

A Study of Connectivity in Millennium Villages in Africa

JYOTSNA PURI, PATRICIA MECHAEL, ROXANA COSMACIUC, DANIELA SLONINSKY, VIJAY MODI, MATT BERG, UYEN KIM HUYNH, NADI KAONGA, SETH OHEMENG-DAPAAH, MAURICE BARAZA, AFOLAYAN EMMANUEL, SIA LYIMO

Abstract— The Millennium Villages Project (MVP) is a community-based comprehensive multi-sectoral approach to achieving the Millennium Development Goals (MDGs) in Africa over a five-year period. MVP and Ericsson’s Consumer Lab collaborated to investigate the baseline conditions for enhanced connectivity and integrating mobile telephony in MVP sites. It is hypothesized that this will accelerate the achievement of the MDGs through improved communication and availability of information. Using quantitative and qualitative methods, the research team aimed to assess the effects of network strengthening and strategic integration in the context of a rural village in a low-income African country. Four Millennium Village sites were examined for this study on connectivity: Bonsaaso, Ghana; Dertu, Kenya; Ikaram, Nigeria; and Mbola, Tanzania. The survey results from the sites showed common attributes for mobile phone owners but usage trends differed across study sites. Given the results, in three of the four sites, there is a significant market to be explored for voice services to be strengthened and made more easily available in terms of infrastructure and costs. Lessons drawn from these sites can provide us with useful insights into the potential for development and use of mobile phones in the rest of the continent, in addition to providing useful policy implications.

Index Terms— Mobile Phone, Rural Africa, MDG-s, Health, Education, Small Business.

I. INTRODUCTION

INFORMATION and communication technologies (ICTs) are critical catalysts for accelerating economic development. Previous research has demonstrated that ICTs are able to enhance access to people and information, economic opportunities and aid businesses, as well as promote health and education [1] [2]. A 2008 World Bank policy paper classified the overall implications of mobile phones for sustainable poverty reduction in direct benefits (macro-economic level, impact on GDP), indirect benefits (reducing market inefficiencies) and intangible benefits (e.g. implications for health and education)¹ [1]. However evidence of the impact of ICTs on development indicators in developing

countries is sparse.

In this context, Ericsson and The Earth Institute, Columbia University initiated the Connectivity Monitoring and Evaluation Study in 2009 to understand potential for economic and social effects from increased access to mobile voice and data communications in the poorest rural parts of Sub-Saharan Africa. The Millennium Villages Project (MVP) is a community-based comprehensive multi-sectoral approach demonstrating the feasibility of achieving the MDGs throughout different regions in Africa over a five to ten year period. The main idea behind the project is that villages can transform themselves and meet the MDGs if they are empowered with affordable science-based solutions. The key institutions involved in the implementation of the MVP are Millennium Promise (MP); the United Nations Development Programme (UNDP); the Earth Institute at Columbia University (EI); and most importantly, the communities and local, district, and national government agencies. The MVP is purposefully linked to the communities and national processes to ensure sustainability and scalability by the governments.

MVP and Ericsson have been collaborating to conduct targeted research in the project sites, beginning with the analysis of pre-existing MVP baseline data on access to information and communication technology (ICT) and complementary qualitative survey work in four MVP sites—namely Bonsaaso, Ghana; Dertu, Kenya; Ikaram, Nigeria; and Mbola, Tanzania.

II. LITERATURE REVIEW

On the macro level, ICT infrastructure rollouts can have a positive effect on a developing nation’s growth [3]. It is the micro level, however, that is receiving increasing attention as ICTs are now viewed more as a “critical enabler” in the development process rather than as its ultimate goal [4]. Studies have shown that improved market information flows, higher productivity, and increased business and employment opportunities are all benefits brought about by ICTs [3]. Interventions that leverage ICT for primary education include the use of radio, television, Internet, and mobile technologies for mobile learning. As the number of Internet subscribers in Africa continues to grow exponentially (the number of subscribers in South Africa alone increased from 370,000 in 2000 to 2,853,453 in 2001), governments and NGOs seek to

¹ The World Bank 2009 study titled “ICT for development Extending Reach and Increasing Impact” shows that an increase of 10% in mobile phone adaptation in developing countries is associated with growth in GDP per capita of 0.8%. Information and Communications for Development: Extending Reach and Increasing Impact. 2009, The World Bank: Washington DC.

provide more PCs to children with the hopes that Internet access will foster a sound primary education [5-6].

Empowering women in developing countries has important social and moral underpinnings and is also an essential factor contributing to women's ability to achieve improved health and reduce mortality and morbidity [7]. Gender equality can be achieved by increasing women's access to education, technology and economic resources, as well as improving their health and reducing susceptibility to disease and violence. By "leapfrogging" the standard telecommunication structure, mothers can now call ahead to clinics to inquire on the availability of doctors before traveling for hours to receive care for their children [8]. Most of the adverse conditions experienced by expectant mothers can be prevented or treated with reproductive health services, antenatal care, trained health workers assisting in delivery, and access to emergency obstetric care [9]. Efforts using ICTs include establishing electronic medical records systems, introducing emergency toll-free numbers, disseminating educational information on child and maternal health via SMS to pregnant women, enhancing diagnostic and treatment support for health workers, creating call centers and utilizing telemedicine, and providing health workers—particularly midwives, paramedics, and traditional birth attendants—with mobile phones [10].

Mobile phones present an opportunity "to address and positively impact many health challenges facing resource-poor countries" [11]. Only with multi-stakeholder cooperation can implementation obstacles (ineffective regulatory regimes preventing new investment, business models for rural ICT access that are not financially sustainable, ICT solutions that do not meet the needs of poor communities) be addressed [4].

III. OBJECTIVES

The aim of the Millennium Villages Project Connectivity Study is to better understand the current and potential uses of mobile information communication technologies (ICT) in achieving the Millennium Development Goals. Specifically, the study's objectives are to understand the profile of current users of mobile phone and their phone usage practices; to assess the potential impact of mobile accessibility in health, education, small business and household sectors; and to understand barriers to a wider uptake of mobile technologies and related services, while suggesting policies to overcome these barriers.

IV. METHODOLOGY

The Millennium Villages represent a unique setting for investigating the impact of various development interventions. Four Millennium Village Project (MVP) sites in Africa were examined for this study. Village clusters included in the study are located in rural areas of Ghana, Nigeria, Kenya and Tanzania and represent a combined population of approximately 120,000 people.

The study uses a mixed methods approach, combining quantitative and qualitative methods to identify trends and assess the potential of mobile data and voice communication

technologies. It analyzes Millennium Villages Project (MVP) baseline survey data and qualitative interviews in four MVP sites in Ghana, Nigeria, Kenya and Tanzania across different sectors/population groups, namely health, education, small businesses and households. Baseline data was collected in 2006/7 and covered 1021 representative households. Semi-structured interviews during May-July, 2009 complemented baseline data. A total of 235 interviews were conducted by trained local interviewers in the native language of the respondents, digitally recorded and then transcribed and translated into English. An average of sixty interviews was conducted by the MVP team per site (67 Bonaaso, 59 Dertu, 51 Ikaram, 58 Mbola). Respondents were also approximately equally split among sectors: 74 households (representing trends within the general population with a focus on agriculture and cross-sectoral uses); 39 health- including administrators, clinic staff, community health workers (CHWs); 67 education- including administrators, teachers, and students; and 55 small business enterprises. Respondents were purposefully selected within the research sites to be mobile phone users, and were not compensated for their participation in the research.

To the extent that the occupational, educational and poverty characteristics of these sites represent most areas in Sub-Saharan Africa, lessons drawn from these sites can provide us with useful insights into the potential and use for development in the rest of the continent.

V. RESULTS

The results show that the introduction of mobile phone networks has the potential to influence human development in remote villages. Three out of four people interviewed expressed that they benefit socially and/or financially from being able to use a mobile phone. Expanding the experience from the study combined with the ongoing growth in subscriptions we believe that a large majority of the approximately 57 million people living in rural areas in these four countries could benefit from mobile communications with reasonable levels of investment in additional telecommunications infrastructure.

Mobile phone usage trends and their potential for impact on livelihoods differs across study sites, depending on the communities, their overall level of connectivity, and the duration and dependability of network availability. Mobile phones are likely to be owned by households that are on average better educated, involved in activities other than agriculture, male headed, and are relatively better situated economically. However, the direction of causality needs to be examined more.

In this section, we discuss main trends in use of mobile phones for the four study sites. To understand the results of this study it is useful to locate the four sites on a hypothetical 'connectivity' scale, locating Dertu-Kenya, a pastoral nomadic community in North East Kenya, at the lowest end (most recent in getting connectivity) and Ikaram-Nigeria, a peri-urban community in Ondo State, at the highest end (longest to have had connectivity). Bonaaso-Ghana and Mbola-Tanzania

are located in the middle - both have had connectivity for similar periods of time.

A. Dertu, Kenya

Dertu, Kenya is the most recently connected. In absolute terms there has been dramatic growth but the overall level of connectivity development is still low. Associated behavioral, cultural and professional patterns clearly mirror this. In 2006, there was no mobile network present in Dertu and the MVP baseline study shows that less than 4% of the population in Dertu used mobile phones. Interviews in 2009 show that a community that is otherwise semi-nomadic and predominantly pastoralist has many critical applications for mobile phones, and these are being rapidly deployed. Interviewees emphasized the role of mobile phones in providing health services, ensuring labor mobility and lowering transaction costs. Voice calls are the predominant means of communication. Monetary sacrifices and a rapid change in behavior patterns underscore that mobile phones represent a need in the community where there is still inadequate infrastructure - poor roads, lack of electricity and slow postal service.

B. Bonsaaso, Ghana

The study site of Bonsaaso, Ghana is located a little higher than Dertu on the connectivity scale. In 2007, 14% of the households owned a mobile phone. On average mobile phone users are more educated compared to those in Dertu. The population is also market oriented and cocoa is grown in this rain-forest region for commercial purposes. To alleviate the barriers due to poor physical infrastructure, mobile phones represent an important source of connectivity for personal and business activities. In 2009, there were multiple operators providing service in the site and a greater use of mobile applications. Small and medium business enterprise owners emphasized their ability to explore new opportunities and keep in touch with their customers. In addition to the benefits they expressed, residents claimed that they have to make sacrifices to own and use a mobile phone.

C. Mbola, Tanzania

Mbola, Tanzania is similar to Bonsaaso on the connectivity scale with similar road and other infrastructure conditions. At the time of the baseline survey in 2007, more than 10% of the population of the cluster owned a mobile phone, slightly higher than the national average. The population of the cluster is also more educated than the other two sites, and its poverty levels are lower. In-depth interviews reveal that the most important impact in Mbola is observed in the health sector, where they reported using mobile phones to respond to emergencies, saving lives and consulting doctors. Similar to the other two sites, people make sacrifices in their daily lives to acquire and use mobile phones.

D. Ikaram, Nigeria

Ikaram, Nigeria has been connected for the longest period of time and has the best access to roads and electricity. In 2007, 53% of the population in the village cluster owned a mobile phone. In 2009, qualitative interviews show that the use of mobile phone complements physical infrastructure (like roads,

electricity) and the availability of social services in this peri-urban site. In addition to voice, SMS services and other customized applications are used, (including radio and Internet) illustrating a more mature ICT environment. One fourth of all interviewees stated that they used mobile phones for transferring money and remittances. Use of mobile phones is especially important for business and enterprise owners at the site. Uses and operational costs of mobile phones in health, education and business are taken for granted in Ikaram. In contrast to the other sites, residents in this site did not mention sacrifices in livelihoods for using their mobile phone. However there is a demand for cheaper or free phones and many interviewees own mobile phones that were gifted to them.

VI. DISCUSSION

The countries included in this study account for approximately 250 million people of which 150 million live in rural areas [12]. In 2006 at the time of the MVP baseline survey, addressing connectivity impact of the poorest of the poor of the rural population, 40% of the rural population in Sub-Saharan Africa had mobile phone signal coverage [13], but only 5% of the rural population actually used a mobile phone. These figures are changing rapidly: In 2009, mobile subscriptions had risen to cover 42%² of the 250 million inhabitants. The potential for expansion of ownership and use of voice and data services is significant. Benefits of mobile phones are consistent across sites with respect to health, education, income generation and households.

A. Potential for Health Sector

In the literature, benefits related to health emanate mainly from an increased ability to address emergencies and communication to access transportation, health services, and health-related information. Mobile phones are being used to monitor and support children under 5, pregnant women and newborns and to generate records on patients via applications such as ChildCount+ (Refer to www.childcount.org).

For this study, in-depth interviews were conducted with almost 10%³ of the health sector workers in the Millennium Village clusters who provide health services to households. The most common reasons and benefits for mobile phone use were to address emergencies (30 out of 39 respondents) and for consultations between health staff (26 out of 39 respondents). Other health-related uses included access to medications in the case of drug stock outs and supply chain management (23 out of 39 respondents) and reducing mortality rates (22 out of 39 respondents). The use of mobile phone in health sector has been consistently similar across the research sites. In each site, at least one example of the use of mobile phones was provided in which the ability to communicate and mobilize transportation was thought to be associated with saving a life (Refer to Chart 1).

For example, in Dertu a 33 year old woman stated:

² Estimate based on Informa Telecoms and Services. Data reported by mobile phone operators.

³ The total number of health care workers in the 79 Millennium Villages are 800.

“It was my husband who was bitten by a snake, so a neighbor who was having a phone called the MVP staff in Dertu and reported the incident so the MVP sent us the vehicle to my husband and they really saved because from the time he bite till the next day he was in comma the treatment that he received in the Dertu hospital has improved his status.”

In Ikaram, health workers underscored the use of mobile phones for medical information related either to administration or patient care. The use of cameras was described by interviewees as an important application that they could use to take pictures and transmit for diagnostic and treatment support. Today, this use is primarily voice and SMS. As networks expand and 3G and Mobile Broad Band are brought in, the potential for images will be unlimited. On a large scale, two targeted uses of mobile phones lend themselves to large-scale effective deployment.

The first application is the use by health workers in facilitating better provision of quality health care. In this study, 39 health workers were interviewed. All of them used a mobile phone and most of them (36) owned one and testified to its utility. Health workers surveyed acknowledged that mobile phones are an essential part of their activities and that being able to consult with colleagues over difficult or emergency cases made them more efficient and more confident in their work (23% of interviewed health workers) (Refer to Chart 1).

A 27-year-old female, who works at the Keniago clinic in the CHIPS zone in Bonsaaso, describes:

“There was an emergency at Fahiakobo which I called the midwife to help and also during the IOD session, I had a problem so I called for assistance.”

Numbers for health workers in rural areas across Sub-Saharan Africa are unavailable but in Nigeria there are approximately 115,000 health traditional and skilled community health workers (all in rural areas) in 2004 [14]. Conservatively assuming that all four study countries have at least 200,000 health workers in rural areas, mobile phones represent a strategic means to create a cadre of well trained and accountable health workers who are easily accessible and whose reach and quality of care can be extended through mobile technology.

The second application is the use of mobile phones in reducing mortality. In all four countries, mortality rates are very high. On average across the four countries, at least 330 of 1000 adults will die between the age of 15 and 60 every year. (In Tanzania this number is 504) [15]. Similarly child mortality rates (deaths of children under the age of 5) are very high (on average 142 deaths per 1000 live births).

Using the following numbers, there are approximately 300,000 medical personnel (including nurses/midwives, physicians and pharmacy personnel) in these four countries, and 40% of the combined population is rural and lives below the poverty line, it is estimated that health services are not easily accessible to about 100 million people [12]. Many deaths can be avoided with improved access to transportation and emergency medical services (Refer to Chart 2). In our sample, more than two-thirds of the health workers used mobile phones to attend to emergencies and report saving

several lives with the use of mobile phones. If we assume that one life could be saved per year by using a phone in the case of emergencies (mentioned by 30 health workers) we estimate the ability to save some 6000⁴ lives in a year in the four countries of the study.

Further research should be targeted towards examining the possible impact of ICTs on health prevention, general and emergency service delivery, and well-being. Studies should also be conducted on the cost-effectiveness of implementing mobile phone targeted applications. A recent review conducted by the Earth Institute reviewed 2,449 studies that present research on policy barriers and gaps in mHealth (mobile Health) in low and middle income countries [16]. It found that while mHealth studies exist, their scope tends to focus on user preferences with limited examination of health outcomes, impacts, or cost-benefits and savings.

Furthermore, detailed impacts and cost benefit studies of ICTs on health outcomes, DALYs (Disability Adjusted Life Years) and the cost-effectiveness of mHealth and telemedicine applications, are needed to effectively create a basis for investment decisions.

B. Potential for Education Sector

Although pupil-teacher ratios are reasonable (44 students to a teacher on average in primary schools) in the four countries of the study, statistics hide heterogeneity in ratios amongst rural areas and also ignore presence of trained teachers and quality of education. In Nigeria and Ghana especially, only 50% of the teachers in primary schools are estimated to be trained/skilled [17-18]. The ability of mobile phones in helping retain teachers in remote, rural areas could be extremely relevant.

For this study 44 teachers and education related administrators and 23 students were interviewed. The main benefits of mobile phones arose from ensuring teacher presence, teacher quality and student attendance. In-depth interviews show that school staff is especially likely to use mobile phones for communicating with other teachers and improving management of schools, students, and contacting parents. Overall, across the four countries, 34% of the 44 teachers and administrators believed that mobile phones helped improve the management of the schools, and 25% believed that by using mobile phone they helped increase student attendance. Improvement in student attendance was particularly relevant in Mbola, versus rest of sites (7 out of 10 respondents).

One School Management Committee Member in Dertu described it as:

“It has improved the management of the school by facilitating meetings and other activities. it has led to smooth running of the system e.g. the headmistress can contact the district officials when there is shortage of food in the boarding without necessarily traveling thus saving time, energy and money.”

⁴ Assumptions: In 1 out of 30 emergency cases faced by health workers the life is saved because of mobile phone usage (ambulance calling, consultation, etc.); the number is applied to the total rural number of nurses, midwives and physicians in the each country; urban/rural split for health workers is assumed to be the same as split of total population. Total number of lives saved represents the sum of estimations by country.

Other than voice functions, the use of SMS was also mentioned. Among students the evidence of mobile phone impact is less visible, mostly because the focus of MDG 2 is on primary school education and younger students are less likely to have access to a personal mobile phone. Students interviewed for this study underscored some functions that are used by them including games and text messages. But it is unclear whether the introduction of mobile phones has had any influence on student performance. The main benefit expressed by students was ease of access to their parents particularly in relation to mobilizing support, reassuring parents, and paying school fees. More strategic use of mobile technologies and further examination of the mobile phone and mobile broadband access for improving quality of education is needed.

Further Research: A study of 60 schools in Britain showed that there is a positive correlation between ICTs and educational achievement. While the study does not investigate the factors which enable ICT availability to impact student results (like increased teacher effort, new study materials, etc.) it does find that in the year immediately following the installation of broadband, there were significant improvements in pupil's performance on national tests taken at the age of 16 [19]. This represents an area of further application and research in Africa. Along with student performance, teacher retention and training should also be further studied.

C. Potential for Poverty Reduction

Research on the direct benefits of mobile phones on economic development indicates a potential causal relationship between mobile phone penetration and income growth. For example a study done in the Niger finds that mobile phones reduce price dispersion across markets by 6.4% and intra-annual variation by 10%. Importantly the study finds that this impact is higher when markets are further away or are connected via roads with low quality [20]. Another study finds that mobile phone network expansion in Uganda has led to an increase in sale prices for Banana farmers⁵ [21]. A study by Jensen (2007) also showed that mobile phones reduce price dispersion among fish sellers in Kerala state in India [22]. Our study found some cross-site evidence of income increase at a micro level.

Of the purposively selected 235 individuals interviewed for the study all used a mobile phone. These users reported an average monthly expense of \$14⁶ on buying airtime (monthly amounts are computed using average top-up amount and reported frequency of top-ups). Interviewees believe that they spend about 5-15% of their self-reported (and post-use) income on using mobile phones. These numbers point towards the potential gain in utility from mobile phones, considering that gains should theoretically equal the spending on mobile phones to make these expenditures rational.

Overall, a little more than one-fourth the small business owners and households that used phones indicated that they had experienced an increase in income that they attributed to their mobile phone. Increase in number of customers has been

⁵ This study cannot examine impact of mobile phones over time because of the absence of time series data.

⁶ Exchange rate used from July 1st, 2009. Not PPP adjusted. Average based on self reported top up and frequency of top up.

particularly noticed in Mbola (23 out of 33 respondents), while increase in income was mostly mentioned in Ikaram (18 out of 29 respondents). The range of the income increase responses was very large (ranging from 2% to 400%) and requires further examination. But many specifically mentioned an increase in customers and contacts. Respondents have also reported making savings on transportation costs. Saving on transportation costs have been reported consistently across all research sites. On average, respondents reported to save 5 USD⁷ per trip not undertaken. However this does not account for additional trips taken as a result of increased business and networks.

In Ikaram, a man stated:

"The changes are many-before I bought my own phone, my customer cannot reach me easily, I loss a lot of revenue in the process."

"Mobile phone has improved my contacts with my customers and family."

"It has made me "available" for several opportunities."

In Dertu, a respondent said:

"The mobile phone has reduced my transport costs because I can communicate to other people and get information concerning market prices in Garissa town of which I could have paid Kshs 600 for one trip which I save that amount for other use. Before there was mobile phone coverage we used to write letters or send people to Garissa."

Although not representative of the general population in the study sites, these savings and income increases represent a significant potential market for mobile phone operators providing services in similar environments. Users of mobile phones are generally better off than the average population and on average approximately 25% of the populations in these study sites are above the poverty line. The potential for market development is thus substantial.

Another consequence of mobile phone use is developing and maintaining social and safety networks that allow people to remain connected and reduce isolation. Although non-monetized, this is an important aspect of welfare and social safety networks that cannot be ignored. To many villagers the mobile phone has made it possible to get emotional or financial support when in desperate need.

While overall there was very little variance in how men and women described the benefits they derived from mobile phone ownership and use, women more frequently reported feeling more connected, experiencing few challenges in using mobile phones, and receiving their mobile phone as a gift. Men in the sample more frequently described their benefits as savings in time and avoided transportation. Men were also more likely to describe having made sacrifices to have and maintain their mobile phones. A recent study on the mobile phone gender gap in low and middle-income countries, sponsored by the GSMA Development Fund and the Cherie Blaire Foundation [23] show that mobile phones are increasingly being accessed by women and serve as a potential tool in addressing MDG 3.

Further research on income and welfare impacts of mobile phones is clearly required. For example, an econometric

⁷ Exchange rate used from July 1st, 2009. Not PPP adjusted. Average based on self reported cost of trip in Mbola (Tanzania) and Bonsaaso (Ghana).

analysis across Indian states showed that Indian states with high mobile penetration can be expected to grow faster than states with lower mobile penetration rates by 1.2% points a year more on average for every 10% increase in the penetration rate [24]. This study was unable to make these inferences. There are obvious problems in using self-reported income to estimate impacts. A study of welfare and income impacts that examines this issue robustly and in detail promises to provide important and new insights.

D. Barriers to Uptake

Relative to income levels, operational cost of phones is perceived to be high. Mobile phones are frequently shared across households. In the study sites, where $\frac{3}{4}$ of the population earn less than 1 USD, multiple phones in one household are rare. Borrowing across households and from friends and other social contacts was common and frequent. Buying multiple SIM cards and using it on a borrowed instrument was especially common. Also in remote villages without on-grid electricity and with few generators, it can be both time consuming and expensive to get the mobile phone battery charged which hinders a more extensive use.

All the sites chosen for the study are poor with preliminary investigations suggesting that at least two-thirds of the populations earn less than \$30/month (1993 PPP adjusted) in these sites. Table I shows average costs of calling across the four sites. Mobile phone use and ownership represent a sacrifice for most. In Dertu, Kenya, monthly expenditure on mobile phone services (self-reported expenditure on top-ups per month) ranged from \$2 to almost \$50 per person (31 respondents). In Bonsaaso, Ghana, in 2009, users of mobile phones spend in the range of \$1.5-53 per month (31 respondents), up from \$4 in 2007. In Ikaram, in 2007 owners spent almost \$18 per month on use (36 respondents). In 2009, interviewees spent an average of \$14 per month on mobile phones (140 respondents).⁸

High investment and operational costs and lack of electricity are the main barriers to extensive rural deployment by operators and subsequently the uptake of mobile phone basic voice and data services. The net effect of access to mobile and data services on health and education levels will depend upon investment in those services and related infrastructure.

E. Implications

A first implication from this discussion is that innovative and non-traditional business modes are needed to successfully exploit the full potential of ICTs and access to services to be extended to rural areas. One mechanism for this is to re-think deployment of networks and provision of services. Efforts to promote tower sharing and the use of solar and wind power by mobile phone operators can help significantly reduce the cost of providing services and increase coverage. Innovative services can dramatically improve affordability for end users. Here there is a definite role for public policy by allocating funding for ICT development in championing increased and enhanced mobile phone use by addressing regulatory barriers

⁸ All conversions into US Dollars are for the year the survey was undertaken. These prices have not been PPP adjusted. Monthly spending computed based on self reported top-up amount and top up frequency.

and lowering prices for consumers to realize the potential social and economic benefits. Complementary road and power infrastructure should also be examined to ensure increased benefits of telecommunications infrastructure. The basic infrastructure as presented in this report has great potential to provide benefits across all MDGs, but this will only be possible if network coverage is universal.

A second implication is that mobile phones have an important role in developing and promoting accountable governance systems. As a stand alone device mobile phones require limited literacy and numeracy and are not bound by language barriers. Most people quickly learn how to make a call and the immediate benefits stimulate further usage. There is some evidence that employed public professionals have acquired mobile phones to enhance their own productivity. Governments should be encouraged to become more strategic in leveraging access through mobile phones between the general population and health and education institutions. An emphasis on user and sector-specific services, applications, and information portals, that are cost-effective in providing information, are needed particularly for health, education, and agriculture and also more business related applications that increase knowledge about prices, business opportunities and market information in remote and infrastructure poor areas of the continent where physical access is poor. Another recommendation is the use of mobile payments as a means of paying government workers in the health and education sectors.

A third implication is to understand the need to develop and promote public ICT applications using voice and text messaging customized for collecting information, monitoring, and providing support in areas such as health and education and creating community-based information systems. The impact for child mortality, maternal mortality and reducing rates of HIV/AIDS, TB and Malaria are significant and real. Working with national governments to mainstream these applications and using a central investment or planning authority can help to mainstream these efforts into national e-governance initiatives.

VII. CONCLUSION

Using evidence from a baseline dataset of 1021 households and interviews of 235 individuals in four Millennium Village sites in rural Africa, we observe that despite high levels of poverty, being connected is a high priority for most inhabitants. Benefits are real and they are monetary and non-monetary – and in the form of increased income, decreased travel, enhanced sense of well-being and capacity to respond to emergencies and specific advantages in business development, health, and education. The main barriers to maximizing these benefits are cost, access to the networks for seamless connectivity, access to complementary infrastructure such as electricity and roads, and access to targeted services that capitalize on available telecommunications infrastructure-including m-Banking, m-Health, educational activities and agriculture and trade information services. In 2009, 3G networks were deployed by Ericsson in the Ghana, Tanzania and Nigerian Millennium Village sites, but it is too early to

evaluate the impact that access to mobile broadband has had, even though studies have indicated substantial possibilities for development.

This study calls to action four main stakeholder groups. First, national governments, being a customer to operators, must enable and promote usage of basic voice and text services among government employees. They should also utilize the deployed networks to improve delivery of services such as health and education to their citizens and also create an enabling policy environment that provides adequate incentives to mobile phone operators to provide universal access to telecommunications services. Second, mobile phone operators should review and revise their pricing and business practices so that social services can be deployed at scale to the poorest segments of the population. Third, policy makers and donors should move beyond investments in pilot programs to more strategic scalable and sustainable initiatives that leverage on the widely deployed and available telecommunications infrastructure aimed at accelerating the achievement of the MDGs. Finally academic and research communities should more rigorously assess the effects of telecommunications on the lives of individuals living in rural communities where large benefits can be reaped through small investments. Specifically, cost-benefit analyses and studies of public goods should be undertaken.

APPENDIX

Please refer to charts, table and figures at end of this paper.

ACKNOWLEDGMENTS

The Millennium Villages Project Connectivity Monitoring and Evaluation Study team at the Earth Institute, Columbia University, Jyotsna Puri, Patricia Mechael, Roxana Cosmaciuc, Daniela Sloninsky, Vijay Modi, Matt Berg, Uyen Kim Huynh and Nadi Kaonga, would like to thank Ericsson for its commitment to leveraging telecommunications infrastructure and services for achieving the Millennium Development Goals (MDGs). From Ericsson the team would especially like to acknowledge the support of the following for this study: Elaine Weidman, Benny Iguchi-Epstein, Henrik Pålsson, Mohit Bhasin, and colleagues from Auger- Anna Mitteregger and Annalena Carlsson.

At the Earth Institute the team owes a debt of gratitude to Jeffrey Sachs, Joanna Rubinstein, Cheryl Palm, Paul Pronyk, Maria Muniz and colleagues at Millennium Promise and the United Nations Development Programme. This research would not have been possible without the hands-on leadership and technical support in the study countries, provided by the following Team Leaders and Database Managers: In Bonsaaso, Ghana - Samuel Afram and Seth Ohemeng-Dapaah; in Dertu, Kenya - Ahmed Mohamed and Maurice Baraza; in Ikaram, Nigeria - Niyi Onabanjo and Afolayan Emmanuel; in Mbola, Tanzania - Gerson Nyadzi and Sia Lyimo. For their work on the background research on ICT and the MDGs, we appreciate the efforts of Elizabeth Americo, Lin Fu, Adina Goldberger and Kate Haley.

REFERENCES

1. *Information and Communications for Development: Extending Reach and Increasing Impact*. 2009, The World Bank: Washington DC.
2. Bhavnani, A.C., R.Janakiram, S., Silarszky, P. *The Role of Mobile Phones in Sustainable Rural Poverty Reduction*, W.B.I.P. Division, Editor. July 15, 2008.
3. *HMS Wireless. The GSMA Development Fund Top 20: Research on the Economics and Social Impact of Mobile Communications in Developing Countries*. 2009.
4. Gilhooly, D., *Innovation and Investment: Information and Communication Technologies and the Millennium Development Goals. Report Prepared for the United Nations ICT Task Force in Support of the Science, Technology & Innovation Task Force of the United Nations Millennium Project*. 2009.
5. Thioune, R., *Information and communication technologies for development in Africa. Ottawa: International Development Research Centre. Council for the Development of Social Science Research in Africa*, 2003.
6. Isaacs, S., *Against All Odds: Reflections on the Challenges of SchoolNet Africa. Harnessing the potential of ICT for education a multistakeholder approach ; proceedings from the Dublin Global Forum of the United Nations ICT Task Force*. 2005.
7. Simwaka, B.N., et al., *Meeting Millennium Development Goals 3 and 5* BMJ, 2005(Oct.): p. 708-709.
8. Kalil, T., *Harnessing the Mobile Revolution*. Tagore LLC, 2001.
9. *United Nations, comp. Millennium Development Goals Report 2009. Rep. New York: United Nations Department of Economic and Social Affairs*. 2009.
10. Mechael, P.N., *mHealth Ethnography Report*. In collaboration with Dodowa Health Research Center. MoTECH. 2009.
11. Leach-Lemens, C., *Using mobile phones in HIV care and prevention HIV & AIDS Treatment in Practice* 2009(137): p. 2-8.
12. *Urban and Rural Areas*. 2007, United Nations Department of Economic and Social Affairs. .

13. *Measuring Information and Communication Technology Availability in Villages and Rural Areas*. May 2008, Market Information and Statistics Division, International Telecommunications Union, Geneva.
14. *Summary Data, Nigeria*. 2004, World Health Organization.
15. *Summary Data Tanzania*. World Health Organization, 2006.
16. Mechael, P., et al., *Barriers and Gaps Affecting mHealth in Low and Middle Income Countries: Policy White Paper* 2010.
17. *Summary Data, Ghana*. 2008, Institute of Statistics, UNESCO.
18. *Summary Data, Nigeria*. 2006, Institute of Statistics, UNESCO.
19. *British Educational Communications and Technology Agency. The Impact of Information and Communication Technologies on Pupil Learning and Attainment*. 2002.
20. Aker, J., *Does Digital Divide or Provide? The Impact of Cell Phones on Grain Markets in Niger*. 2008.
21. Muto, M. and T. Yamano, *The Impact of Mobile Phone Coverage Expansion on Market Participation: Panel Data Evidence from Uganda*. World Development, 2009.
22. Jensen, R., *The Digita Provide: Information (Technology), Market Performance and Welfare in the South Indian Fisheries Sector*. Quarterly Journal Of Economics, 2007. **122**(3).
23. *Vital Wave Consulting. Women & Mobile: A Global Opportunity A study on the mobile phone gender gap in low and middle-income countries*. Research and report commissioned by the GSMA Development Fund and Cherie Blaire Foundation for Women, 2010.
24. Kathura, R., Uppal M., Mamta India: *An Econometric Analysis of the Mobile Phone*. The Vodaphone Public Policy Series, 2009(Number 9).
25. *International Telecommunications Union. Measuring the Information Society-The ICT Development Index*. 2009.

Improved care for patients, through consultations with professionals

“The problem which I have overcome by the access of mobile phone was the problem of difficulty in giving birth. I called a doctor asking him what can I do and the doctor told me the procedures to follow on overcoming the problem I followed and things went smoothly.”

Woman, 32, Health Worker, Mbola.

“The uses of mobile phone affect the quality of care which I can provide for the patient. I once had to make a call to ask on how to deal with different kind of medicine to give the patient. This will help to provide quality treatment which could not be done without mobile phone.”

Health Worker, Mbola

“The last problems a patient referred with chronic malaria and TB and inform the nurse in charge about the matter and told me to bring the patient to the facility I brought her and she was treated well and become ok.”

Male, 33, Health Worker, Dertu

Improved health facilities management (drug supplies, referrals)

“At first, we collected all drugs from Manso-Kwanta but we have a store house within our cluster now [Bonsaaso]. Since we have a store house, any storage announced will be supplied immediately at least within 2 days.”

Health worker, Bonsaaso

“When there is the need for drugs at the facility then they can make a call at the doctor and inform him of the shortage and what drugs are needed at the facility.”

Woman, 50, Health Worker, Mbola

“In our health centre we refer four or six people per month through phone communication which helps the doctors to advise me to refer women who seem to have a difficult deliverance and those who are seriously injured. The outcome in many occasions is positive as they receive good care and treatment compared if they would be left at home.”

Male, 30, Health Worker, Mbola

Chart 1: Hypothesis for “Creating a Cadre of Well supported and Efficient Health Professionals”

Improved emergency response

“There was an emergency at Fahiakobo which I called the midwife to help and also during the IOD session, I had a problem so I called for assistance.”

Woman, 27, Health Worker, Bonsaaso

“Individuals who have my numbers at times call on emergency situation which I respond.”

Ambulance driver

“In case of any work related problems we call the MVP and MOH office. The problem that have made us contact others are like snake bite where we called the MVP office who provide transport for the patient to the dispensary. If there was no phone it would be very difficult as the patient would be left to die.”

Male, 33, Health Worker, Dertu

Saving lives

“At first, the maternal mortality rate was very high, but now it has reduced drastically. The community members are able to call us to address issues quickly which could have lead to death. It has also helped to reduce child mortality, burden of HIV and AIDS, malaria and other diseases.”

Woman, 27, Health Worker, Bonsaaso

“Mobile phone helped me to have quick and early information about the people who suffer from serious sickness for example lack of water in the body and blood. It helps to

ask quick help especially medicine from the distance areas and ask a quick help from the professional doctors. Phones provide information, help, advice on care for the sick and treatment. Sick people are quickly helped and as a result deaths are reduced and serious diseases are being treated on time.”

Man, 30, Health Worker

“It was my husband who was bitten by a snake, so a neighbor who was having a phone called the MVP staff in Dertu and reported the incident so the MVP sent us the vehicle to my husband and they really saved because from the time he bite till the next day he was in comma the treatment that he received in the Dertu hospital has improved his status.”

Woman, 33, Household, Dertu

Chart 2: Hypothesis for “Access to instant communication saves lives”

Improved management and teacher retention	<p>“It has improved the management of the school by facilitating meetings and other activities. it has led to smooth running of the system e.g. the headmistress can contact the district officials when there is shortage of food in the boarding without necessarily traveling thus saving time, energy and money.”</p> <p style="text-align: right;">Dertu, School Management Committee Member</p> <p>“Teachers are willing to stay and teach because of the little availability of the network.”</p>
Increased enrolment and attendance	<p style="text-align: right;">Bonsaaso, Teacher</p> <p>“(Mobile phones) help teacher on having retention, they help increase student attendance rates because the times he (student) is not at school the teacher can call the parents to ask if he/she is at time home which makes the students attend (school).”</p> <p style="text-align: right;">Man, 30, administrator, Bonsaaso</p> <p>“It [mobile phones] has really improved by increasing the number of pastoralist children in school.”</p> <p style="text-align: right;">Teacher, Dertu</p>

Chart 3: Hypothesis for “Better quality of education and increased enrolment”

Income increase through increased access to relevant market information:	<p>“Since I started using a mobile phone life has changed because now I can do things which before I couldn’t do. I can ask the price of goods even if I am very far, I can sell goods through using phone. Before I couldn’t do it, I had to go physically and then ask the price and it was a cost. Now I can use 500 but before I could spend even 5000.”</p> <p style="text-align: right;">Woman, 46, small business Mbola</p> <p>“Using the phone has changed my methods of selling the fish in the village through my contacts so I would not run at a loss. I call people or they call me whenever they need to buy some goats or sheep and some come as far as 3 miles to buy because they can call me on the phone to negotiate beforehand”.</p> <p style="text-align: right;">Bonsaaso</p>
Increased income through better access to customers:	<p>“The changes are many; before I bought my own phone, my customer cannot reach me easily, I loss a lot of revenue in the process.”</p> <p style="text-align: right;">Respondent,</p> <p>“It has made me “available” for several opportunities.”</p> <p style="text-align: right;">Respondent, Ikaram</p> <p>“Since I got the phone, I have been able to make so many contacts for all kinds of jobs. My customers are able to call me to inform me, if they have any assignment for me. When I need information, I use my phone to call for the information and when my customers or others want to pass information to me, they call me to inform me.”</p> <p style="text-align: right;">Man, 19-year-old</p>
Increase disposable income through saving of travel money:	<p>“The mobile phone has reduced my transport costs because I can communicate to other people and get information concerning market prices in Garissa town of which I could have paid Kshs 600 for one trip which I save that amount for other use. Before there was mobile phone coverage, we used to write letters or send people to Garissa.”</p> <p style="text-align: right;">Respondent, Dertu</p> <p>“The mobile phone has cut down my transports and movements drastically. I use the time saved to go to the farm. If I should travel I spend about four days to one week, and the transport costs about GH¢ 8 or GH¢ 10 Ghana cedis. I use that money as house keeping money and sometimes use the money to buy clothing.”</p> <p style="text-align: right;">Woman, 36, Bonsaaso</p>

Chart 4: Hypothesis for “Increased income”

Strengthened bonds within the family/relatives

“I sacrificed a lot since its price is equivalent to two goats but it’s worth because it’s beneficial. I communicate to my daughter wherever am. They also communicate to me; I get information so I had to buy it.”

Small business owner, Dertu
“The reason for purchase was to have communication with friends and family, especially my children’s who are studying at town and I am communicating with customers and through having phone, number of customers have increased and made me expand my business through having regular communication.”

Woman, 46, small business, Mbola

“My husband bought it for me. We got the phone so that we may be able to communicate easily.....”

Respondent, Ikaram

Increased peace of mind by financial security and immediate access to a social network

“Mobile phone improved greatly communication with my family, and this reduces my fears and anxieties.... Before I used to write letter and I have to wait for at least a month to get response back.”

Respondent, Ikaram

“On safety it has improved 99%. If something happens (danger) I will contact others phone and I will get rescued. Also yesterday there were two vehicles which collided we called Dertu and Garissa and the police came immediately.”

Respondent, Dertu

“When my mother almost had a stroke. My grand-daughter called me - I was away relaxing with friend. I had to call a driver to come and take my mother to Ikare. (I was too shocked to drive; I thought my mother is going to die)”

Respondent, Ikaram

“It makes is very easy to reach relatives and discuss various matters. There are times when we can’t afford the school fees. We then call our older children (who live in the bigger towns) and ask them to donate money. Before the mobile phone it was very difficult to ask for money since travelling to each child involved high costs, and their son was almost expelled once due to late payment.”

Female respondent, Ikaram

Chart 5: Hypothesis for “Affecting Social and Safety networks”

Table I: Cost (US\$) for a one minute call, Four study sites, 2008.

	Tanzania	Nigeria	Kenya	Ghana
Mobile Off-Network Call price for 1-minute non-peak hours in USD	0.29	0.26	0.38	0.09
Mobile Off-Network Call price for 1-minute peak hours in USD	0.34	0.36	0.38	0.14
Mobile On-Network Call price for 1-minute non-peak hours in USD	0.19	0.17	0.21	0.09
Mobile On-Network Call price for 1-minute peak hours in USD	0.22	0.31	0.21	0.15
Price of one SMS, 2008, in USD	0.04	0.09	0.05	0.04

Source: [25]

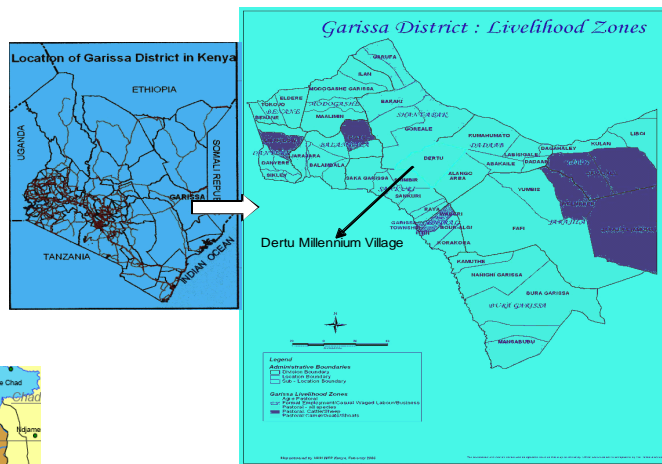
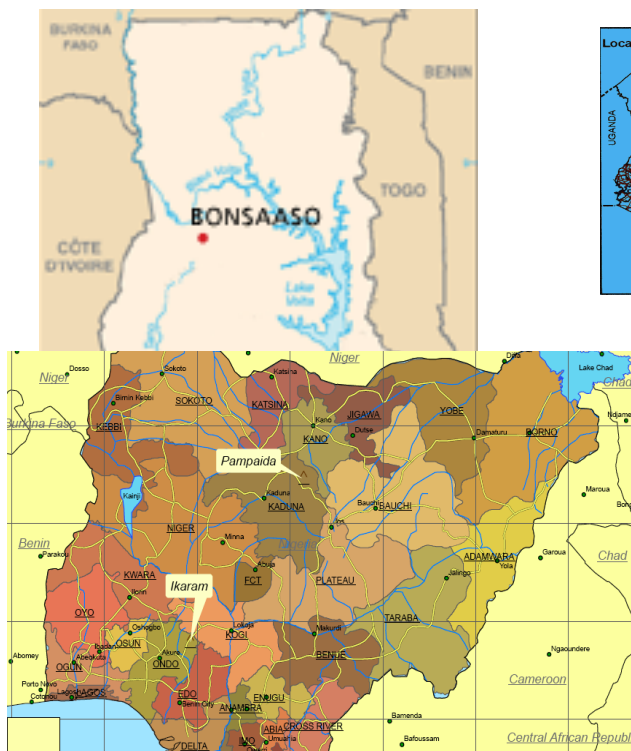


Figure 1: MVP Site—Bonsaaso, Ghana
Figure 2: MVP Site—Dertu, Kenya



Figure 3: MVP Site—Ikaram, Nigeria

Figure 4: MVP Site—Mbola, Tanzania