscribers can also pay for movie tickets, sporting events with their phones (Bollier, 2006).

5.2. Regulatory and Political Environment

Levels of Government

Political stability and a favorable regulatory environment to facilitate m-government initiatives are some of the most important concerns for effective functioning. The constitutional division of the government function in India is very much like that of the federal government system of the United States. It is basically divided into three levels – Central government level, State level and Municipal level. One area where mobile technology is deemed important in India is perhaps its contribution towards the democratization of access to government services. With the digitization of information and the convergence of technology, citizens are able to gain easy access to government information at all levels. Hence a crucial issue for India would be close cooperation and collaborations amongst the various levels of government which will harmonize their joint efforts.

Policy Development

In India, the government began to realize the importance of developing the telecom industry and decided to revisit its telecom policy and in 1999 set up the National Telecom Policy, which separated the licensing and service provisions, as a precursor to corporatizing. Subsequently, in the early part of 2001, the Indian Group of Ministers (GoM), chaired by Finance Minister Yashwant Sinha, formally approved the draft of the nation's Communication Convergence Bill (CCB). Perhaps the most significant component of the bill is its creation of the Communications Commission of India (CCI), which would act as a super regulator overseeing telecommunications, broadcast, and information technology (Menon, 2004). These policies have helped India to engage competitively in the information highway market. With strong centralized government and policy support, the Indian mobile market has moved from a duopoly market structure to a competitive market with the current four service providers in the market providing mobile services (voice and data).

In India, based on the targeted audience, there are now wide arrays of terrestrial and satellite based solutions to choose from for the service providers. For example, leading Internet service providers such as Sify, BSNL, Pronto Networks, and Dishnet Wireless have setup Wi-Fi networks in airports, coffee shops, and other locations in metropolitan areas allowing for mobile services via telecommunication devices. In Mysore, India, WiFyNet has installed a city-wide Wi-Fi network of 130 square km. In the Pune municipality, the state government has partnered with Intel and developed a city-wide Wi-Fi network of 400km square. Such partnership with governmental and policy support can create community wireless networks that can help the country reap rapid results.

5.3. Awareness and Acceptance

At the Division of Public Administration & Knowledge Management (DPADM) of the United Nations, there are often requests for support from the UN member states for their effort in programmes to raise awareness as well as in education and training in m-government initiatives for development (e-government development in Africa: Progress Made and Challenges Ahead, 2008). Once the required infrastructures are in place, the next step will be to look towards creating awareness and fostering acceptance amongst the citizens as well as the various government departments. This would include *increasing mobile wireless literacy; developing the relevant skills through training in the various agencies and departments, as well as redefining the various governments' products and services for implementation in the mobile arena*. Any e-government or m-government initiative would be pointless if the acceptance rate by the citizens is low. Process participation by citizens is crucial for the success of m-government programmes. The various government agencies need to coordinate the diffusion of the necessary information and services to the mobile platform. The high mobile penetration rate will facilitate a high level of acceptance amongst the citizens.

Appropriate training and induction is essential to ensure minimal disruption to services or cause unnecessary stress for both the agencies involved and the users. In the Southern Indian state of Karnataka, land records have been computerized and there are also applications for monitoring activities covering developmental programmes, addressing public grievances and disaster management. There is also a VSAT based communication network that supports real-time data applications for power generation and distribution. For these changes to be implemented successfully there needs to be proper dissemination of information as well as educating the workforce about the potential benefits, and training is a must to ensure a smooth transition (Ghosh & Arora, 2005).

In India, with its diverse land areas and variations in social and economic status of its people, acceptance of any new e-government or m-government initiative is crucial for its success. In Madhya Pradesh, the *Gyandoot* project was welcomed in the drought-prone area as it provided the villagers with vital government information and documents such as income and residence certificates. Project FRIENDS (Fast, Reliable, Instant, Effective, Network for Disbursement of Services) in the Kerala State of India is well-received as it gives the people the convenience to process bill payments in one local centre. At the same centre, the AKSHAYA project provides diverse information and government services that local people can access. These two initiatives are very well-received by the people as they have helped to develop social networks and generate entrepreneurial activities that, in turn, increase the productivity of the local people (Zambrano and Dandjinou, 2005).

In Bangladesh, a survey by Hossan, Habib and Kushchu (2006) to understand *e-Citizens Service Application* system found that more than two thirds of the government officials were not clear about the government's initiatives, indicating that there is a lack of coordinated briefing within the various government departments. For future m-government strategies to work, then training of officials, managing information and instant feedback systems would be essential for disseminating such services.

5.4. Security and Privacy

Security and privacy concerns are perhaps the most important considerations for both the government as well as the citizens in any m-government projects. There needs to be *data integrity* particularly in relation to loss and theft as well as *transaction audit* and *transparency*. There should also be secure storage of data. Security issues are of special concern for policing work, which is a highly networked activity. A mobile network must be highly secured in order to enhance police efficiency. In New South Wales, Australia, the NSW Department of Health maintains a high level of system security as they are sending health warning messages as well as health-check reminders to its citizens' mobile phones *(*Al-khamayseh et. al., 2006). In the United States, the Virginia state was the first to launch a

wireless state portal, "*My Mobile Virginia*" that allows government services to be accessed via wireless and mobile devices. According to Moon (2004) the Virginia m-government system is protected by encryption and subscription requirements to prevent any possible tampering and the mobile services are protected by the same security measures as the Virginia government portal, hence generating trust and acceptance from the citizens.

According to Chang and Kannan, (2002) mobile technologies are more susceptible to security breaches as the devices are easily stolen and have relatively weak built-in security measures. There are three main areas of security concerns for mobile technology – *network infrastructure, software applications and device problems.* Other researchers such as Mitra (2004) propose that factors including *IT skills, system security* as well as *network acceptability* are crucial for e-government or m-government police activities.

Examples from around the world have shown the importance and problems of security and privacy to both the government and citizens. In the Philippines, the success of the Text 2920 project where crimes can be reported with SMS was hindered by the lack of public trust for the security and privacy of the people. The citizens are concerned that their particulars are not secure and will be leaked out if they were to make a report (Alampay, 2002). In Kenya, the M-PESA project would not have been a success if the users are not confident that their money is secure in the system as the M-PESA system allows the user to use their mobile phones like a bank account, where they can credit their account at their local telecommunication provider, and then use it to pay for a wide range of services without the need to use cash (From e-Government to m-Government, 2007).

In India, the Information Technology Act which came into effect in 2000 allows for official documents to be authenticated with digital signatures and also provides for various security measures for digital signatures.

5.5 Equitable Access

Equitable access to information is one of the most vital principles in the emerging global information economy. In countries around the world, with the rise of mobile technologies, there is an increase in the number of services being developed that cater to the localized needs of the people. Ideally, the interface must be able to adapt and cater or facilitate the needs of the various socio-economic groups. Gender differences, illiteracy, poverty and urban rural divides have been some of the causes of digital divide (Luca and Sylla, 2003; Mathison, 2003). Some researchers, e.g. Lee, Tan and Trimi (2006), have argued that m-government initiatives can help to bridge the digital divide caused by uneven distribution of internet connectivity, especially in developing countries.

In China, the 150 million mobile phone owners can now send SMS to the officials of the National People's Congress. In the Philippines, half of the cabinet agencies have SMS-based services that allow citizens to ask for information or to comment and complain about government officials and services. In the UK, the London police has a service that sends alerts to businesses in London about security threats; including bomb alerts and other attacks. At the height of the SARS incident, the Hong Kong government sent a blanket text message to six million mobile phones in a bid to allay fears from rumors about the disease (From e-Government to m-Government, 2007).

In the city of Turino, Italy, the government has launched an m-government initiative, *BluTo, w*hich uses Bluetooth technology to provide inherent located content to citizens and tourists. As the Bluetooth technology is based on short range connectivity, it is able to provide data transfer at zero cost; the public administration of the city feels that it is an important and useful technology to overcome the concern of digital divide as all individuals with a mobile Bluetooth device will be able to receive useful information and services (Carcillo, Marcellin and Tringale, 2006). Likewise, in the city of Mexico, there exists an intelligent city project, *Digital Tlalpan* that incorporates electronic services through mobile technologies linking the government departments, the universities, hospitals and the private

sectors. One expected outcome of this initiative is to bridge the digital divide between the people through the creation of digital community centers.

6. Discussion and Conclusions

M-government is the new emerging system of delivering citizen services and a subset of e-government. The latter is a platform where information and communication technologies are used to enhance public sector services or the delivery of the government services. When m-government initiatives come into force, the switch is to a platform that focuses on wireless technologies such as mobile phones, laptops and PDAs that are connected to Local Area Network (LANs) making services available anytime and almost anywhere to both government officials and citizens.

Through this paper, we have attempted to sieve through the huge amount of research that has been done on ICTs and e-government as well as the emerging researches that are being done on m-government to identify some factors which we feel will impact the success of an m-government project. We identified five factors – *Infrastructural Investment, Regulatory and Political environment, Awareness and Acceptance, Security and Privacy* and *Equitable Access.* Through a preliminary review of some of the projects around the world and in India, it is proposed that in order for India and any country to successfully implement a full-fledged m-government platform with a plethora of public services, the following issues based on the five factors need to be addressed.

First, the domestic telecommunication device manufacturing industry will need to keep up with the demand in the services sector, as the majority of the demand for telecommunication equipment and technologies is currently met through foreign imports. According to a World Bank report in 2006, there is a huge untapped market in the Indian mobile sector with the country's three key growth drivers in telecommunication: a) *competition* which has ensured that India currently has one of the lowest tariffs in the world; b) *effective regulator* in the form of TRAI, an effective and trusted independent regulator; and c) *market potential* as India positioned to take over China as the next telecom sector boom with the falling tariffs resulting in increased usage levels.

Second, related to the infrastructural development, is the extension of telecom services to the rural areas of India to aid in developmental projects. As proposed in the earlier section, a public private partnership (PPP) may be the most viable option for the country. Given the uncertainties involved in undertaking such large-scale investment, more cohesive business models with co-sharing of risk and greater interlink between the private sector investors, and the government would be more desirable. We feel that it is a win-win situation with the government and the operator sharing the cost of building the required infrastructures. As Gupta and Jana (2003) conclude, India is lagging behind due to poor infrastructure and the corresponding slow response to the emerging cyber-culture.

Third, India still lacks a robust framework for data protection and ensuring the privacy of the users. As Gupta and Jana (2003) suggest, India will need time to catch up with the big cities such as New York, which has had huge investment and much more lead time to build up a system that protects the citizens' information from unauthorized access, damage, modification or disclosure.

Four, the adoption of an m-government platform does present India with the opportunity to bridge the gap between the haves and have-not in the country. As Singh and Sahu (2008) suggest, mobile phones distribution, unlike computers, is not restricted to those with higher socio economic status. The mobile phone penetration in India is much higher than its internet penetration rate. Moving to a mobile platform may be the right direction for India in the bid to bridge the digital divide. Already the changes are apparent as the mobile systems are being used extensively for commercial purposes, as Indians are being targeted by local and transnational companies for promoting products and services

Finally, if privacy, security and control measures are put in place through various hardware mechanisms, m-government services will greatly enhance efficiency of the

government sectors, greater government – citizen interface, political participation, transparency, reduction in mediating and exploitation by middle men and corruption, which are already being felt through the e-government strategies in India and other Asian countries (Chand, 2006; Ghosh, 2003; Karan, 2004). Therefore, in conclusion, though India is still at the initial stage of most of its m-government projects, it certainly has the potential to adapt the ways the country can leverage on the emerging mobile technologies to enhance the quantity and quality of its public services.

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Poster and Demo Abstracts

Preparing Students in Africa for Social Entrepreneurship in Mobile Technology: Current and Future Efforts in Senegal

Christelle SCHARFF[1], Anita WASILEWSKA[2], Mamadou BOUSSO[3], Ibrahima NDIAYE[3], Mbarou GASSAMA-MBAYE[4]
[1]*Pace University, New York, USA*
Email: cscharff@pace.edu
[2]*Stony Brook University, Stony Brook, USA*
Email: anita@cs.sunysb.edu
[3]*Université de Thiès, Thiès, Senegal*
Email: mamadoubousso@gmail.com, ibndiaye2004@gmail.com
[4]*National Council of Negro Women, Dakar, Senegal*
Email: mbarou.gassamambaye@gmail.com

Africa is the fastest growing mobile phone market in the world. Mobile phone subscribers have risen to more than 200 millions. The role of mobile phones is however still limited by the number and scope of available mobile phone applications – in particular applications specific to the needs of the African market.

An important question to be asked is: Who will develop the mobile phone applications that will have a social impact on the populations of Africa? We believe that African students will play a crucial role but need to be prepared appropriately as software developers/engineers and entrepreneurs to be actors in this promising field. There are currently very few initiatives that focus on exposing African students to mobile technologies and most of them target English-speaking countries (e.g., EPROM http://eprom.mit.edu).

The University of Thiès and the National Council of Negro Women (NCNW) in Senegal (a francophone country) and Pace University and Stony Brook University in the US are currently collaborating together to enable undergraduate computer science students of the University of Thiès to work together on the development of mobile phone applications that will empower women owning traditional businesses in Senegal. In parallel, the students will be educated on the potential and procedures for creating start-ups to commercialize their products.

A model called ICTESen (Information and Communication Technologies Entrepreneurship for Senegal) was established to support these goals. It is based on:

1. Creating a community of students, faculty, practitioners and local associations.
2. Providing the students with skills for mobile application development and entrepreneurship.
3. Applying the acquired knowledge to work on “real projects” for “real clients” to develop “real solutions”.
4. Deploying the solutions to trained clients.
5. Transferring the acquired skills to the creation of start-ups.

The ICTESen model will be implemented at a bootcamp that will take place at the University of Thiès in January 2009. During the bootcamp, the students will develop mobile

phone applications for seven women, the “real clients”, who work in the art, craft, textile and fishery sectors and are incubated by NCNW. Thus, the innovative aspect of our approach is that it focuses on having Senegalese students develop mobile phone applications for Senegalese businesses and making a social impact in their local communities. The needs of the women were assessed in July 2008. The mobile phone software that are considered crucial by the women are accounting software that would permit them to control their sales and spending and make them distinguish private from business spending. One association was interested in educational mobile games for young children.

To increase the chance of having mobile phone applications successfully deployed in Senegal, students from Stony Brook University are currently developing mobile phone applications that will help students in Senegal have more concrete ideas and a starting point for their own applications. Additionally, to ensure commercial quality for the developed applications, students will iteratively improve their prototypes during and after the bootcamp with feedback from stakeholders (e.g., clients), mentors (e.g., industry leaders) and peers (e.g., students in Senegal and the USA). The mobile phone applications will be deployed on phones that will be provided to the women. Students will train the women such that they can use the mobile phone software efficiently. The perception of the usefulness of the mobile phone applications and their impact on the improvement of the lives and businesses of the women will be evaluated through interviews.

This poster presents the project, the ICTESen model, the needs of the women in terms of mobile phone applications, and examples of mobile phone applications to be developed during the bootcamp.

Acknowledgement

The wiki of the project is available at http://www.mobilesenegal.com.

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Open Hardware and Software Solutions for Mobile Services

Alberto ESCUDERO-PASCUAL[1], Louise BERTHILSON[2]
IT46, Stockholm, Sweden
[1]*Tel: +46 702 86 7989, Email: aep@it46.se*
[2]*Tel: +46 706 50 6749, Email: louise@it46.se*

1. Introduction

During the M4D Conference, IT46 demonstrated three technologies where we have been involved in the last two years:

- **Media Sprinkler**: The Media Sprinkler is a GSM telephony gateway that bridges services of the global mobile network (GSM) with the Internet (IP). The main goal of the system is to provide a flexible architecture that helps to develop innovative applications that require the use of mobile phones and short message services (SMS).
- **Celliax Asterisk**: The latest addition to the Media Sprinkler is Celliax and Skypiax, two new communication channels that provide a low-cost access to the GSM and Skype networks. IT46 has integrated the open source drive of Giovanni Maruzzelli, an Italian open source developer with experience in applying technology in challenging areas.
- **Free telephony project**: The free telephony project provides free hardware designs for telephone systems. Both the hardware and the software are open. You are free to copy, modify and re-use the hardware designs.

This paper focuses on the Media Sprinkler in terms of its technology, functionality and possible applications.

2. The Media Sprinkler

The *Media Sprinkler* is a GSM telephony gateway that bridges services of the global mobile network (GSM) with the Internet (IP). The main goal of the system is to provide a flexible architecture that helps to develop innovative applications based on mobile phones and short message services (SMS).

Apart from being able to handle SMSs, the sprinkler also acts as a complex audio mixer, capable of routing GSM calls to the traditional phone network or linking calls between different GSM operators. What makes the sprinkler attractive is its portability which enables the possibility of deploying a SMS server without the need of being directly connected to the operator's wired network.

In a nutshell, the Media Sprinkler integrates in a single unit, a connection to the GSM (mobile telephony), the PSTN (fix telephony) and IP network (Internet).

3. What can be done with the Media Sprinkler?

The *sprinkler* provides a simple way to develop new applications, hiding to the programmer the more complex aspects of dealing with Internet and GSM calls. The possibilities are

endless as the platform can easily be adapted within hours to implement any new service. For example, the platform allows:

- The creation of new information services via voice or SMS, suitable for campaigns, media coverage, password reminders, etc.
- The interconnection of GSM phone calls between different operators.
- To record and play pre-recorded messages from and to any voice media.
- To publish SMS content into the Internet (web, mail, Twitter, etc.).

4. History

The first version of the system was known as the SMS-G2 (GSM SMS gateway). It was designed in 2007 as part of the communication platform for Drumnet in Nairob, Kenya. The development of the GSM gateway was founded by the International Development Research Centre of Canada.

The system was deployed as part of the Drumnet initiative, a project of PRIDE Africa that is building agricultural and financial services using SMSs. The first release of the system (February 2008) provided a simple and flexible interface to send and receive SMS via two Kenyan providers, Celtel and Safaricom.

As a result of that experience, a second version of the prototype has been developed. The Media Sprinkler of September 2008 adds new functionalities to the previous version. The system now has the possibility of (1) sending bulk SMS, (2) forwarding SMSs to web services such as *Twitter* and (3) interconnecting scheduled phone calls to any pre-recorded content (playback).

5. Technology

The media gateway is the result of integrating several open source projects into a low-power platform that includes the VoiSmart VGSM PCI card. The core software of the unit runs GNU/Linux (Debian etch 4.0), asterisk 1.4.x (open source PBX) and vstuff 1.0 (vgsm channel driver).

Applications that want to make use of the GSM services can interface directly with the unit by means of the Asterisk Manager API or a set of high level PHP5 libraries.

6. Sample applications

As a proof of concept and in order to illustrate the flexibility of the platform and how quickly we can develop new applications, we have written a set of sample applications.

1. SMS bulk scheduler

The application allows scheduling distribution of bulk-SMS to a selection of phone numbers.

2. Incoming SMS to Email/Twitter

The application allows the processing of incoming SMS and the posting of the content to a third party Internet site such as Twitter.

3. Automatic GSM call forwarder with playback

The application allows scheduling calls and playbacking a pre-recorded message

4. Phone number harvester

The application allows identifying active GSM numbers and tracking their status.

7. Functionality

The *Media Sprinkler* has all the functionality of the asterisk open source PBX plus all the possibilities that emerge from connecting the Internet and/or the PSTN (traditional phone system) to the GSM network.

Current features include:

- Sending and receiving SMS
- UTF8 Support
- Processing of incoming SMS
- SMS to Twitter Gateway
- GSM call forwarding to PSTN, GSM or IP networks
- Playback services
- SMS load balancing by means of huntgroups
- Autonomous deployment (no need of direct wired connection to a GSM SMPP/HTTP gateway)
- Low power (<20 Watts)
- Extension of GSM coverage (~30 Km)
- Call privacy and call identification privacy

Features under development include:

- GSM call forwarding to Skype, Gtalk, etc.
- GSM and SMS billing system

Acknowledgement

Information on further developments is to be found in the News column of http://www.it46.se/.

Changing Mobile Phone Usage in India and Its Impact on Social Identity

Sridevi PADMANABHAN
Cluster of Excellence "Asia and Europe in a Global Context", Graduate Program for Transcultural Studies, University of Heidelberg
Tel: +49 178 6900597, Email: sridevi.padmanabhan@gmail.com

The study aims to explore the economic and social changes in low-literacy and low-income populations in India, brought about by the introduction of a relatively new communication technology – the mobile phone.

Modern communication technologies have been developed and essentially tailored to fulfil the needs of the high-income, literate populace that is characteristic of developed countries.

My contention is that low-income populations in the process of adapting this communication technology have made it an integral part of their identity.

An ethnographic study, which includes in-depth interviews and participant observation of mobile phone usage, rituals and patterns, both in social and economic spheres in rural populations is my planned method of research. An initial historical study of the mobile phone industry in India, along with probable material in the form of focus group data and group discussions, will also add to this.

My idea rests on several observations:

- A majority of low-income, low-literacy populations have a fluid and temporary identity. They lack any form of permanent identification and are under the radar of governmental and institutional surveillance. For a migrant population, the mobile phone could be an integral part of constructing identity.
- The so-called 'emerging market' has circumvented technological, physical, educational, amongst other barriers to creatively use mobile phones to uplift themselves. The mobile phone's varied adaptations are many – whether as a tool to access banking, increase profits, or in instances of community ownership of a mobile phone, or illiterate people using the mobile phone [1], [2], [3]. The huge second-hand markets for mobile phones, the unorganised mobile repair industry, are all instances of this localised usage which do not find widespread discussion in the concepts of 'emerging markets'.
- This interesting aspect of "vernacular globalization" [4] has low-income and rural populations engaging with a global, modern communication technology, to construct an "alternative social imaginary" [5] through their non-traditional uses and adaptations of it.

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Epihandy Mobile – A Mobile Data Collection Tool

Charles TUMWEBAZE[1], Frank NKUYAHAGA[2]
Faculty of Computing and IT, Makerere University, Kampala, Uganda
[1]*Tel: +256 712513893, ctumwebaze@cit.mak.ac.ug*
[2]*Tel: +256 752503147, hagafrank@cit.mak.ac.ug*

Abstract: In this paper we describe an application for data collection on mobile phones. We present our Epihandy mobile application from a user perspective and then explain some underlying concepts and details. Main features include a user interface optimized for mobile phones to enable data collection.

1. Introduction

We describe our application from a user's perspective. Epihandy mobile is divided into two parts, namely the mobile device application and the server application. The mobile device application runs on Java enabled mobile phones, running on cldc 1.0 and midp 2.0, and the server application runs on desktop computers.

2. Epihandy Main Menu

After starting our program, the main menu is displayed, giving the user a number of options to choose from as shown in Figure 1.

Figure 1. Main Menu

The various items are explained in the following paragraphs.

Select Study: Selects a study from a list. A study is a collection of related forms. The selected study is the one used when downloading forms, or selecting forms for data entry. Examples could be Malaria Study, Tuberculosis Study, etc.

Select Form: To display a list of forms for the selected study, you will be able to select a particular from for data entry.

Download Study List: Downloads a list of studies from the server. This function will download information about available studies on the server (this option will not download the actual forms for the study). A user will then be able to select a study of interest and subsequently download only those forms that relate to a study of interest.

Download Forms: Downloads a list of forms for a selected study from the server.

Upload Data: Sends data to the server using the selected connection type. This uploads data entered for all studies loaded on the device.

Settings: To set the connection type and other applications properties.

Logout: To end a user session. Logout can be used to switch users without quitting the application.

When the main menu is displayed, the user can select Exit to close the application.

2. Usage

When running the application for the first time, you will be required to enter a username and password. If no users are downloaded from the server, you will be able to log in with username user and blank password. These are used when connecting to the server for downloading form definitions. (Access to the device does not mean access to the server as this requires a valid username and password).

When downloading form definitions, a list of valid users will also be downloaded. When connecting to the server for the first time, you will be required to choose a connection type (HTTP, Data Cable, SMS, Bluetooth, or File). This will be saved as the default connection type.

This connection type can be changed by selecting the Settings menu and then choosing the appropriate Connection item.

Using Epihandy Mobile requires a user to:

- Download a list of studies. (Download Study List) menu item.
- Select a study from the menu items.
- Download forms for the Study. (Use Download Forms menu item).
- Enter data to Forms. Only one form can be used for data entry at a time
- Upload captured data to the server. (Use Upload Data menu item).

Epihandy Mobile was created with off-line mode capabilities with data being stored on the phone until a connection to a server is available for upload.

3. Data Entry

When the user chooses the Select Form item in Figure 1, a list of available forms, in the selected study, will be displayed as shown in Figure 2(a).

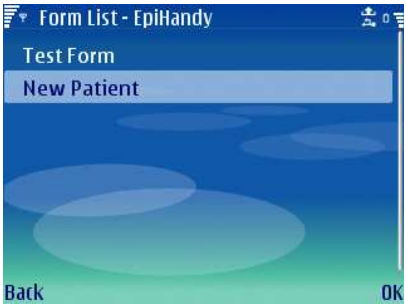

Figure 2. (a) Select Form

Figure 2. (b) List of Collected Data

The user selects the form he/she wishes to capture data for. A list of previously collected data, if any, for the selected form will be displayed as in Figure 2 (b).

For a selected form, there is a submenu with options for New or Delete data (Figure 2c). When selecting existing data items the data form will be displayed (Figure 2d). This record/item can now be edited.

Figure 2. (c) Submenu for New/Delete Data

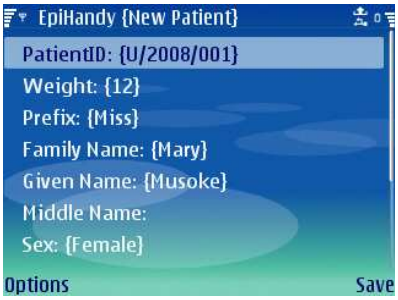

Figure 2. (d) Display Existing Data

When a form is opened, the form questions will appear, with data, if any, at the end of each question text. The user can edit an answer to the question by just selecting it, which opens up an editor appropriate for the question. E.g. editor for dates will be different from that of numeric inputs, single-select inputs (such as Mr, Mrs) or multiple-select questions (see examples in Figures 3–5).

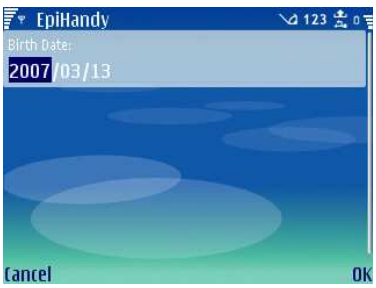

Figure 3. Date Editor

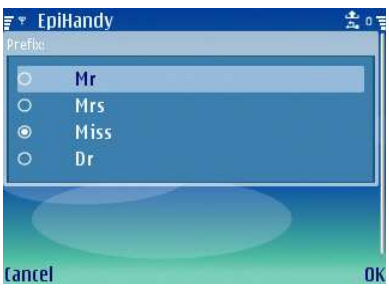

Figure 4. Single Select Editor

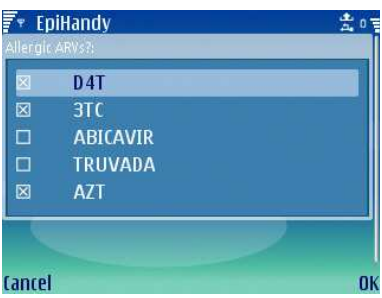

Figure 5. Multiple Select Editor

If a form has more than one page, users scroll between the pages by using Next Page and Previous Page items in a submenu. Users can select Cancel to close the form without saving.

4. User settings

Epihandy Mobile allows the user to customize General Settings and Connection Type.

Under **General Settings** there are two options:

- *Single Question Edit*: Tick this to display one question at a time on the phone screen during data entry. If unchecked, Epihandy mobile will display more than one question during data entry.
- *Background Save*: Tick this to automatically save data, in the background, as you fill forms. This guards against data loss in the event of sudden application failure, e.g., if the phone battery runs out.

The Connection Type menu specifies the method of connection to the server. Available connection settings are the following:

- *HTTP*: To connect to the server over GPRS or WiFi. A valid URL of the server is needed, e.g., http://localhost:8080/openmrs/moduleServlet/xforms/xformDownload.
- *Bluetooth*: To connect to server using Bluetooth, one will need to specify the Bluetooth address on which the server is listening.
- *Data Cable*: When using a data cable to connect to the server.
- *SMS*: To send data to server as SMS, the user will need to supply the number of the modem that the server is connected to.
- *File*: To save data as files on, say, the phone's memory card and then transferring them manually to the server.

5. Server Application

This is the application the mobile device application connects to on the server so that it can download forms and upload data. The services that can be provided here are Bluetooth, SMS and HTTP. A dropdown list provides available services that a user can choose to start or stop.

For one to use these services, the server machine has to have the necessary hardware to support the service e.g. for Bluetooth, the server machine has to have Bluetooth hardware to support the service this applies to SMS and HTTP as well.

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WPSS: Wireless Patient Surveillance System using Zigbee standards

Amr Mohamed, Tarek Elfouly, Shima Ibrahim, Fatma Y. al-Kuwari, Fatma al-Qahtani, and Eman al-Sulati
Department of Computer Science and Engineering, Qatar University, Doha, Qatar, P.O.Box 2713
Tel: +974-485-2899, Email: amrm@qu.edu.qa

The goal of this project is to design and implement a wireless sensing system for monitoring patient state heart rate and provide patient charts that help track the patient well-being and produce alerts and notifications for patient critical events. This is advanced technology, but it will be helpful not only in industrialised countries but also in regions of the world where hospitals do not have a wired data communication infrastructure.

By the WPSS system, we present a proof-of-concept of wireless patient monitoring system. The system measures the patient heart signal and performs three major processing stages including analogue to digital conversion, heart beat detection, and communicating patient heart information between the sensors and the host central system. The WPSS system leverages the ZigBee emerging standards for communication between the sensors and the host central system. The host provides a user interface to display patient charts and provides alerts and notifications representing critical events pre-configured on the patient server subsystem PSS. WPSS has been deployed to several sensor platforms, which all use a full running ZigBee stack provided by microchip.

The project undergoes four stages, namely: measurements using patient monitoring device (PMD), signal processing, communication, and analyzing. In the first stage, measuring patients' heart signals will be performed using outfitted sensors, and fed to the patient server subsystem (PSS) as continuous analogue signals. In the second stage, analogue signals will be processed via attached low-power microcontrollers that are used for filtering, digitizing, and preparing digital signals for communication. In the third stage, patient information is transmitted through wireless interface to a server, and stored into a database. In the Final stage, the host is responsible for analyzing patient information and producing alarms reporting the patients' critical conditions.

The system architecture is shown in Figure 1.

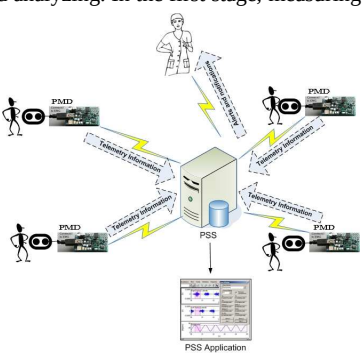

Figure 1: WPSS System Architecture

In short, the main objectives are:

- Measuring patients heart rate using sensor
- Processing measured information using microcontroller
- Implementing a heart beat detection algorithm
- Sending the processed information through wireless interface to a host
- Analyzing and saving patient history in a database
- Providing a user-friendly interface that helps the doctors or the nurses to interact easily with the application to query specific patient information.

Report from the Workshop

“Collaboration in East Africa: Project Planning”

Workshop Report: Collaboration in East Africa

Johan HELLSTRÖM[1], Ali NDIWALANA[2]
[1]*Upgraid, Kampala, Uganda*
Tel: +256 753 932 939, Email:johan@upgraid.org
[2]*Faculty of Computing and ICT` Makerere Univ., Uganda*
Tel: + 256 752 408 498, Email: ally@dicts.mak.ac.ug

Abstract: A follow-up to the Nov'08 "First M4D Workshop in East Africa", Kampala, was held during the M4D 2008 conference focusing on areas for concrete project planning, esp. networking, dissemination, and coordination.

1. Background

A lot has been said about mobile phone usage and its potential to spur development in developing regions. But have we really seen anything interesting that goes beyond voice communication and simple SMS? Many may have heard about the developments in the Philippines, and in Kenya the m-banking application called M-PESA is fairly well discussed and known. A few might have heard of the innovative usage of FrontlineSMS[1] and RapidSMS[2] (SMS bulk tool and management systems that allow mass-messaging, monitoring and data collection) by civil society organisations in the region. The M4D conference in December 2008 has shed light on some more application types, but let us step one month back. "The first M4D Workshop in East Africa", sponsored by Sida and organised by the Directorate of ICT Support at Makerere University, Uganda, Knowledge Consulting Ltd and UPGRAID, clearly showed that there are far more applications around than the well known m-banking and mass-messaging tools.

More than 80 participants from all over East Africa, some travelling all the way from South Africa, UK and Sweden, came to Kampala the 5th and 6th of November, 2008, to learn more about mobile application development and share knowledge regarding mobile developments in the region. The main conclusion drawn from the workshop was the realisation that there was need for more collaboration and networking, across different sectors and across borders. This will help the mobile fraternity to learn more about what is going on in different places, facilitate generation of new ideas and strategic partnerships, and hopefully help learn from one another by building on what has come before and through this moving forward. The workshop proved that open, inclusive and neutral multi-stakeholder forums are key in facilitating knowledge sharing, awareness building and networking among a diverse field of stakeholders.

All the participants have played an important role in generating the "M4D in East Africa Plan of Action". It consists of four main themes, which attempt to address many of the challenges identified by the participants. The themes include:

1. The creation of a **M4D in East Africa Forum** with specific working groups for continuous networking, sharing of ideas, knowledge and developments. Six specific working groups have been/will be created, namely:

[1] www.frontlinesms.com
[2] http://sourceforge.net/projects/rapidsms

- East African m-health Association,
- East African Programmer/Tech Association,
- East African m-agriculture Group,
- M4D Research Group,
- M-banking Taskforce, and
- East African mGovernment Group.

2. To make the **M4D in East Africa Workshop an annual event** and use it as a mechanism to evaluate progress, see what needs to be done and brainstorm on solutions. The M4D in East Africa Forum will facilitate in-between the workshops, helping to provide continuity.
3. Setting up **M4D Innovation Centres** to pilot and scale-up projects. The innovations centres will be connected to the East African Universities.
4. The development of a sustainability **M4D Tool Kit** for mobile application projects consisting of standards, regulations, sector reviews, compatibility, funding etc.

It is now up to key stakeholders to push the East African agenda forward. In line with this call, SPIDER sponsored a workshop in conjunction with the M4D 2008 Conference in Karlstad, Sweden, 11th and 12th of December, 2008. The workshop was meant to build directly on the outcomes from the Kampala workshop and had as its goals to:

- Bring the knowledge and experiences presented in Kampala to Sweden;
- Have experts (academics and practitioners) within SPIDER's network + some additional experts to meet around the Kampala themes;
- Investigate and discuss some selected project ideas/proposals raised in Kampala in order to form strategic alliances with already formed groups in East Africa for further collaboration.

2. Karlstad Discussions and Outcomes

After a plenum presentation at the M4D 2008 conference about the workshop sponsor SPIDER by Karoline Beronius, the workshop itself (consisting of 20 specially invited persons and several interested conference delegates) started by providing an overview of the current situation regarding mobile telephony usage in East Africa. Data from Research ICT Africa's *Household e-Access and e-Usage Survey* was presented. Conducted in 2007 and 2008, the survey covered 23,000 respondents across 17 countries in Africa. Sticking to the East African context, amongst the population of 16 years old and above, 52% in Kenya have a mobile phone or an active SIM card. In Rwanda the figure is 10%, while in Tanzania and Uganda 21%.

When it comes to expenditure, people seem to spend more or less half of their disposable income on mobile communications as summarised in the table below. This seems to resonate with a few presentations in other sessions at the conference that examined whether mobile expenditure was diverting meagre resources away from other critical needs of the poor.

Table 1: Monthly mobile expenditure

	Kenya	**Rwanda**	**Tanzania**	**Uganda**
Monthly mobile expenditure in US$ / monthly income US$	16,7%	10,3%	15,4%	10,8%
Monthly mobile expenditure in US$ / monthly disposable income US$	52,5%	65,5%	28,9%	48,6%

2.1 Challenges and obstacles

The RIA survey also shows that people below the poverty line are not gaining money by owning a mobile phone. Given this background, challenges and obstacles regarding mobile phone usage were articulated and discussed. Some of these included:

- There is a lack of training and skills development (both in relation to application development as well as usage)
- Language is still a big barrier in different ways. There are plenty of local languages to take into consideration. Local language literacy is also an issue as fluency in speech does not necessarily equate to fluency in reading and writing that particular language
- Documentation of actual network coverage is not authoritative (or the actual quality of the network), while subscriber numbers are computed in a myriad of ways
- Issues of total cost of ownership and affordability for end-users are not always given due consideration or when considered, are not made explicit to end-users
- Awareness of what has been done before and lessons learnt from the process is rather limited because of the limited documentation and sharing (regarding existing applications, solutions and possible usage)
- Sustainability is still a big deal and is not given due consideration from the onset of most projects. Hence many projects tend to die as development partners or other initiators move on
- Scaling-up applications and solutions is still a big challenge. Many tend to stagnate at or fizzle out at the pilot stage
- Coordination and collaboration among stakeholders across different sectors as well as across borders is practically non-existent
- Plenty of regulatory issues still need to be addressed and these will require some form of harmonization across East African for better impact
- Appreciation of consumer rights and their enforcement as well as understanding of customer obligations are all still largely under-developed

How can these challenges and obstacles be addressed? Different ideas were mentioned during the workshop and many of these were already captured in the Plan of Action, which was commended as a good starting point. A challenge especially highlighted at the Karlstad workshop was the need to identify willing and responsible actors and defining reasonable time lines within which different action points would be accomplished. Further, it was recommended that a business model/plan should be developed and written for each and every action point. A question was also raised concerning quality assurance mechanisms and how the actors would be able to measure real impact. This would not be something only for the donors' sake, but is also important in helping to make the applications and services more sustainable and scalable. Suggested reading on this topic is the newly published compendium *Impact Assessment of ICT4D Projects* (Richard Heeks and Alemayehu Molla, 2008[3]).

2.2 Initiatives in other parts of the world

In order to make the M4D in East Africa initiative successful it is important to network with already existing initiatives in other parts of the world wherever possible. India, the Philippines and South Africa were mentioned as interesting countries to partner with.

[3] www.sed.manchester.ac.uk/idpm/research/publications/wp/di/di_wp36.htm

Some other ideas were to link the M4D Tool Kit theme with Tactical Technology Collective[4] who recently developed a tool kit called *Mobiles in-a-box: Tools and Tactics for Mobile Advocacy*, which is a collection of tools, tactics, how-to guides and case studies. The actors of the M4D Tool Kit idea should also look at Betavine[5] that supports and stimulates the development of new applications for mobile phones.

Actors responsible for the M4D Innovation Centres should look at iDISC, the infoDev Incubator Support Center,[6] which is a virtual networking and knowledge sharing platform for incubators and technology parks leveraging ICT to facilitate entrepreneurship and new business creation in developing countries and learn from their successes and failures. It should also be in line with EPROM (Entrepreneurial Programming and Research on Mobiles) and their Mobile Phone Programming Curriculum initiative[7].

2.3 M4D Innovation Centres in East Africa

Regarding the notion of setting up M4D Innovation Centres in East Africa to pilot and scale-up projects – this was something discussed and developed quite extensively during the workshop. An idea was mooted to start a collaborative program and deployment to be run by Eastern African universities and collaborating EU universities to promote a regional mobile content and services provider sector, with the aim of promoting sustainable economic development through mobile technology and services. Such a program will promote collaboration between Eastern African universities, with universities and research centres abroad and the mobile industry for a sustainable social and regional economic development. A data base of research areas and innovative mobile services research and development works in Eastern African universities will speed up the setting up of incubation support for venture start-ups, on mobile technology and services.

Makerere University in Uganda and University of Nairobi in Kenya will brainstorm and explore different avenues that will help them to generate a proposal to make the M4D Innovation Centres idea a reality.

2.4 Gaps and a Government Digest on M4D

Other issues discussed during the workshop were the gaps between academics and practitioners, and between developers and end-users.

Given the hierarchical decision making structure in the East African society, we need to find ways to bridge the gap between the technical people (and their solutions) and the senior management (the ones in power who are looking for solutions) in the private sector. The East African M4D Forum should strive to identify mobile champions in companies and government institutions and get them interested and involved. In the discussion that followed a brief m-governance presentation the conclusion was that there are many possibilities using the mobile phone in citizen-government interaction: during emergencies, civic education such as health and environment campaigns, and in attempts to empower the citizens (through transparency, accountability) etc. Innovative mobile phone usage will also, most certainly, reduce man-to-man interaction which will lead to fewer possibilities for 'kitu kidogo' (kiswahili for something small). But how to bridge the gaps mentioned above, and the gaps between middle and senior management? An idea that came up is to create a regular "Government Digest on M4D" that goes out to senior managers and ministers periodically, which should empower them and make them look wise by educating them about available solutions that are yet to be rolled out or have been rolled out elsewhere.

We need to benchmark, map, document, and present case studies to demystify the technology. This is valid not only for senior management but also the end users too. Related

[4] http://mobiles.tacticaltech.org/
[5] http://www.betavine.net/
[6] http://idisc.infodev.org/
[7] http://eprom.mit.edu/

to this – **M4D research should be available and presented in an understandable format** not only meant for academics but for all, including the end-users.

2.5 Duplication of efforts

New initiatives need to connect to and build on already existing or past ones to avoid duplication. At the moment, too many pilots are doing more or less the same thing without taking into account what their counterparts might have already learnt. It is important to ask the question what is the application good for and what is the business rationale? Someone will need to pay for the solution in the end, let it be the government or the end-user. In the discussion that followed, the question of why mobiles are not used more among organisations in developing regions did come up. The key factors, according to one of the participants include: cost factors, lack of technical know-how, and the suitability of applications to people's existing needs.

2.6 Conclusions: Reaching decision makers, sharing knowledge, long-term views

It was agreed that there is a need to identify and make the decision makers in the East African region aware of the possibilities of using mobile phones for development. This coupled with more and better avenues for knowledge sharing amongst the different mobile initiatives will help to provide a solid foundation for mobile application development in East Africa. If/when donors have a role to play in it they should commit themselves for a long term and not only fund assessments, workshops and ad-hoc projects. This will increase sustainability, local ownership, and the much needed scaling up.

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Read more

http://m4d.kcl.co.ug/
http://groups.google.co.ug/group/M4DinEA
http://m4d.humanit.org/
http://www.spidercenter.org/

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