

Mobile phones' potential to address information and communication needs of healthcare workers in isolated rural areas in Peru

Introduction

The aim of this paper is to present the main findings of the interviews and observation undertaken in health locations in rural areas of Peru, aimed at exploring the application of mobile technology for health in isolated areas, and thereby to provide wider reflections about the use of mobile phones to improve health delivery in isolated areas in developing countries. It also reflects on methodological complexities, particularly those related to the application of online research methods, through the experience gained during the research.

The great growth of the penetration of mobile phones in developing countries has attracted the attention of the ICT4D community and numerous publications reflect about their impact for development (see for example Donner, 2005; Vodafone, 2004; Sullivan, 2007 or Scott *et al.*, 2004). A part of this literature is focused on the application of mobile phones for health delivery (bridges.org, 2005; Katz, 2005 or Voxiva, 2005). Nevertheless, publications about the application of mobile phones for health focused in rural areas of developing countries are still scarce. This paper focuses on this gap of the literature, focusing on rural areas of Peru and wider reflecting about the behavior of mobile phones in this specific context.

Given the evolution and forecasts of penetration of mobile phones in developing countries (see Gartner, 2006 or Donner, 2005) as well as the appealing of these devices for the population (Castells *et al.*, 2007), it is important to remark that Health Ministries in developing countries and development agencies have not paid enough attention to the possibilities that mobile technology brings for health delivery.

This paper reports on the interviews to healthcare workers undertaken in rural areas of Peru, aimed at exploring their perception about how mobile phones can contribute to the resolution of their information and communication needs, as well as provide wider reflections about the general debate about the benefits of mobile phones for health for development. The workers were chosen as participants in two innovative and contrasting ICT4D projects: CellPREVEN and EHAS, seeking at obtaining valuable feedback about their experience on one side, and their opinion as healthcare workers with no previous experience on the use of mobile telephony within an ICT4D initiative, on the other. Additionally, the paper aims at exploring the

complexities involved in the methodology, particularly the difficulties in the appliance of online research methods during the research.

The article is structured as follows: first, the context of the research is presented; after that, some methodological issues about the field work in Peru are discussed. Next, the most remarkable findings of the interviews are presented, linked to wider reflections about the benefits of mobile phones in rural areas of developing countries. These results highlight three important advantages provided by mobile phones: the value of the immediacy in the communication for emergencies, the potential of multimedia capabilities of mobile phones and the improved reliability comparing to other technologies, but they also reflect on the recent limitations for their adoption and use in isolated communities. The article ends concluding that the application of mobile phones for health delivery is clear and of great impact in isolated areas of developing countries, but limited at this moment, with great potential in the short term.

Context

Mobile phones' contribution for health in developing countries

One of the most important problems faced by healthcare workers in rural areas in developing countries is the lack of information and communication networks. Meeting health workers' information and communication needs is potentially the most appropriate strategy to improve healthcare in rural areas of developing countries (Pakenham-Walsh, Priestley and Smith, 1997 and Metin, Villeret et al., 1997). According to James Grant, former executive director of UNICEF, "the most urgent task before us is to get medical and health knowledge to those most in need of that knowledge. Of the approximately 50 million people who were dying each year in the late 1980s, fully two thirds could have been saved through the application of that knowledge" (Pakenham-Walsh, Priestley and Smith, 1997, unnumbered). One decade after these sentences, the situation has not progressed markedly.

The great expansion of mobile phones in developing countries involves new opportunities to improve efficiency, productivity and communication in the health sector, and help to achieve better quality services at reduced cost (Katz, 2005). Universally speaking, cellular technology has six main intrinsic features appropriate for its adoption in developing countries: low infrastructure investment, ease of use, low energy consumption, affordability of services and devices, surpassing unfavorable geographic structures and less vulnerability to vandalism and

natural disasters than other technologies. Mobile technology has thus overcome many of the barriers “in a natural way” and revolutionized communications in many developing countries, even in rural areas, where connectivity is reached by the first time. In this sense, Heeks (2005) proposes a major effort to test the utility of massive mobile base for development purposes. Some of the applications for health include: management of health data, access to information for health workers, telemedicine and health promotion, as well as communication in emergencies.

Despite this potential, literature is scarce in mobile telephony’s application for health in rural areas. Some of the most remarkable experiences are: Satelife Project, which uses GSM coverage to download and transmit the information to PDAs through a jacket (Keysha and Genevieve, 2003); the sending of SMS in Kenya for free with VIH/AIDS information for health promotion, including a free and anonymous service of questions/answers (Jones, 2005 and Katz, 2005); the campaign to educate people about HIV/AIDS and malaria using cellular technology sending free text messages in Mali (PlusNews, 2004); the adherence to tuberculosis treatments via SMS to remind patients to take their medication at pre-determined times in the OnCue project in Cape Town (bridges.org, 2005); the Interactive Voice Response System used in India for Electronic Helpline on HIV/AIDS (Chandra, 2005); the Mobile for Good project in Kenya, based at using mobile technology to improve the lives of people, among others, with health services such as SMS-based health tips or anonymous questions about HIV/AIDS and Breast Cancer for subscribers (<http://www.mobileforgood.com>; accessed 6th May 2006); or the Jiva Teledoc project, using Java-enabled mobile phones and GPRS coverage to support telemedicine in rural areas in India (Jiva Institute, 2003). These are anecdotal experiences that show how mobile phones are increasingly considered as a tool to meet health needs in developing countries and how there is a growing debate in the ICT4D community in order to explore the benefits of mobile telephony for health in developing countries; however, this field is still very recent and there is hardly any academic paper at this respect.

In this context, a set of interviews to healthcare workers was undertaken in Peru, to explore how mobile phones contribute to meet healthcare workers’ information and communication needs, focusing in rural areas. In this sense, interviews explored particular issues such as the reliability of this technology, how multimedia capabilities are contributing or can contribute for accomplishing daily tasks, the benefits and limitations of the communication through mobile phones, as well as the main difficulties for their use. These issues were treated through the perception of interviewees and health personnel observed, and will be addressed in next

sections. Additionally, online research methods were used, incorporating complex methodological issues that are worth reflecting below in this paper.

Choice of the country for the interviews

Peru was chosen as the country for undertaking the interviews and observation for four main reasons. First, Peru is a Latin American country that has experienced a diversity of mHealth projects implementation in recent years (see for example the experience of Voxiva, 2005 and 2005i). Second, in geographical terms, this country consists of three main natural distinguishable regions: the coastal zone, the highlands and the eastern hills and lowlands (Amazonia), with important repercussions for wireless penetration, which is not as great as in other developing countries, particularly African countries (in general, with a flatter surface). Third, although this penetration has grown in the recent years in Peru, it keeps on being mainly concentrated in the capital Lima as well as among privileged groups (Instituto Nacional de Estadística e Informática, 2006). Finally, there is a remarkable lack of resources for health delivery in rural areas of this country; specifically, information and communication resources were limited in health locations and the appearance of mobile technology represents a new challenge for this situation (this matter is further explored in next section). Therefore, the outlook in Peru was optimal in order to check the advantages and limitations of mobile technology for its adoption in rural areas, and assess how it can contribute to improve health delivery in rural areas.

Lack of resources for health delivery in rural areas of Peru

There is a great shortage of human, material, information and communication resources for health delivery in rural areas of Peru. In Health Posts (most basic centre of attention), healthcare workers are nurses, recent-graduates, auxiliary midwives and health-staff in general, and they are responsible for different health tasks (such as diagnosis, data collection, prevention measures, providing information, administration of drugs and basic treatments, education of people in mother-child, basic family and sexual-care). In addition, there is an important shortage of professionals, particularly in rural areas (Chetley *et al.*, 2006; Fraser and MacGrath, 2000). Table 1 illustrates the situation for the rural province of Quispicanchi in Cusco, Peru, visited during the field work:

	Quispicanchi Province	Proportion of each role to the total	Proportion of health staff to the general population	Total in Cusco Department
Doctor	17	15%	1 Doctor each 4836 persons	325
Nurse	25	22%	1 Nurse each 3289 persons	493
Dentist	3	3%	1 Dentist each 27401 persons	44
Midwife	14	12%	1 Midwife each 5872 persons	212
Psychologist	0	0%	0 Psychologist	10
Dietitian	0	0%	0 Dietitian	7
Pharmacist	0	0%	0 Pharmacist	12
Other Health Professional	0	0%	0 Other Health Professional	38
Total Health Professional	59	52%	1 Health Professional each 1394 persons	1,141
Nurse's aides and assistants	40	35%	1 Nurse's aides and assistants each 2056 persons	1,291
Other	14	12%	1 Other each 5872 persons	318
TOTAL	113	100%		2,75

Table 1 – Distribution of health staff in the Quispicanchi Province. Own elaboration based on data in Iirsa Sur and Walsh (2007)

As shown in the table, almost half of the staff is not health professional but have other profiles, lacking the proper education for complex decisions in treatments and diagnosis. In addition, the situation of these workers is often precarious, in terms of resources and access to information and communication. This deficiency of training, as well as lack of information and communication networks, lead to less informed decisions and diagnosis, and causes feelings of isolation and lack of professional development (Kemp, Aitken *et al.*, 2003; Villaroel, 2006; Fraser and McGrath, 2000). According to a survey for the EHAS Project in four Peruvian regions, 75% of rural healthcare workers suffer from this isolation feeling (<http://www.ahas.org>, accessed 25th October 2006). Interviews undertaken aimed, among others, to explore this isolation feeling and the possibilities of mobile telephony to improve this situation.

On the other hand, distances are huge in isolated communities in the mountains and travelling takes a long time because roads and paths are not in good condition, making the health delivery difficult and limited for many isolated areas. Healthcare workers in rural areas normally forward more complicated patients to provincial hospitals. This is the case of the Cusco Regional Hospital, visited during the interviews period, accepting referrals from 49

health centres and 231 health posts (MINSA, 2008). Furthermore, transport conditions are limited in this department, as illustrated in the following table:

Cusco Department's surface:	76.225 km ²
Total length of roads and paths:	5.433,23 Km
Road (asphalt):	2.414,14 Km (44,4%)
Road (not asphalt):	748,28 (13,8%)
Path:	1.762,88 (32,4%)

Table 2 – Road's situation in Cusco Department. Data at 2007, own elaboration from Iirsa Sur and Walsh (2007) and <http://www.cusco-peru.org/cusco-peru/informacion-general-cusco-informacion-general.shtml> (accessed 3rd February 2008)

There is a wide consensus in the literature about the value of mobile phones in order to save the need of transport and time to search for health attendance as well as provide information and communication to health workers (Vodafone, 2004; Souter *et al.*, 2005; Telecommunications in Action, 1999), particularly in locations where no previous communication tools existed and during emergencies. Interviews aimed, among others, to explore these possibilities in the mountainous area of Cusco, commented above.

Choice of field work areas and projects

Interviews were undertaken in two different geographical areas of Peru: Piura and Cusco. These locations were chosen according to two main reasons. First, they correspond to areas where ICT development projects had been or were being undertaken: CellPREVEN (Piura) and EHAS (Cusco). Second, geographical conditionings of these locations are very unlike: the rural town of Piura, in a Northern region of the same name in Peru, is an example of the most developed part of the country, the coast, whilst communities in the mountainous area of Cusco are illustrative of the isolation of great part of the rural population (although not as isolated as communities in the forest area of the country). In general terms, the coastal area of Peru has higher human development indexes, whilst the mountains and the forest are more rural areas with worst living conditions. In particular, health delivery and penetration of wireless technology in the mountains is more limited than in urban settings. As the final motivation of this study is to explore how mobile phones can help the poorest groups through better information and communication of healthcare workers, this orientation aimed at exploring two contrasting regions (including rural locations with high poverty levels and worse health indicators as well as rural locations with better conditions) to compare the interaction

of healthcare workers with wireless technologies in contrasting settings, in order to analyze the influence of the rural setting.

First project included in the study was CellPREVEN, a pilot testing a real time health surveillance system for adverse events using cell phones in urban areas of Chinchipe, Huanuco and Piura (last one was the visited area). Basically, interviews to participants in this project were undertaken in San Jose Healthcare Post, in a district of the city of Piura. The aim of this project was to monitor adverse events in sexual workers for real-time collection and transmission of information via mobile phones, allowing early detection and decision-making (Curioso et al, 2006). This project was deployed during years 2004-2005 and there are two major reasons why this project was chosen for inclusion in this study: first, the integration of mobile phones for health in the surveillance tasks of healthcare workers was the focus of this pilot project, thus the interest for this study lies in healthcare workers' experience with mobile phones; and second, it was a pilot experience that was not scaled up, thus it provides useful hints to understand the limitations of mobile phones in development projects. The project was implemented by Voxiva, an information-solutions provider focused on strengthening health care systems in developing countries, with experience in Rwanda, USA, India, Peru and Argentina (see Voxiva, 2005, Voxiva ii, 2005 or Donner, 2004). This international, nation-wide projects experience indicates that mHealth projects are not anecdotal; on the contrary, they are just been tested in different settings. This organisation has recently joined a public-private partnership to implement "Phones-for-Health", to extend their technology for tuberculosis, malaria and other infectious diseases in ten African countries, being one of the most ambitious mHealth projects that has yet been conceptualized (International Herald Tribune, 2007).

The other project involved in the study was EHAS-Cusco, part of the larger program EHAS, implemented all around Latin America, based on the use of cheap wireless technologies to connect isolated areas. In the Cusco region, WIFI is being used to provide telephone as well as Internet connection to Health Centres and Posts. This is a mountainous area with lots of small isolated communities where healthcare workers have scarce resources and the health service is limited for a great part of the population. Contacting medical attendance is difficult from these isolated areas in the mountains: approximately only 30% of the areas visited had means of communication such as radio or satellite telephone (mobile telephony is excluded in the rate). In this context, introduction of mobile phones can really make a difference. Therefore, the objectives for including this project in the study were basically two: first, to check the impact of the introduction of the ICT in isolated locations, and second, to assess the impact of the introduction of mobile technologies in the context of a developmental project not

specifically focused on mobile phones. In total, three Health Centres and three Health Posts in the Cusco-Sur and Urcos Micro networks were visited, as well as the main Regional Hospital in Cusco. In general, work conditions of Health Posts in isolated areas in these places were much harder than those in urban Health Centres, including the technological situation.

Methodological issues

Methods used

The primary objective of data collection was to represent the subjective viewpoint of healthcare workers about mobile phones, thus a qualitative approach was adopted, through two main methods: in-depth interviews and observation. The qualitative approach was chosen in search of a depth understanding of the situation and motivations of healthcare workers (Patton, 2002; Bowen, 2005; Padgett *et al.*, 2003). On the other side, using two different methods in the data collection process (triangulation) is a common practice to ensure credibility and guarantee rigour in qualitative studies (Baxter and Eyles, 1997; Creswell and Miller, 2000; Oktay, 2003). Basically, seeing things from different perspectives is important because the means through which data are collected have an effect on the findings (Laws *et al.*, 2003), although Baxter and Eyles (1997) warn that simply using different methods does not necessarily imply rigour.

Interviews are one of the most popular methods in qualitative research (Patton, 2002) and were indeed the major tool for data collecting. Central aim of interviews was to approach the perception of healthcare workers about the applications of mobile phones to improve their daily tasks. Semi-structured interviews were used in order to give to the interviewee the opportunity to express their thoughts freely. Keeping this aim on mind, questions were adapted depending on the profile of the interviewee (participant in CellPREVEN project, participant in EHAS project, non participant in any development project, more qualified roles – doctors, project managers, etc.-). Basic topics covered during the interviews include: what roles do ICTs (and mobile phones in particular) play in healthcare workers' tasks, particularly in emergencies; exploring their opinion about mobile telephony and its capabilities, including multimedia capabilities of most modern handsets; examining their perception about the reliability of mobile technology (and their trust on them for accomplishing tasks), as well as the main difficulties for their use. Other topics were also included, such as the contribution of ICTs in reducing their isolation in remote areas, the ease of use of this technology and their opinion about how their information and communication needs could be addressed and implemented.

Finally, it should be remarked that no incentives were paid to respondents, avoiding participants with financial interests, the sense of obligation for respondents, the creation of expectations of recompense in the future, false answers to please the researcher, and of course, cost (Laws et al, 2003 and Padgett, 2003).

Observation was the second method used for the study. It was not considered in the methodology but was proposed by managers in EHAS during my stay in Cusco, because people in the mountains are reserved and there would not be many results by formally chatting. Additionally, the objective of including direct observations was to check whether what people said they did or thought was actually reflected in their behaviour (Laws et al., 2003). This way, theoretically, the other person's perspective is explored through interviews and observations allow this information to be checked against their actual behaviour, providing a new complementary source of data collection (Patton, 2002). Usually, large amounts of time are needed to use this method effectively, but this was not feasible in this study, thus unobtrusive shorter focused observations were undertaken in specific locations on actors, processes and situations.

Challenges of using online research methods

The generalization of Internet and the methodological potential and versatility of online methods are causing them to be increasingly considered for research in all fields of social science (Shaw *et al.*, 2006; Graffigna and Bosio, 2006; Sade-Beck, 2004; Hine, 2000). Given my condition of part-time distance-based student, new technologies provided opportunities for research methodology, as a source of information, dissemination and data gathering, and as a complement of the information traditionally obtained through long periods in the field, helping to solve calendar limitations. However, these methods have hardly been used in developing countries and there is not relevant literature focused on these countries. As online research methods were appropriate to gather valuable information as part of the overall approach adopted, their use supposed a challenge for this research.

In general terms, online methods are valuable for research because of three main advantages. First and most important, they are particularly suitable in order to mitigate distance and time difficulties, implying significant savings in the cost of the project (replacing the need to travel, paperwork or telephone) comparing to traditional methods (Shaw *et al.*, 2006; Hine, 2000). Qualitative research is normally associated with immersion in the problems and implies

spending long times in the field -*prolonged engagement*- (Baxter and Eyles, 1997; Laws *et al.*, 2003). In this sense, online research methods allow contacting people over long periods of time (often more than in traditional field work, covering a period of months, even years), as well as facilitating the contact of geographically dispersed populations. In addition, online methods are not as strongly conditioned by the size of the group as in traditional research, enabling broader populations to be contacted, for example, through online focus groups or surveys (Oringderff, 2004). Second, they are a cutting-edge approach for a methodology, making the research more appealing for respondents and acting as an enabler for their motivation (Sade-Beck, 2004). Third, the anonymity provided by the Internet is another possibility for research, promoting self-disclosure in responses; additionally, if asynchronous written tools are used (such as email or forums), participants can write formal meditated reflections (Oringderff, 2004). This research intended to benefit from these possibilities. Additionally, I firmly believe that technology can make a difference for developing countries, and as an ICT4D researcher, I consider that ICTs are also appropriate for the research processes themselves.

On the contrary, distrust in being contacted by an unknown researcher through the Internet is an important disadvantage of online researching. In addition, it is often assumed that many communication elements are lost in interview that are not undertaken on a face-to-face basis, particularly those derived from the lack of visual clues. Main implications include additional difficulties in building rapport and controlling attention on the topic (Laws *et al.*, 2003; Shaw *et al.*, 2006; Greenbaum, 1998). Undoubtedly, the use of new communication tools has a strong impact on the research process. However, strategies can be developed to build trust and confidence with the interviewee. Reactions, silences, emotions or distractions can also be tracked in an online interview, just as they can in a telephone one. On the other side, the lack of face-to-face contact reduces interviewer bias and can help to self-disclosure. Indeed, the setting provides new dynamics and specificities (Graffigna and Bosio, 2006). Finally, it should be remarked that the use of online research methods is introducing new elements in the debate about rigour and validity and there is not surprisingly some academic scepticism about it (Sade-Beck, 2004; Greenbaum, 1998 and 2000).

Online research methods are not normally the sole source of data because they only provide a partial and limited picture without the link to the 'real world', particularly information of the wider social-cultural context in which the interviewees live (Sade-Beck, 2004). For this reason, a combined approach was intended for this research, integrating the concepts emerging from two methodologies (online plus field work period), aiming at the triangulation through the

combination of traditional methods during the field work with those derived from the online world, therefore providing a new layer to ensure the validity of the research. Graffigna and Bosio (2006) name this approach the *differential perspective*, considering online methods as new, different and complementary tools and not a mere transposition or replacement of traditional methods into the virtual setting.

An anonymous online survey was thus created to obtain general responses from healthcare workers about their feelings, opinions and motivations in respect to mobile phones and the role they have in improving their daily tasks¹. Although initial forecasts pointed that this cutting-edge approach to obtain data could be feasible, it turned out to work improperly. Potential respondents in isolated rural areas were to be contacted thanks to an official list of email provided by the Cusco Regional Hospital, but results showed that the emails were not read. 53% of the introduction emails were returned because of full mailbox or inexistent email address; 37% did not get any answer, and 10% were successful. Due to the few amount of answers received (4 in total), they were not used as complementary information because they were not considered representative. The most suitable explanation for the lack of responses is that Internet access is limited or inexistent in those rural areas, as well as the education needed to do it. These negative results in the trial of use an online survey in order to get information from healthcare workers in isolated areas of developing countries lead to the reflection about the non-convenience of online research methods in that context. On the contrary, other communication tools such as voIP applications and instant messaging have been successfully used with the project managers located in Lima, in an urban context. In this case, the innovation and appealing of online researching have been positives in order to obtain fluent communication and predisposition of the interviewees.

Influence of the focus on two projects

The selection of two contrasting projects in the same country had implications for the rigour and validity of the study. First, it is important to be careful when generalising about the concepts and findings, particularly with a qualitative approach as the one used in this study – what is called transferability in Lincoln and Guba's Naturalistic Inquiry (1985). In addition, in the case of CellPREVEN, the number of participants was limited as it was a pilot project, and their experience was past because it had been finished three years ago. Therefore, findings will should be treated with caution and bound to the setting of this particular study. However, this

¹ The survey is available yet at <http://celularesysalud.notlong.com/> (date: 21th July 2008).

does not imply that selection of particular cases for field work in qualitative research is not valuable. Selected cases in qualitative inquiry aim at providing an insight into the phenomenon, not generalization (Patton, 2002); in addition, experiences and findings may be common to larger groups (Baxter and Eyles, 1997; Baptista and Sampieri, 2004). In this case, results about the perceptions of healthcare workers concerning the role of mobile phones in health projects are linked to the specific context of this research (Peru, projects Cell Preven and EHAS, this moment), but some elements and lessons learnt will be valuable for other researches in other developing countries. Results presented in this paper also help to avoid generalisations: the penetration of mobile phones in rural areas of Peru is low and mHealth initiatives in other locations, often enthusiastic, are invited to consider the findings from this research. It is important to remark, though, that chosen projects have a high degree of representativeness and include relevant elements in the mHealth debates (they are 'rich information' cases). Basically, CellPREVEN explores the use of mobile phones in developing countries, using existing infrastructure, and paying close attention to the ease of use through an intuitive interface (interactive voice response), whilst experience in EHAS locations has contributed to assess the benefits and limitations of the mobile technology in a context with no 'mobile development intervention' and compare it with alternative technologies in a rural context. Therefore, given the geographical and technological diversity of the projects, as well as the confines of this study, the focus on two major projects is appropriate and the most remarkable value is the insight in the mHealth field.

In addition, interviews were strongly influenced by the fact that the contact had been established through Voxiva and EHAS staff. I was often identified as part of those organizations, and this had different consequences, both positives (collaborative attitude) and negatives (focus in the projects themselves instead of my interests). Benefits surpassed the problems caused by this identification by far, because of the positive attitudes, as well as the possibilities of reaching workers that could be hardly reachable otherwise (in addition, in the case of CellPREVEN, with previous experience of work with mobile phones).

Selection of healthcare workers as the 'unit of analysis'

The health of the wider population is the end beneficiary of better informed and communicated healthcare workers and better health service delivery. This is only true under certain conditions and does not necessarily imply that benefit reaches the poorest groups, but this study restricts to explore whether or not technology is able to improve the working

conditions of healthcare staff. According to this approach, healthcare workers in rural areas (including nurses, midwives, health technicians and doctors) were the unit of analysis. However, focusing on healthcare workers as the unit of analysis has three implications related to rigor. First, there is a risk in only considering one perspective among the actors involved in health delivery. Though, it should be noted that certainly, this is the most appropriate group to collect data to know more about the possibilities of mobile phones for health in rural areas. In order to have a broader picture of the situation and a better informed analysis, a set of complementary interviews with key informants were undertaken, including Voxiva and EHAS project managers and technical staff, staff of the Ministry of Health and a professor of the University Cayetano Heredia. The second implication of this approach is that responsibility for identifying the benefits attributable to the interventions, their outcomes and their impact are transferred to healthcare workers, which could bias the findings (Adamchack, Bond *et al.*, 2000). For a more rigorous approach, information from key informants was also used in order to triangulate the data collected, as well as other sources of information, such as OSIPTEL², INIE or international development agencies. The third implication is that, in general, healthcare systems are overburdened in developing countries, and there is a shortage of professionals. Thus healthcare workers have an important work load and, for ethical reasons, time for interviews was short in order to not distracting them from their daily tasks.

The potential of mobile phones for health in isolated rural areas in Peru

The field work provided rich information on the potential of mobile telephony to address information and communication needs of healthcare workers in isolated areas in Peru. This paper focuses on four relevant findings, concerning the immediacy in the communication for emergencies, the potential of multimedia capabilities, the reliability comparing to other technologies, as well as the cost and coverage as the recent limitations for their wider adoption and use for health in isolated communities. As commented previously, these four areas (immediacy, reliability, multimedia capabilities and limitations for adoption for health in rural areas) have not been sufficiently dealt in literature when referring to application for health in rural areas of developing countries, therefore this paper aims at exploring them through the results of this study. Finally, each finding is linked to reflections about its application in a wider context.

² OSIPTEL stands for “Organismo Supervisor de Inversión Privada en Telecomunicaciones”. It is the Telecommunications Regulation Body of Peru.

Emergencies

Mobile phones alleviate the critical situation in emergencies, where available

Immediacy in the communication is one of the most remarkable elements of mobile technologies, being relevant for health delivery, particularly in emergencies. The sooner the communication, the higher the possibilities of survival. This attribute of mobile telephony is essential in order to understand the benefits for rural areas, where, often, it is the only way to ask for help. One of the most relevant results of the field work is that the immediacy intrinsic property of mobile phones provides a great potential to fight maternal death and save many lives which depend on the urgency in the response in isolated rural areas in Peru. However, the analysis of the data collected allows concluding that only a short number of communities receive these benefits nowadays.

Results in the region of Catcca (Cusco) indicate that only 20% of the small isolated communities located far from the Health Centre benefit from the mobile telephony, with important consequences for emergencies, whilst the rest (80%) do not. A doctor in the Health Centre of Cattca explains how complications during the birth is the most common cause of emergencies in the area, because mothers do not normally contact their doctor during all the pregnancy and even during the birth itself. The doctor comments, as an example, the case of the 300-inhabitants community of Kismiljaila (4-hours walk from the Catcca Health Center), which does not have mobile telephony coverage nor other communication technology, thus they have to walk or ride a horse to ask for an ambulance. The doctor exclaims:

“If cellular phones existed In Kismiljaila, as in many other sectors, a lot of mothers’ lives would be saved”³.

This testimony illustrates the value attached by doctors in the mountains of Cusco to have immediate communication in emergencies derived from complications during the birth, and the association of mobile telephony as a valid technology to overcome this problem. Similarly, a doctor with professional experience in rural locations of the region of Piura, explains how, according to her experience, mobile phones could be useful even in very-isolated areas in the jungle to coordinate emergencies:

³ Original in Spanish: “Si los celulares existieran en Kismiljaila, como en muchos otros sectores, las vidas de muchas madres se salvarían”.

“In a village near here, with higher mortality-rate than here, in town, a woman told me that her sister had haemorrhages, and she ended up dying. With a telephone ring (...) and her life could have been saved”⁴.

Additionally, a partner of this doctor expressed her satisfaction about the day when she received a call from a depressed patient who had been diagnosed of VIH/AIDS and was thinking on suicide. She could successfully calm her down, and stresses the importance of having the mobile phone at that moment. These doctors’ reflections invite us to pay attention to the direct impact of mobile phones in saving lives in emergencies.

Wider reflections about the contribution of mobile phones for emergencies: the case of maternal death

In order to understand how mobile phones can contribute to alleviate the complications during health emergencies in isolated areas thanks to the inherent immediacy of their communication, the problem of maternal death is detailed, moving along from the specific case of the regions where field work has been undertaken. The choice of the maternal death as an example to illustrate the possibilities of mobile phones for emergencies responds to the fact that, according to majority of the healthcare workers interviewed in the Cusco region, complications during the birth are the main cause of emergencies in the region, and one of the main causes of death (indeed, more than 80% of the interviewees in the Cusco area mentioned the birth complications as an important worry in their daily tasks).

According to the WHO, maternal death is one of the most important health inequalities in the world. As an example, the proportion of maternal deaths in Africa is nearly 90 times the one in Europe (WHOSIS, 2008). The death of the mother has a devastating impact in the families, and thus control of maternal death is on the agenda of International Agreements such as the United Nations Millenium Development Goals, where it is highlighted as the Goal number 5 (<http://www.un.org/millenniumgoals/>, accessed 19th June 2008). Maternal and children death rates in Peru are among the highest in Latin America, with 240 maternal deaths per 100.000 newborns (data at 2005 from WHOSIS, 2008). In the Cusco region, data collected is consistent with the information provided by OGE (2005), where it is stated that Cusco is the department with the highest maternal-death rate:

⁴ Original in Spanish: *“En un pueblo de cerca de aquí, con la tasa de mortalidad más alta que aquí, en la ciudad, una mujer me contó que su hermana tenía hemorragias y acabó muriendo. Con una llamada telefónica (...) se podría haber salvado.”*

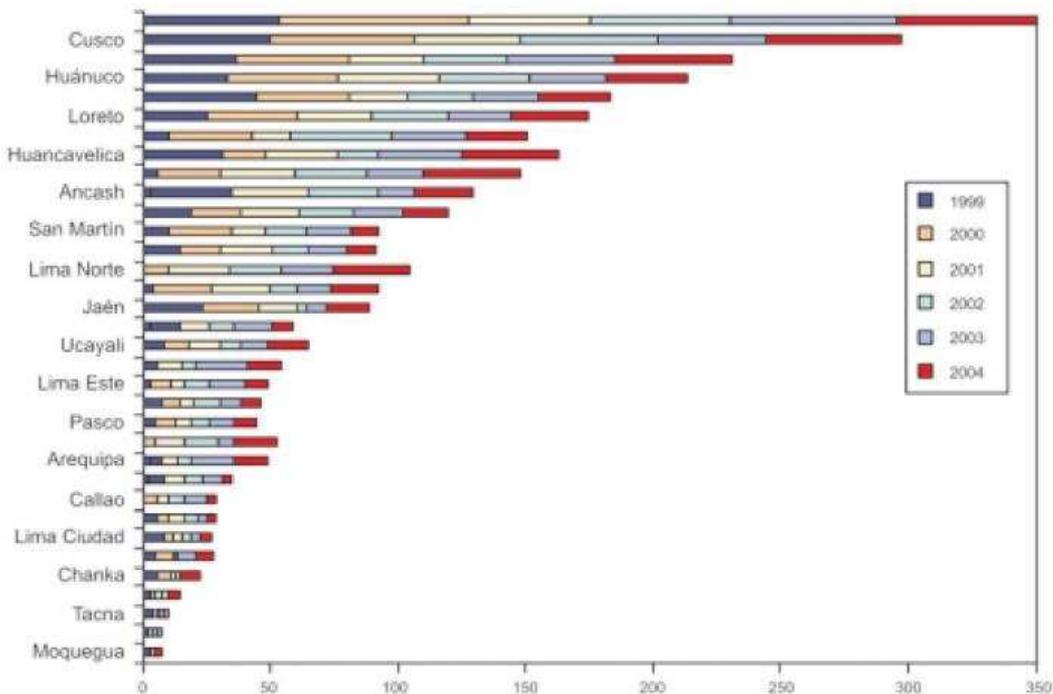


Figure 1. Notified maternal deaths in 2004, grouped by DISAs.

Source: OGE (2005); accessed 10th February 2008

Amnesty International (2006) provides an interesting human-right approach to maternal death rates in rural areas of Peru. According to its report, Peruvian State has made some progress in guaranteeing mothers' right during pregnancy, birth and post-birth, but it is still failing in rural areas in spite of the acquisition of commitments through International Agreements (such as the Universal Declaration of Human Rights, the International Conference on Population and Development and the Millennium Development Goals) as well as National Laws (such as 1993 Peru's Constitution and 1997 Act on the General Health System). According to these commitments, Peruvian State has acquired the obligation of guaranteeing the accessibility of health delivery (eliminating existing economical, physical, information and cultural barriers), the acceptability of the health delivery (in regards to cultural traditions and gender requirements) and the quality (of the health locations and health delivery), in equal terms for all the population, existing specific obligations concerning the reproductive-health and childhood health. The creation of the Health Integral Insurance was oriented to guarantee health delivery among the population living in poverty or extreme poverty, and had implications in relation to maternal health and care of children below 4 years-old. Nevertheless, the report informs that 25% of the population of the country (approximately 6.500.000 persons) has not access to basic health care (MINSa, 2002).

Since 1999, maternal death is included as one of the indicators in the Peruvian Surveillance System (OGE, 2005). It is defined as the death of a woman while she is pregnant or in the 42 following days after the birth, due to any cause related to the pregnancy – or aggravated during the pregnancy - or birth. Progress has been made in the indicators since then, but important differences in maternal health care remain between urban and rural areas: in 2004, the percentage of births attended by professional health personnel was 71% in urban areas, whilst it was 43% in rural ones; similarly, in 2004, 5% of women did not receive prenatal health care in the cities -it was 9% in 2000- against a 25% in rural areas -no improvement in the same period of time- (Amnesty International, 2006).

The main causes of maternal death in Peru are twofold: the fragile health situation of women, and the limited access to health care, with higher impact in depressed and rural areas (OGE, 2005b). Most of the maternal and child deaths in rural areas could be avoided if pregnant women were able to access proper health delivery facilities, especially during the birth, because many death factors (such as haemorrhages, infectious diseases, or causes derived from complications during birth or abortions) have their origin at that moment (MINSA, 2002; Amnesty International, 2006). There are three main barriers for a better reproductive-health attention during pregnancy, birth and post-birth for women and newborn in rural areas. First and most important, pregnant women lack economic resources (OGE, 2005 and 2005b; Amnesty International 2006). It is important to remark at this respect the importance of costs such as the transport, the time and the lack of incomes during the time spent to attend for consultation, because mobile phones have a direct impact in reducing those costs. Transport includes the cost of the travel of the mother, but also the cost when the health personnel move for a house call in an emergency (which is also assumed by mothers). Second, most of the rural health posts lack clear and accessible information (both for health staff and for patients) in respect to the maternal/children health service (Amnesty International, 2006). Finally, there is a generalised lack of acceptance of maternal health delivery services in rural areas, where there exists a different conception of this kind of services (OGE, 2005b); illiterateness and low-education levels abound in rural areas and women have fear of the contraceptives, shame, fear to be sterilized, mistrust and cold and illuminated wards, very different from traditional births attended by local midwives or neighbours (MINSA 2002). In the interviews undertaken by Amnesty International (2006) in a rural sector in Iquitos, women concluded that they preferred to give birth at home because of two main reasons: the cost of getting into the nearest health location, and that the time to rest in the health centre was much more reduced and companion was more limited than at their own home. In this sense, a

nurse interviewed in the health post of Kcauri, explained how she had to travel frequently around the mountains, and she had to make intense efforts in health promotion, particularly with women living in isolated communities who prefer to give birth with local attendants instead of doctors or professional staff in health posts.

Results of the field work show that ICTs can contribute to overcome the barriers previously identified and can provoke a direct impact in reducing the maternal and children deaths. The communication of mobile phones to ask for help or advice is the most remarkable contribution to reduce maternal death, as commented repeatedly by healthcare workers. Saving the need of transport and time is a valuable contribution of mobile telephony which becomes critical in emergencies. In this context, mobile phones contribute to coordinate the health care, in three different ways:

- First, patients can send for the doctor and ask for attendance if they are not able to get to the nearest health location.
- Second, patients can inform that they are going to the health location in order to coordinate their reception. A driver in the region of Urcay explained how he is frequently phoned to his mobile phone to pick up patients for emergencies from isolated communities where any communication technology exists. On the other side, two doctors in Catcca confirm the need both to be informed from arrival of patients and to inform for referrals to the Cusco Regional Hospital when further attention is needed, but state that this is rarely done due to the lack of means of communication among the population. They add that many people walk during several hours to get to their nearest health post and there are no health professionals when they arrive during all day. This is critical in emergencies. This was checked personally in the Kcauri health post, where, during at least 3 hours, no health personnel could be found. Finally a nurse appeared, arguing that:

“I have no idea where the doctor is. She should be here today, because it is not a holiday day”⁵.

Reasons for leaving from work are out of the scope of this paper, but it is important to remark here that previous communications for coordination are particularly relevant to save time of long travels, which even aggravates the health of the persons who travel and get no attention, and is critical in emergencies. The utility of mobile phones

⁵ Original in Spanish: *“No tengo ni idea de dónde está la doctora. Debería estar aquí hoy, porque hoy no es fiesta”*

in order to coordinate this kind of communications is evident. It should be noted, though, that a pharmacist in the health post of Kcauri remarked how many health staff in posts in communities preferred to use other means to warn the Cusco Regional Hospital, because using mobile phones there is no evidence of the call and the information has often been ignored.

- Third, patients who have decided not to visit the doctor and face complications, can ask for a second opinion or technical advice as the last chance in an emergency. Mechael (2005) explains how specialists are considered only for extreme cases in Egypt (in most of the cases they have to move physically but they need more than three hours of travel), and that most relevant consultations occur between traditional birth attendants and nurse mid-wives, or nurse mid-wives and physicians regarding cases.

As shown, in the three possibilities, being able to communicate in a given moment is crucial for the life of the patient. In this context, mobile phones provide a unique tool to communicate and obtain an immediate response in order to obtain help from a health professional, wherever the mother is. Results from the fieldwork emphasize how mobile telephony is increasingly considered in the mountainous areas of Cusco with this objective. In this same sense, Mechael (2005) argues that there is little known about the impact of mobile phones in relation to maternal and child health in developing countries, and concludes for her case study in Egypt that the main contribution of mobile phones is to reduce the response time to obstetric emergencies to contact formal and informal means of medical transport. The potential of staying in touch anytime and anywhere is also highlighted by *Castells et al. (2007)*, who state that mobile phones allow a permanent and ubiquitous form of connectivity. This is critical when the connected people are doctors and health staff.

In conclusion, the immediacy of the communication through mobile phones makes them appropriate for coordination in emergencies, providing opportunities to fight maternal death and save many lives which depend on the urgency in the response in isolated rural areas. Nowadays, benefits can only be achieved in a short number of communities due to the scarce adoption in rural areas caused by the lack of coverage and the high cost, but these limitations will be overcome in the short term, as explained next.

Multimedia capabilities

Multimedia capabilities are appealing for healthcare workers

Recent multimedia capabilities of mobile phones, and photography capabilities in particular, provide attractive possibilities for the practice of telemedicine and search of a second opinion in rural areas of Peru, but benefits for health delivery in these areas will only be a reality in the short term due to lack of network infrastructure and high cost of the devices.

The appealing of multimedia capabilities for healthcare workers was checked during the field work, through numerous testimonies of healthcare workers. In the sample considered living in isolated areas, healthcare staff observed and interviewed shared enthusiasm for advanced capabilities in mobile phones. As an example, a doctor in the region of Piura claims:

“Now, Claro⁶ is offering better and cheaper handsets, but only when calling to other Claros. You have video, camera and so on, and cheaper than before. I really like those things. Although it is obsolete in one year’s time.”⁷

She also explains how she likes the camera capabilities of the mobile phone I carry with me (Sony Ericsson T630, 0.1 Megapixels CIF 288x352 Resolution). At least four more interviewees expressed specifically their interest in the evolution of capabilities in mobile phones related to photography. In Catcca, an isolated area in the mountains of the Cusco region, a doctor owned a camera phone and was really excited about the possibilities of making photographs in this rural environment for professional use, to save them or to ask for advice to colleagues; among the photos in his camera, he showed several ones of an abortion and photos of skin injuries.

In the sample analysed, only one in 26 healthcare personnel (23 in rural areas) interviewed and observed had a photography-enabled mobile phone. In addition, in none of the establishments visited, included the hospital, a digital camera was seen. According to the project managers interviewed, one of the main causes for this lack of adoption was the cost of the handsets. All testimonies of healthcare workers collected during the field work (in Lima, Piura and Cusco) agreed at this point.

⁶ Claro is the second largest mobile phone network in Peru, and it is part of the telecom group Amércia Móvil which is the fourth largest operator in the world ([http://en.wikipedia.org/wiki/Claro_\(mobile_phone_network\)](http://en.wikipedia.org/wiki/Claro_(mobile_phone_network)); accessed 26th May 2008)

⁷ Original in Spanish: “Ahora Claro está dando mejores equipos y más económicos, pero entre Claro y Claro. Tienes videos, cámara y todo eso, y más barato. Me gustan mucho esas cosas. Aunque al año ya está desactualizado el equipo.”

Wider implications: contribution of camera phones for better health delivery

The interest shown by healthcare staff is the first condition for the success of application of advanced capabilities of mobile phones to health practices in rural areas. Given camera phones' applications for telehealth and this appealing for healthcare workers, a wider reflection about the possibilities of these capabilities in the near future is presented.

Mobile phones' capability of photography is useful for health workers in rural areas in developing countries, due to two main reasons: its value for achieving a second opinion and for telemedicine, and the lack of other appropriate devices in these areas for these tasks:

1. As explained above, healthcare staff in rural areas is not expert in all the fields of medicine and distances for referrals are huge in rural isolated areas; in this context, second opinion and telemedicine are effective tools for health delivery (Chetley *et al.*, 2006). In the areas visited in Cusco, the utility of obtaining help in the diagnosis is evident considering the profile of the health staff in the area (shown in
2. Table 1) and the distances for referrals (shown in
3. Table 1). In particular, multimedia information is valuable in order to have a complete view and offer a better diagnosis or opinion. Greenberg (2005) states that telemedicine is relevant in developing countries for certain specialities such as dermatology and cyto-pathology, where simple cameras can get all the information needed for the tediagnosis, rather than for others such as cardiology or radiology, where complex remote equipments (ultrasound systems, electrocardiogram, digital sphygmomanometer) are needed. Jiva Institute (2003) is an example of successful appliance of camera phones in the rural context of a developing country. Therefore, mobile phones could provide simple diagnosis functionalities useful for telemedicine and second opinion through the use of their integrated digital photo camera.
4. As commented previously, healthcare staff in rural areas normally lacks of appropriate tools to take and send photographs, as well as other basic material resource. This outlook can change drastically with the appearance of camera phones.

As a result, camera phones provide a good opportunity to improve health delivery. However, benefits only will be achieved in the short term. Recent situation is that camera phones' penetration is minimal in isolated areas of Peru. As shown previously, the ownership of a camera phone is anecdotic (only 1 in 26 healthcare workers interviewed owned a camera phone). It was also commented that cost keeps on being the most serious difficulty for the adoption (in particular with advanced accessories such as photo camera). However, there has

been an outstanding decrease in prices last years, as well as the generalization of the digital camera as an accessory integrated in the mobile phones, as will be explained in the next section. This massive standardization of the digital camera, together to the decrease in prices and the good predisposition of healthcare workers provoke that, in the near future, lack of advanced equipment could be substituted by easy-to-use, relatively-cheap, adequate for telemedicine camera phones, contributing to a better health delivery in isolated areas.

Reliability

Reliability of mobile phone communication and its use for health communications in rural areas

Results of field work indicate that the reliability of communication using mobile phones is perceived as being superior to that provided by other technologies available in isolated areas, particularly the radio. The concept of 'reliability' is used here to refer to the chances of success that a communication can be established and a conversation can be effectively maintained; it is thus closely related to the operation of the technology and has direct consequences on the trustworthiness that people have for the technology. In this sense, reliability of communication is a critical element when its purpose is contacting health personnel (Donner, 2004). This is particularly true in the case of emergencies, when a life can be saved if the communication is effective and is on time; proper operation of the technology can be the difference between life and death.

During the field work, it was evident that the arrival of mobile phones in rural areas has changed the precarious situation that existed previously in terms of the reliability of communications, leading to their common use among healthcare workers, as well as among the population who want to contact them for health purposes (in places where it is available). Two-way radio has traditionally been used as a communication tool in isolated areas, where no other communication existed previously, but its lack of reliability has meant that mobile phones are increasingly being adopted for health communications. All but one of the interviewees in areas with mobile connectivity commented that they used and trusted mobile phones more than radios during emergencies. Similarly, in the Urcos Health Center, it was commented that mobile phones act as a security channel for emergency communication with the Cusco Regional Hospital when other ICTs, such as radio or Instant Messaging, fail. In this same sense, the person responsible for health at the Catcca Health Center states that:

“Many health posts that have mobile phones call to my Movistar, in particular for emergencies”⁸.

As stated previously, according to the data collected, only 20% of communities located far from the Health Centre benefitted from mobile phones coverage, whilst the rest (80%) do not. However, the testimony of the doctor in Catcca indicates that, where available, they are becoming the safer channel. Furthermore, the mobile phone has become a reference for patients in emergencies and complicated situations. Two examples illustrate this. When asked for a concrete situation when the mobile phone has made a difference for her, a doctor expressed her satisfaction about the day when she received a call from a depressed patient who had been diagnosed with HIV/AIDS and was thinking of committing suicide. She could successfully calm her down, and stressed the importance of having the mobile phone at that moment, because the girl knew that she could use that channel and she could contact the doctor exactly at the right moment. On the other hand, two Health Posts were closed during field work visits, but there were signs that gave a mobile phone number for emergencies - presumably, the number of the health personnel in charge. Thus, reliability of the mobile telephony service is becoming essential in order to facilitate the coordination of health needs, acting as a reference for population.

However, several reliability problems were collected during the interviews and observations undertaken, indicating that situation is still far from the way it is in developed countries, or in the urban context in developing ones. This was also checked with my own mobile phone in the rural locations of Urcos, Catcca and Kcauri, in the mountainous Cusco region, where the availability of the service failed some times, even in a fixed position with mobile connectivity. In Urcos, a bigger village in the mountains in the same region, two interviewees commented that reception is still unreliable - these interviewees frequently travelled around the communities of its health micro-network. Signal disappearance was also reported by a doctor in the town of Piura, in locations where there is coverage in normal conditions. The doctor commented that many times these wrong operations were solved by just walking several meters:

“We had some difficulties but they were solved soon, the failure only lasted a while”⁹.

⁸ Original in Spanish: “Muchos puestos de salud que tienen teléfono celular me llaman a mi Movistar, sobre todo para emergencias”. Movistar is the brand name of the service telephony provided by Telefonica Móviles in Peru.

⁹ Original in Spanish: “Teníamos un poquito de dificultad pero se solucionaba en el momento, en un ratito era nada más lo que fallaba”

Similarly, an expert of the Last Mile Initiative project commented in respect to Jauja (a region located near Lima) that:

“There is coverage in certain places, but in many others there is not. You have to walk two blocks to phone. Receiving calls is a hard task”¹⁰

These failures indicate that the technology is not completely reliable in these areas and health staff and population are conscious about that. Evidently, failed calls or lack of reception affect people’s trust in technology. However, it should be remarked that previous testimonies included positive comments about ways to solve the reliability problems and played down the importance of the problem.

The above results are based on the subjective points of view of healthcare workers interviewed during the field work in the regions of Piura and Cusco, referring qualitatively to their experience in the use of mobile telephony. Nevertheless, these results are consistent with the quantitative information provided in a recent report by OSIPTEL (2007). OSIPTEL monitors the quality of the mobile service provided by operators since December 2006, through three main indicators: TINE (*Tasa de Intentos no Establecidos* - failure rate in call establishments); TLLI (*Tasa de Llamadas Interrumpidas* – conversation interruptions rate, once the communication is established); and TOE (*Tasa de Ocupación de Enlaces* – time that infrastructure links are busy, closely related to the traffic lost); being the concept ‘quality’ used by OSIPTEL equivalent to the ‘reliability’ one used in this article. The conclusion of this report is that, in this period, the three main operators (Telefonica Moviles, América Móviles and Nextel del Perú) have failed to fulfill their minimum requirements. As an example, Telefónica Móviles:

1. Failed to fulfill the requirements for TLLI (<2%) in four months, using the day as the measuring unit. This indicates that there were more unexpected interruptions of calls (once established) than the 2% maximum permitted by OSIPTEL.
2. Failed to fulfill the requirements for TINE (reaching 3%, whilst the maximum permitted is 2%) in the months of April 2006, December 2006, April 2007 and June 2007, using the month as measuring unit. If the measuring unit is the day, there were failures to fulfill the requirement all the months from December 2006 to May 2007. This indicates that more failures in call establishments than permitted occurred systematically during these months.

¹⁰ Original in Spanish: “Hay cobertura en algunas zonas, pero en ciertas zonas no entra. Tienes que andar dos cuadras para poder llamar. Recepcionar no es fácil.”

3. Failed to fulfill the requirements for TOE – with a loss of traffic of 13,465 Erlangs in base stations.

These results ratify the perception of healthcare workers presented previously: reliability of mobile communications service is high and, although the service fails more times than permitted by the OSIPTEL, these failures to fulfill the requirements are not excessive.

Wider reflections: factors influencing the reliability of mobile telephony

Factors influencing the reliability of mobile telephony can be divided into three main categories: technological, human and external. Technological factors can in turn be divided into two groups: handsets and network reliability.

Technological Factors: Reliability of handsets

According to the perception of the healthcare workers using mobile telephony who were interviewed during the field work, the two most common causes of wrong operation of mobile handsets are overheating and battery discharge. With reference to overheating, a doctor taking part of the CellPREVEN project, using the phone to report surveillance information in the Piura region, reported how she had certain difficulties with her handset because it 'overheated' and the communication was finished because of this problem:

"Sometimes we had difficulties, because sometimes the cellular phone turned itself off. It overheated and then (..) we had to call again"¹¹

This same abnormal performance was reported by her partner:

"It suddenly cut out. It was like a beep. And we had to make the interview again".¹²

According to their testimonies, faulty operation was particularly significant in the summertime. This had serious consequences for trustworthiness in the device itself, as one of them explained:

"The telephone was really hot and it burnt your ear. I don't know if that energy can cause you any harm, as cancer?"¹³

¹¹ Original in Spanish: "Pero a veces teníamos dificultades, porque a veces se apagaba el celular, se calentaba, recalentaba mucho y entonces (...) teníamos que volver a hacer la entrevista, volver a llamar, no?"

¹² Original in Spanish: "Se cortó de repente. Era como un chillido. Y tuvimos que repetir la entrevista".

¹³ Original in Spanish: "El teléfono se calienta y te quemaba la oreja, al rojo vivo. No sé si la energía te puede producir algún daño, como cáncer"

The other main cause of faulty operation noted by the respondents was that the batteries suddenly discharged. This caused serious trustworthiness problems to the participants in the CellPREVEN project, because they could not rely on a good service unless they could be in locations where they were able to recharge their batteries. The problem of energy consumption is common to most technologies in developing countries, where the electric grid is unreliable and non-existent in many cases, particularly in rural areas (Dholakia and Kshetri, 2001; for imaginative solutions for the problem of energy in developing countries, see USAID Cooperative, 2004 and DOT-Comments Challenge, 2005). As commented during the interviews, mobile phones handsets are not free yet from power-related problems and dependences. Nevertheless, they need little power compared to other technologies such as computers (even compared to new smaller devices such as Simputer or Municator), and it is not considered nowadays an important limitation for the spread of the technology (Dholakia and Kshetri, 2001). Finally, wrong operation of batteries is becoming less frequent as the technology improves its performance, and could be considered anecdotal in the near future, as they are in developed countries.

These two problems were reported by the same two users in the Piura region, working with a particular model of mobile phone and for a specific use that implied long call durations. On the contrary, they were not mentioned by the rest of the sample who frequently used mobile phones in order to communicate. The small number of people reporting problems with the handsets, comparing to the whole of the sample, indicates that these are not widespread problems and mobile phone handsets in developing countries do not show important reliability troubles.

Finally, it should be noted that handsets in developing countries are commonly older than the ones in developed countries, but this does not imply that their performance is poorer than more modern ones in terms of reliability. As an example, the Nokia 1100 is the top-selling electronics product in history since it was first launched in 2003 (data valid at 10th July 2008; see <http://uk.reuters.com/article/airNews/idUKL0262945620070503>; accessed 10th July 2008), being a basic phone targeted for low-income users and developing regions, and is remarkable because of its reliability and robustness (see http://www.nokia.com/NOKIA_COM_1/About_Nokia/Press/Press_Events/zz_New_Potential/JuhaPinomaa-Moscow03.pdf; accessed 16th July 2008).

Technological Factors: Reliability of the network

In general terms, reliability of a network depends on the technology used and the sizing of the network. In respect to the technology used, it should be stated that quality, security and reliability of mobile telephony communications has increased considerably since the appearance of second-generation digital wireless technology, in comparison with first-generation analogue mobile telephony (Minges, 2001; Roldán, 2004). In Peru, contemporary network infrastructure is mostly digital (OSIPTEL, 2007).

There are basically two standards in second-generation mobile technologies: Global System for Mobile communications (GSM), the contemporary most used digital standard for mobile telephony, and Code Division Multiple Access (CDMA) (Roldán, 2004; OSIPTEL, 2007; Engvall and Hesselmark, 2004). New generation standards include General Packet Radio Service (GPRS) and Enhanced Data Rate for Global Evolution (EDGE) –evolutions of GSM- and IS-95B – evolution of CDMA- for 2.5 generation mobile technologies, and CDMA2000 for third generation (Fundación para la Innovación Bankinter, 2004; Minges, 2001). In Peru, most of the infrastructure existing nowadays in Peru is GSM. Telefónica Móviles Perú initially installed CDMA for the backbones but it has progressively migrated to GSM, as reported by two different experts of Voxiva and Last Mile Initiative interviewed during the field work. Both technologies are able to operate in different bandwidths: 450 MHz, 850 MHz, 900 MHz, 1800 MHz and 1900 MHz for the case of GSM, and 450 Mhz, 800 Mhz, 1700 Mhz, 1800 Mhz, 1900 Mhz and 2100 Mhz for the case of CDMA (Roldán, 2004; OSIPTEL, 2007). The propagation of the signal is different in each of these ranges: lower frequencies correspond to longer wavelengths, which allow wider penetration (less vulnerability to obstacles and achievement of further distances). Thus, the sizing of the network cells must consider the bandwidth used and more base stations will be needed when operating in the range of 1900 MHz in comparison to 800 MHz (Fundación para la Innovación Bankinter, 2004). In Peru, the three main operators use the 800 MHz and 1900 Mhz bands (OSIPTEL, 2007).

Cell size and shape design depends basically on the expected traffic and the obstacles, configuring the power of transmission, antenna radiation, and reception in the border and cells. The physical environment is another aspect to consider. The signal is much more attenuated in areas with more obstacles, such as mountains, forcing the use of higher towers, higher power of signal transmission, as well as higher technical cost of deployment and maintenance of network infrastructure (Engvall and Hesselmark, 2004). This is the case in the very mountainous Cusco region, adding to the problem of low population density; on the other side, in urban areas, large buildings are also important obstacles, but a higher cell density helps to overcome this situation which is economically justified by a higher population density

(Engvall and Hesselmark, 2004; Donner, 2004). During the field work interviews, several experts commented that there is “wireless telephony” (free translation of *tecnología libre inalámbrica*) in Peru, consisting of the connection of specific remote locations through CDMA in the 450 MHz band, such as in the Guaichirí region; nevertheless, its use is anecdotal.

Failure in any of the Access or Transport Networks – elements such as cables, connections or equipment; configuration; alternative routes to address the traffic; backup equipment.- causes wrong operations and failures in the communications, limiting the reliability of the technology and undermining the confidence of people in it. In this respect, Scott *et al.* (2004) explain how reliability of the networks keeps on being one of the main constraints on use of mobile telephony in developing countries. As checked during the field work, these wrong operations occur in Peru, particularly in rural areas, but fortunately, they are not widespread and technology is perceived as being reliable for communication by healthcare workers and the population in general.

Human factors

Sizing of network infrastructures is usually made according to forecasts about likely network use by users. It is normally based on the traffic in a “rush hour” (hour with maximum traffic) plus extra capacity for security reasons and forecasts of traffic growth. As commented previously, figures provided by OSIPTEL (2007) reflect the fact that sizing of the infrastructure has not been increased and has not grown to absorb the growing demand of users in the country, causing failures in the service. The consequence is that, even in conditions of expected user behavior (in respect to mobile calls), the service provided does not fulfill the minimum requirements demanded by the Peruvian Government, undermining the perception of reliability among the population. In addition to this problem, abnormal increases in demand of the service by users, caused by human behavior, aggravate this problem, causing more failures in the communications and diminishing the feeling of reliability of this technology. Abnormal increases in the traffic can result from free days, special social events or natural disasters (the case of earthquakes will be detailed below).

A second type of human factor related to behavior of users does not influence the reliability of the technology itself, but rather the perception of reliability among the population, and consequently the feeling of trust in the technology. As commented previously, the mobile phone number of healthcare workers has become a reference for a great part of the population, increasing the feeling of safety among patients, who are able to use an immediate communication channel to ask for help. However, even if technological factors work properly,

the fact that some healthcare workers neglect their duties can increase the feeling that this communication channel is not as reliable as it is. Several experiences of people living in the Cusco region illustrate this problem, and are typified by the case of Urcay. During the visit to this community, no-one attended the Health Post, and a notice in the door informed about the contact number of the person in charge. This was a mobile phone number, reinforcing the idea of the mobile phone as a reference for population, previously commented. However, after three attempts to contact this number, even though a ringtone was found there was not an answer. More trials failed repeatedly several hours later. People asked near the post commented that this was a normal situation. Therefore, neglect of the duties of being contacted (added to absenteeism) influence the perception of mobile phones as a reliable channel for health purposes, but it should be remarked that this fact has nothing to do with the particularities of the technology.

External factors

Finally, reliability is strongly influenced by external factors, such as vandalism, software or hardware attacks, electricity grid failures, weather or natural disasters. In general, the operation of mobile phones is robust in respect to all of these factors (Dholakia and Kshetri, 2001; Sullivan, 2007). However, the robustness of the mobile service failed during the 8.0 moment magnitude scale earthquake that hit Peru on 15th August, causing important human and material losses in Pisco, Ica, Chincha or San Vicente de Cañete, among others. I arrived in Peru three days after the earthquake, and thus witnessed some of its consequences. Mobile telephony was paralyzed on the day of the earthquake and several days after, but it should be emphasised that all of the other communication technologies available in the area also failed.

OSIPTEL designated a High Level Commission to find out about the problems that occurred during the earthquake and following days, the main results of which are presented here (for the complete report, see OSIPTEL, 2007). The earthquake caused important losses and breakdowns in the mobile equipment in the affected areas, but the effect of the earthquake was felt (in terms of communication) all over the country, where the increase in the traffic caused important failures in the mobile service (according to OSIPTEL, 2007 a total of 247 base stations belonging to Telefónica Móviles, América Móvil Perú and Nextel in all the country did not work during and after the earthquake). According to the GSM Association, a huge increase in traffic is common during disasters and many days afterwards (Coyle, 2005). The contract with OSIPTEL establishes that the normal Service Level Agreements (SLA) are not applicable for disasters; however, a time is scheduled to guarantee the re-establishment of the service, and it

was not appropriate after the earthquake. The report thus ends up recommending penalties for all the operators (OSIPTEL, 2007).

Mobile communications play an important role in managing the different early phases following a disaster: early detection, impact of the disaster, immediate consequences and recovery (Coyle, 2005). The strengths of the technology are the speed with which mobile networks can recover (in comparison to other forms of communication) and its capacity to “improve the process of getting the right resources to the people and places where they are most needed after a disaster” (Coyle, 2005, *page 34*), as well as facilitating the flow of information among relatives and friends. In this sense, a doctor in Piura explained with pain how she had not been able to contact her workmates in Pisco, even ten days after the earthquake (phoning to her cellular numbers). Her hair-raising testimony illustrates some of the failures analyzed in the report by OSIPTEL (2007):

“Now, with the earthquake, there is not answer when you call a mobile number in Pisco. There is not answer on Internet too, and there is not electricity. What has happened with our workmates there? Now there are not phones there. They are providing with electricity generators to charge the batteries of the mobile phones, but our mates keep on not answering our calls”¹⁴

Comparison with the reliability of other technologies

The above paragraphs note that the reliability of mobile phones is, and is perceived as, good in general terms, although there are still important problems in the communications that undermine this perception. The potential of the reliability of mobile phones relies on its comparison with the one by other technologies existing in rural areas.

The first technology presented is the two-way radio, because it is the most extended technology in isolated locations in Peru (Martinez, 2003), and in this sense, it could be considered a ‘competitor’ as appropriate technology to solve communication limitations in isolated areas. In this respect, all of the interviewees referring to this point except one (a Department Responsible in the Cusco Regional Hospital) agreed in that the radio is not a reliable technology and mobile phones’ communication is much more reliable. At least fifteen testimonies of health staff reflecting this fact were collected in the Cusco area, although what

¹⁴ Original in Spanish: “Ahora con el terremoto de Pisco, no hay respuesta en el celular, en Internet, no hay luz. Qué ha pasado con nuestras compañeras allí? Ahorita allí no hay teléfonos. Están llevando ahorita generadores para cargar los celulares pero aún así no lo cogen mis compañeras.”

is presented here is an experience of observation in the Cusco Regional Hospital, because it illustrates perfectly the difficulties reported by many of the interviewees. During my visit to that hospital, I was able to observe several failed communications through radio, such as the one by a health professional trying to communicate repeatedly with the Health Post of Kcosñipata without success:

“Kcosñipata, can you hear me? Attention, can you hear me? Let’s pass to channel number 8... Can you hear me now? Let’s go back to 9...”¹⁵

The quality of the signal was very bad, with strong interferences and disturbing background noises, and the line was breaking up. After three attempts, the health professional gave up. Radio failure also occurred in bigger villages such as Urcos. In this instance, health staff in Urcos explains how the radio is normally used for communication during the mornings, but *“you cannot rely on it”¹⁶*, and it does not work properly in the evenings. In those cases, testimonies stated that mobile phones were increasingly being used when the radio was not operative. Similarly, a doctor in Urpay explained how mobile phones are used in Catcca when there is no radio service. He continued explaining that, in that mountainous area, radio operation is not reliable at all, and it depends on the time during the day (it does not work properly in the afternoons, evenings and nights), on the weather, and even on *“God’s will”*. Therefore, in rural locations of Peru where coverage existed (according to field work results, 20% of the small isolated communities in the Catcca area), mobile phones are increasingly replacing radio, particularly for emergencies and referrals of patients, due to its greater reliability for health communications. However, the dominant communication technology in isolated rural Health Posts in Peru remains two-way radio, because there is insufficient mobile coverage and additionally, MINSA equips every Health Post with a radio, as well as ambulances (visit <http://www.minsa.gob.pe/> or Martinez, 2003 for more information). Therefore, in theory, radio communication is available nowadays in all Health Posts. However, an expert in the Cusco Regional Hospital confirmed the reliability problems reported by all interviewees in Health Posts in rural locations, and proposed it as a parallel network for emergencies, stating that mobile phone communication is becoming the dominant form of communication used in places with coverage.

The situation with television is similar to that of the radio. Both in Urcos and Catcca it was commented that the television signal is not received during the night in these mountainous

¹⁵ Original in Spanish: *“Kcosñipata, me escucha? Atención, me escucha? Pasemos a la 8... Me escucha ahora? Vuelva a la 9”*

¹⁶ Original in Spanish: *“No te puedes fiar de ella”*.

areas. This was not further explored because the aim was to research the reliability of the communication in mobile phones, and television does not provide duplex communication.

Another relevant technology in rural areas of Peru is satellite telephony. The most important effort by the Peruvian Government to reach Universal Access and enable telephony for rural locations in Peru was the installation since the year 2000 of nearly 6000 satellite public phones by means of the enterprise GILAT Peru, based on VSAT technology and financed by the program FITEL (Fondo de Inversión en Telecomunicaciones) (for the evolution in the installation of telephones of this program, see http://www.osiptel.gob.pe/Index.ASP?T=T&P=%2Fosipteldocs%2Fgpr%2Fel_sector%2Ftelefon_a%2Fost_04.htm; accessed 9th September 2008) for a complete list of public phones, see <http://www.gilat.com.pe/guia/MainGuia.htm> and search by “FITEL” in the column “abonado”; accessed 9th July 2008). According to three different experts interviewed during the field work, the four main problems of satellite phones are cost, technical maintenance, complex use, and location (these public phones are frequently placed inside a private property and depend on the presence of the owner who is able to open). Referring to cost, the per-minute charge to telephones (fixed network or wireless network) is S./0,9 using a satellite phone, almost the double than using a mobile phone, S./0.50.¹⁷ The satellite-phone call price depends strongly on the destiny of the call; actually, if mobile phones are excluded, this average reduces to S./0,53, equivalent to that of mobile phones (nevertheless, mobile phones are also considered an expensive technology nowadays). In conclusion, although in terms of reliability there are not convincing arguments against satellite phones, these four factors are meaning that this technology is not becoming the expected solution. In this context, the experts interviewed explained that, in practice, most satellite phones are being abandoned due to these problems and they are not becoming a solution for isolated areas.

Finally, during the field work, it was noted, in the rural context, that mobile phones are more robust to storms than are computers. As an example, all the health staff in the Health Centre of Kcauri explained how two of the three computers they owned had broken down due to a storm. The only one not affected was the one installed as part of the EHAS project, because it had an Uninterruptible Power Supply (UPS). Nevertheless, none of the computers (excluding the ones by EHAS) in Health Centers and Health Posts visited during the field work (15

¹⁷ The per-minute charge using a mobile phone is calculated from the plan “Tarifa Única” of Movistar, which includes the same price for calls to other Movistar, other brands, as well as to the fixed network (tariffs at 2008, <http://www.movistar.com.pe/default2.aspx?id=21>, accessed 19th September 2008) whilst the per-minute charge using a satellite phone is calculated as the average of the prices of per-minute charge to fixed or mobile telephones, local and long-distance calls from the tariffs of Gilat to Home Perú (tariffs at 2007, available at http://www.gilat.com.pe/tarifas/tarifario_general_2007_abon.htm; accessed 19th September 2008).

computers) had a UPS, and at least 4 of them were not working. In Urpay, I was able to see how staff of the CEDITER group diagnosed the problems in a computer broken down during the same storm, and apparently, its power unit and its graphical unit were not working properly. On the contrary, no mobile phones failures were noticed as a consequence of the storm.

In conclusion, reliability of the communication provided by mobile telephony means that this technology is increasingly considered for health communications in rural areas where there is coverage, partially replacing old communication systems such as two-way radio, in particular for emergencies. Reliability in the rural context is still not as good as in the urban context, with failures in the communication due to technological, human and external factors; nevertheless, it is still perceived as a reliable communication tool valid for health purposes.

Main constraints for the adoption by healthcare workers

Lack of coverage and cost are the main limitations for the adoption of mobile phones by healthcare workers, but the trend is that they will be surpassed in the short term

Cost and lack of coverage are the main limiting factors for the adoption of mobile phones in rural areas, particularly in the poorest isolated areas. An approximate 85% of the interviewees not owning a mobile phone in areas under coverage stated that cost was the main reason, and that they would like to be able to own one if prices would be affordable for them; on the other side, an approximate 90% of the interviewees not owning a mobile phone in areas with no coverage stated that mobile phone were not useful for them because of this lack of coverage, but that they would be interested in the acquisition there existed coverage. As a result, benefits of mobile telephony presented previously are not available for a great part of the population, in spite of the growing interest in the technology.

It should be pointed out that certain authors state that phone communication is perceived as a necessity and households, no matter how poor they are, invest some money if they can afford them (USAID, 2006; Marine and Blanchard, 2004 and Souter *et al.*, 2005). As an example, Brian Richardson, chief executive of Wizzit, a small start-up which is a pioneer in cell phone banking in South Africa, states that "*people might not have shoes but they have a cell phone*" (Harrison, 2005, *unnumbered*). Even more, according to Souter *et al.* (2005), lower income groups spend a greater percentage of their income than high status individuals. Being that the case, the limiting factor would be the lack of coverage, more frequent in Peruvian mountains than in flat

Africa. However, cost was mentioned by all interviewees and is detailed next as a limiting factor.

Coverage

First of all, it should be stated that OSIPTEL does not provide official statistics about mobile telephony's coverage in rural areas, thus information provided in this paper is based on data collected during the field work. Results of the field work indicate that most of the rural communities in mountainous areas are not under coverage of mobile telephony.

Even in areas under coverage, it is limited and is only available in certain locations in the community. As an example, a nurse in the area of Kcauri explained how the population in the community of Ccancahua has to climb up to a small hill in order to be under coverage. Obviously, this limits many possibilities for health related to receiving calls; however, main benefits of communication, particularly during emergencies, are linked to sending calls, and mobile phones keep on making a difference at this point, in spite of limitations.

The penetration of mobile phones in a limited number of communities is making some of them enjoy their benefits and increasing the inequality among them. Therefore, an "internal rural mobile divide" is being opened with this unequal penetration. In this sense, the testimony of a doctor in Catcca is illustrative, explaining that certain places are much better communicated than others, and this can be the difference between live or death in an obstetric emergency. In this sense, the arrival of mobile phones can contribute to improve the situation, but aggravates ever more the precarious situation of other communities with no possibility of mobile telephony, which is further marginalized.

The most accepted theory for the lack of coverage in rural areas and among them, in the poorest ones, is that, traditionally, mobile service providers have focused on the urban market, much more profitable and less risky (Engvall and Hesselmark, 2004). However, a growing body of research evidences that, under certain circumstances, rural market can be profitable. As an example, Engvall and Hesselmark (2004) provides a full example of how rural-GSM micro telephone independent operators which target networks of 20,000 subscribers can be profitable and reach penetration rates of 6 % in about 5 years (assuming conditions like limited mobility, pre-paid available, not fixed lines and easy interconnection with incumbent operator). In this same sense, Scott *et al.* (2004) stated that the next billion mobile users would be won by operators that develop business models that work for poorest groups. Additionally, demand aggregation through shared access models such as community centres or kiosks is a

common scenario in rural areas; see the cases of Vodacom Kiosks in South Africa (http://www.vodacom.co.za/about/community_franchise.jsp; accessed 19th June 2008) or the Grameen Phone in Bangladesh (Sullivan, 2007). On the other hand, authors such as Caspary and O'Connor (2003) argue that there is not enough evidence yet to ensure commercial viability, because until now all existing experiences of GSM coverage in rural areas could be characterised as medium or high density low-income regions. In this same sense, the testimony of a manager of Last Mile Initiative interviewed (for more information about this project, see USAID, 2006) states that most isolated places, such as most communities in the Amazonas forest, will never be under coverage because profitability conditions will never be surpassed and approaching mobile telephony will not make any technical sense (instead, he advises the use of other technologies, such as satellite). In spite of these opinions, the number of experiences with mobile phones in the rural context such as the ones commented previously is growing incessantly in the ICT4D community, inviting to optimism for rural areas in developing countries in the near future.

Cost

The cost of mobile phones has dramatically decreased since first handsets were introduced in Peru in 1983, with an approximated price of \$4000, to contemporary prices in the range of \$20 to \$350 (for more common handsets), depending on the quality of the device (Pierina, 2007). The other main cost involved in mobile telephony is the call cost, but there are not statistics available at this respect in the OSIPTEL website (<http://www.osiptel.gob.pe>), although the perception among the population is that it has progressively been reduced last years.

The trend in prices allows being optimistic for the near future. However, as stated previously, cost keeps on being a barrier for the adoption of mobile telephony. Shared access scenarios commented previously go in the same direction. Additionally, given the benefits for health delivery, subsidizations (by the Health Ministry of Service Providers) for this particular collective could be considered. All of these initiatives would contribute a higher use of mobile telephony (and enjoy of benefits) among healthcare workers.

Due to their interest for telemedicine practices, the particular case of most advanced handsets (such as camera phones) is present next. In this case, the cost limiting factor is more even marked. These handsets are still out of reach for health staff, but the evolution of technology and the decrease in costs allow forecasting affordable prices for them in the short-medium

term. The following table compares the price of ten camera phones, according to promotions by the operator Claro in February 2008:

Camera phone	Price with Claro Chip (S/.)	Resolution	Months to pay in Catcca
Motorola C261	179	0.3 mega pixels VGA Resolution	1,1
LG 120	189	0.3 mega pixels VGA Resolution	1,1
Sony Ericsson K310	259	0.3 mega pixels VGA Resolution	1,5
Nokia 6080	279	0.3 mega pixels VGA Resolution	1,6
Samsung E236	499	VGA, 640x480 pixels	2,9
Sony Ericsson K550i	789	2 MP	4,5
Motorola W510	799	1.3	4,6
LG 550	799	1.3MP	4,6
Nokia 6131	799	1.3MP	4,6
Samsung U106	1149	3 MP	6,5

Table 3. Personal elaboration from data in <http://www.claro.com.pe> and <http://www.phonearena.com> (accessed 2nd February 2008). Prices expressed in Nuevos Soles (S/.). Fourth column considers a 177 S/monthly total salary for a family (Iirsa Sur and Walsh, 2007).

As shown in the table, a low-resolution camera phone can be achieved for the medium salary of a month, considering no other expenses (and no calls). For telemedicine purposes, images taken by low-resolution camera phones are not normally useful, and camera phones with a medium resolution (approximately 1 mega pixel) are out of the financial reach for the majority of health staff. This fact is an indicator of the existence of a 'mobile digital divide' between developing and developed countries. In this sense, Peña (2006) defends that, although mobile penetration in developing countries is growing much faster than in developed ones in absolute terms, this does not imply that the digital divide is narrowing, because quality of the services keeps on being very inferior in developed countries. Camera phones are an example of non-affordable devices in developing countries yet, while they are widely spread in developed ones.

Nevertheless, mobile operators in Peru are now offering new opportunities to approach mobile telephony for all audiences. The evolution of mobile phones' market points out to a more positive situation and forecasts invite to think that this situation will change in the short term. Referring specifically to camera phones, since their appearance in 2000, this accessory

has become increasingly common, becoming a standard piece of equipment (Castells *et al.*, 2007) and the quality of the photographs, measured basically by its resolution, has grown considerably over the past few years (Maddock, 2007). According to Gartner Inc. (2006), worldwide sales of camera phones tripled from 2004 to 2006, and the trend is that 81 percent of the mobile phones sold in 2010 will have a camera integrated:

	2005	2006	Forecast 2010	Growth (2005-2006)	Expected CAGR ¹⁸ (2006-2010)
Africa	7.484,50	15.964,40	45.061,20	113,3%	29,6%
Asia/Pacific	67.629,10	106.721,40	395.506,50	57,8%	38,7%
Eastern Europe	15.819,30	26.098,00	70.656,90	65,0%	28,3%
Japan	42.016,50	45.203,80	44.282,80	7,6%	-0,5%
Latin America	8.646,50	22.547,90	78.406,90	160,8%	36,6%
Middle East	7.336,20	14.138,60	34.402,40	92,7%	24,9%
North America	75.746,70	106.832,20	187.160,20	41,0%	15,0%
Western Europe	95.864,20	122.429,90	166.597,30	27,7%	8,0%
Total	320.543,00	459.936,20	1.022.074,20	43,5%	22.1%

Table 4. Sales of camera phones by region (thousands of units). Source Data: Gartner Dataquest, October 2006 (Gartner Inc., 2006), except fourth column, own elaboration

As shown in Table 1, Latin America and Africa are respectively the first and second regions with higher growth of sales of camera phones in the 2005-2006 periods, and Latin America is forecasted to be the second one with higher growth in the sales of this type of mobile phones in the next years. Of course, this does not imply that it will be among the poorest rural classes, but they could likely be more common among healthcare staff.

In conclusion, lack of coverage and cost are the two more important limitations identified for a higher adoption of mobile telephony among healthcare doctors, although actual trends and forecasts allow thinking that these limitations will be surpassed in the near future.

Conclusions

The main objective of this paper was to fill the gap in the literature about the potential of mobile phones for health purposes in rural areas of developing countries, specifically reflecting

¹⁸ CAGR stands for Compound Annual Growth Rate, which is defined as the year-over-year growth rate of the sales over a specified period of time, and is calculated by taking the nth root of the total percentage growth rate, where n is the number of years in the period (definition adapted from <http://www.investopedia.com/terms/c/cagr.asp>, accessed 4th February 2008)

on four areas: the potential of immediacy of the communication, the multimedia capabilities, the reliability of the technology and the limitations for their adoption. For that purpose, this paper has presented the results of the research intended to explore these issues, undertaken in rural areas of Peru, and has linked them with wider reflections in the ICT4D Community.

First, testimonies collected during field work reflect the value attached by healthcare workers in rural areas to have immediate communication in emergencies, and the association of mobile telephony as a valid technology to overcome this problem. According to the results of the interviews, the perception is that many lives could be saved if this technology would be available for health workers as well as the population in general, particularly in areas where no other communication tool is available. Saving the need of transport and time is a valuable contribution of mobile telephony which becomes critical in emergencies, specifically for coordination. It is noteworthy that in respect to maternal death derived from complications during the birth, mobile phones provide a unique tool to communicate and obtain an immediate response in order to obtain help from a health professional, wherever the mother is.

Second conclusion is that multimedia capabilities of mobile phones and photography in particular, provide a good opportunity to improve health delivery in the near future in rural areas of developing countries, particularly for telemedicine and search of a second opinion. Nowadays, the ownership of a camera phone by health workers is anecdotic (only 1 in 26 workers interviewed owned it). However, the only owner showed his mobile phone enthusiastically, and the interest in the evolution of capabilities in mobile phones was repeated by all interviewees. This good predisposition of healthcare workers, together to the standardization of the digital camera as a common accessory in mobile phones and the decrease in prices provoke that, in the near future, telemedicine and second opinion could be facilitated by mobile phones. Benefits of photography for telemedicine in rural areas have been widely treated in the literature, and mobile phones introduce a new easy-to-use, relatively-cheap, affordable channel for the rural setting, contributing to a better health delivery in isolated areas.

Third, field work results indicate that reliability of mobile phones is perceived by healthcare workers as superior to the one provided by other technologies available in isolated areas, provoking that this technology is increasingly considered for health communications in areas under coverage, partially replacing old communication systems such as radio, in particular for emergencies. However, several reliability problems were collected during the interviews and

observations undertaken, indicating that situation in rural areas is still far from the one in developed countries, or in the urban context in developing ones. These failures are consistent with the quantitative information provided in a recent report by OSIPTEL (2007), where it is explained that the three main operators (*Telefónica Móviles, América Móviles* and *Nextel*) have failed to fulfill the minimum requirements for reliability indicators. Evidently, failed calls or not reception of calls affect to trust in technology. These failures in operation are due to technological, human and external factors; among the last ones, it should be highlighted that important wrong operations of mobile network were reported as a consequence of the earthquake that hit Peru on 15th August 2007. However, in spite of these failures, mobile telephony is perceived by healthcare workers as a reliable communication tool valid for health purposes. In this sense, this positive perception increases when comparing this technology to others such as radio, which keeps on being the most available communication technology in isolated rural Health Posts in Peru. Other ICTs such as television, satellite telephony or computers also present important reliability problems for their use in rural areas.

The fourth conclusion states that main constraints for the adoption of mobile phones by healthcare workers, particularly in the poorest isolated areas, are the lack of coverage and cost, but the trend is that they will be surpassed in the short term. Nowadays, benefits of the immediate, multimedia, reliable communication of mobile phones can only be achieved in a short number of communities (due to the scarce adoption and the lack of coverage in rural areas of Peru) by groups with higher economical status (due to the cost of the handset and the calls), thus increasing the inequality among people and communities and opening an “internal rural mobile divide”, basically due to these two constraints. In respect to first constrain, even in covered areas, coverage is limited and is only available in certain locations in the community. The most accepted theory for the lack of coverage in rural areas (and among them, in the poorest ones) is that, traditionally, mobile service providers have focused on the urban market, much more profitable and less risky; however, the number of experiences with mobile phones in the rural context is growing incessantly in the ICT4D community, inviting to optimism for rural areas in developing countries in the near future. On the other side, in respect to costs, forecasts about the evolution of mobile phones’ market invite to think that this situation will change in the short term (camera phones included). In this sense, Latin America is forecasted to be the second region with higher growth in the sales of camera phones in the next years; of course, this does not imply that it will be among the poorest rural classes, but they could likely be more common among healthcare staff. In conclusion, lack of coverage and cost are the two more important limitations identified for a higher adoption of

mobile telephony among health workers, although actual trends and forecasts allow concluding that these limitations will be surpassed in the near future.

In conclusion, the potential of the use of mobile phones by healthcare workers is clear and of great impact in isolated areas of developing countries, contributing to overcome the lack of resources for health delivery in rural areas through the provision of instant, multimedia, reliable information and communication. Nevertheless, the Peruvian Health Ministry keeps on installing radios in Health Posts and has not led any initiative in relation to mobile telephony yet. In this sense, it is recommended to Peruvian Health Bodies to consider the promotion of mobile telephony among health workers through subsidization models to sustain the cost of the access to mobile telephony for this particular collective. This definitely would encourage the use of mobile phones among healthcare workers, who could benefit from mobile telephony for health delivery. On the other side, many rural areas (particularly in the forest and mountainous regions) are out of mobile phones' coverage. In this sense, governmental bodies such as OSIPTEL are recommended to promote the penetration of mobile telephony in isolated areas through innovative access models and the promotion of mobile telephony universal access, combined with other technologies (such as satellite communication) for extreme cases.

Finally, the methodological complexities that arose during the research have thrown two important results that are deserved to highlight as interesting conclusions for other researchers, specifically related to online research. First, no matter how appropriate the online research approach seems to be, its proper working in developing countries can only be checked through practice. In this sense, apparently, given my particular conditionings and previous communications with experts in Peru, online research methods were well positioned in order to gather complementary information, benefitting from the mitigation of distance, time and cost limitations, the appealing for interviewees and the anonymity. However, the online survey launched did not generate the expected results, with a response rate of 10%. Hypothesis such as the lack of Internet access or inappropriate education, commonly found in the literature when referring to developing countries, can be established as the most suitable explanations for the lack of responses; anyway, results lead to the reflection about the non-convenience of using online research methods in the context of rural areas in developing countries, in order to contact isolated populations, unless online communications channels are checked previously and work properly. On the contrary, the second basic result is the success in communications with experts in urban areas of Peru, inviting to pay more attention to

online methods for research in developing countries as new appealing channels for people, where available.

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