Mobile technologies for development – a comparative study on challenges

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Abstract: This paper compares and analyzes three cases where mobile technology is developed and used for everyday learning in developing countries. Preliminary results from field studies and tests are presented and analyzed in terms of the technical, professional, social, cultural and organizational challenges involved in development. In Bangladesh Virtual Classroom SMS is used together with TV to make education interactive. The eduPhone project develops a system and a method for delivering everyday "situated education", such as emergency medical advice, to people lacking access to such services. The Agricultural Market Information System project disseminates information to improve local agricultural markets and, in particular, supporting small farmers, by mobile phones. The paper reports the cases and findings from investigations and tests, including field studies, laboratory and field tests, and experiences from implementation. We find that technical challenges are not great and in most cases concern innovativeness of application rather than access, use and usability; e-readiness among people is higher than often reported. The main problems lie in organizational challenges – developing a sustainable business model and reorganizing processes consequently – and social and cultural challenges such as local power structures and professional traditions.

Keywords: Mobile applications, e-learning, e-government, development, ICT4D

INTRODUCTION

In many developing countries, Internet penetration is still miniscule while mobile phone availability is very high. This means mobile phone technologies are already today a serious medium for communication, truly available for an enormous number of people. In Bangladesh, which is classified as one of the least developed countries in the world (UN,

2008), and where the three cases in this paper are tested only 0.3% of the population have access to Internet (CIA, 2008), whereas a large majority of the population have access to mobile phones (Islam & Grönlund, 2008). The question is how mobile phones can be used for important development issues such as health care, education, and business communication. This paper presents three cases where mobile technology is developed in attempt to be of assistance in everyday situations to many people in developing countries and analyzes them based on challenges to be met so as not only to develop good systems but actually making them used in everyday operations of providers and the everyday life of people. The research question, hence, is "what challenges – technical, social, organizational, cultural or other – need to be met to develop and implement improved processes based on mobile ICT".

In the *Bangladesh Virtual Classroom* (BVC), SMS is used together with TV to make education interactive. The *eduPhone*1 project develops a system and a method for delivering everyday "situated education", such as emergency medical advice, to people lacking access to such services. The *Agricultural Market Information System* (AMIS) project develops information to improve local agricultural markets and, in particular, supporting small farmers.

The three case studies are related through the technologies used and through their aims. All projects are based on rather simple mobile phone applications and all are aimed at reaching a large share of the, mainly rural, population in Bangladesh. The main difference concerns the projects´ target groups. Whereas the three applications all concern information for empowerment we wanted to reach different marginalized target groups (i.e. rural students, illiterates and small-scale farmers) in order to assess the technologies´ applicability in different contexts.

The paper is organized as follows: First a motivation of the study is made by discussing the concept of development, followed by a description of the method underlying this paper. Thereafter the three cases are presented and their methods discussed. The following section discusses findings and achievements so far and the last section, "Conclusions", compares the cases (in terms of the challenges that have to be met to make these tools integrated in people's lives, in business operations of government agencies, and in the support systems such as legal regulation, professional development and methods for change).

[1] eduPhone is Trademark 394743 issued by Swedish Patent Office (http://www.prv.se/)

DEVELOPMENT

Development is traditionally mainly defined in economic terms, typically dealing with economic growth and poverty alleviation, but just looking at development from an economical perspective gives a very limited picture. In a more fundamental sense development refers to improving the living conditions of the poorest people by "enlarging people's choices" (Peet, 1999), to nurture a culture of tolerance and peace (Albright, 2005) and to increase people's abilities to take control over their own lives (Sen, 1999). Sen thus focuses on the importance of capabilities for development and argues that governments should be measured against the concrete capabilities of their citizens. To the extent that citizens are given increased capabilities to social and democratic improvement development has taken place (Sen, 1999).

The concept of ICT4D, Information and Communication Technologies for Development follows from definitions like the above (although not necessarily limited to any one of them). If the general concept of development is "progress and growth towards a better good" (where the 'good' is usually concerned about economy, politics or social issues); then the concept of ICT4D can be defined as a the use of Information and Communication Technologies to enable progress and growth towards an economic, social and political "better good" (Unwin, 2008). According to Wikipedia ICT4D refers to "the application of Information and Communication Technologies (ICTs) within the field of socio-economic development" (Wikipedia, 2008) – a general definition that is also directly used by, for example, the World Bank (World Bank, 2008) and is implicit in many contexts where terms are not clearly defined.

Based on the above definitions, in the following we generally use the term "development" to mean "a positive change in people's life situations by providing means for increased control of over everyday life". The three cases reviewed concern different everyday life situations – education, farming and health care. Increased control to transform their lives is enabled by access to information and education (Narayan, 2000; Unwin, 2008). Our cases also concern rural development which research has shown to have the most important factor on a country's development as measured by the effect. Rural growth lowers both urban and rural poverty via secondary effects such as people getting a reason to stay in the rural areas instead of moving into the often already overpopulated cities (Danielson, 2001; Ravallion & Datt, 1999). The three cases in this paper all have a focus on the rural parts of Bangladesh. BVC provides education to rural areas, AMIS gives rural farmers access to information, and eduPhone

provides critical information to people living in areas where such information is hard to access (most often rural areas).

METHOD

This paper analyzes three cases of mobile ICT systems which have been developed in cooperation between Örebro University, Sweden, and three universities in Bangladesh – BRAC University, Open University, and Daffodil University – and, in the case of AMIS, the Bangladesh Ministry of Agriculture through its Department of Agricultural Marketing.

This paper makes a comparative analysis between the cases based on data and analyses presented in previous reports (referenced as they appear below). The contribution of this paper is then not new data but a comparative analysis. The general approach for all these cases is Action Research where actors in both Sweden and Bangladesh are involved in the development of the technologies and the methods for delivery. Problem solving has been mutual and based on participants reflections. Tools for data collection for project evaluation have been plentiful; video recordings, observations, interviews, informal conversations and questionnaires. Data has been collected from all identified stakeholders (teachers, students, farmers, ministries and so forth) and adjustments to the applications have continuously been made in accordance with these findings.

Based on these experiences from trying to implement the ICT systems in daily operations we report the challenges encountered. The purpose of reporting this in a comparative study is that we feel many analyses stop at the actual construction of a technical system (which is often somewhat misleadingly called “implementation”). Our experiences say that this is the least complicated part and that changing the behaviour of people and organizations – in particular at the provider side – is the main challenge. The three cases presented here is some evidence to that as we try to explain the nature of the challenges in some detail. This said, the study is by its nature qualitative and three cases, none of which is yet fully implemented, are of course not enough to support far reaching generalization. The fact that the cases are at different stages of development sometimes makes comparisons incomplete (e.g. no social or cultural challenges are yet identified for the eduPhone due to the early stages of the project implementation).

The analysis of this paper is inductive. We started from reviews of all the cases, their project trajectory, investigations and tests made underway. We reviewed the challenges encountered and grouped them inductively by the following categories:

- *Technical challenges* include both issues of system and information design.
- *Organizational challenges* include everything that pertains to management of organizations, business models, economic measures, work and process design, staff education etc.
- *Professional challenges* are those which pertain to professionals as individuals and as a collective; work styles, professional development, status, roles, communities of practice, etc.
- *Social challenges* are those which concern relations among users, outside the organizations, providing information and services. One example is the relation between farmers and local middlemen in the agricultural market information system.
- *Cultural challenges* are those that pertain to specific historically developed patterns in processes related to service delivery. One example is the way teaching is done. This is quite different in different countries, and the point here is that it involves not only professionals (teachers) but also users (students) and indirect users (parents). It can hence not be reduced to professional cultures, neither to social life, but specific cultures developed around certain processes involving both social and professional aspects.

One point about this classification is that there is a hierarchy of difficulty. Meeting a technical challenge is something that can be done in a short time perspective and needs involvement of only a few professionals and users (provided we are not talking about technology at the truly experimental stage, such as automatic translation, which typically is not the case in ICT4D context. ICT4D projects are most often concerned with (at best) innovative implementations of technology already tested and used elsewhere). Organizational challenges can also be made relatively quickly (second level of complexity) if they are deemed useful and economically feasible as long as they do not interfere substantially with the third level, professional challenges. At the professional challenges level it is required that a whole community, or a substantial part thereof, endorse changes. Social challenges and cultural challenges are the most complicated and those with the longest timeline as they involve several groups which need to move in the same direction. While this hierarchy is not strict it is indicative for the kinds of problems involved with "development" as discussed above. The more challenges are at the technical level rather than at any of the other levels the prognosis of quick change is better.

RESULTS AND FINDINGS FROM THE CASES

In this section we briefly report the findings so far from the three cases. We include some description of systems, of the tests we have done, and of the processes we have had to go through to achieve understanding and acceptance of our ideas.

Bangladesh Virtual Classroom

Bangladesh Open University (BOU) is a government agency and the monopoly provider of distance tuition in Bangladesh. It recruits some 800 000 students from 8th grade to university level. BOU operates by traditional methods which do not include interacting with students. The education is transmitted one-way to students via video- and radio lectures and via text books. The Bangladesh Virtual Classroom (BVC) project developed an application for mobile phones together with live lessons on Bangladesh TV to create a "live feeling" and real interaction between teachers and students, among students and with some technical educational resources such as a dictionary. The current implementation is a course in English recruiting some 30 000 students (28 TV lessons have been produced for the course). A Mobile Learning Management System has been developed which include tools for (the tools are explained in more detail in Grönlund & Islam, 2008):

- Learning and interaction between teacher-students, students-student and student-course material, including Self-Assessment Quiz, Questions during class, Participatory Cards, Homework, Meaning, Reading.
- Administrative tools designed for both control and convenience; Registration, Attendance (voluntary, for each lesson; gives access to all the other learning tools), Course information & rules, and Results
- Teacher support tools: the above functions are automated so the teacher only does preparatory work, such as updating the course dictionary or follow-up analysis such as to see how many students took the tests, what the results were, etc. Such statistics, provided by a report generator, give BOU teachers a new view of student activities and results. Previously they had no contact with the students before the final exam after the course is completed by the end of the year.

This is all basic classroom interaction, everyday teacher-student communication, and the BVC system makes it possible to do it at a distance. The mobile applications as well as the concepts about how best to run BVC have been tested in various ways in physical classrooms

and live on TV. Starting from the basic idea of interactivity we first developed a prototype for the mobile application and tested it in ordinary classrooms. After testing the method's doability we did a test on learning effect using a single teacher serving two classes, one present in the same classroom as the teacher and one in another classroom who could see him over video and interact by SMS (Islam et al, 2005). This showed that the method of teacher-student interaction through SMS worked, and there was no difference in learning.

Next we developed two videos designed to be prototypical TV-sent classes, including interactivity between students and teacher. We used BOU teaching material and designed the show for typical BOU students. By using focus groups including students, teachers and BOU management we made sure BOU understood the idea and could translate it to their current way of operation. After this procedure – lasting intermittently for about one year – we arrived at a decision to field test the concept in a complete course at BOU. This effort stretched over some three months and included a preparatory course in the TV lesson format and practice as well as several test recordings. We finally arrived at a format with pre-recorded programs where the "live feeling" was provided by the class directly taking part and the interactivity through the SMS system taking part at any time – the students can watch the TV shows live or on video/DVD at any of the 1300 BOU learning centres distributed across the country. It is running on Bangladesh national TV at the pace of one program a week.

Challenges for BVC

A main lesson learnt during production of these two classes was that it would be difficult to sustain 'live' lessons, i.e. real-time TV shows. This is because a live show requires a high degree of integrated skills in each of the areas involved, including:

- Teacher: a teacher not only needs good pedagogy skills, s/he needs to be comfortable and adept with technology. In addition, the teacher needs to be comfortable with being in front of the 'live' camera.
- Studio staff: studio staff needs to understand the interactivity introduced by the BVC methodology.
- Teaching material: the teaching material has to be laid out sequentially in a manner that lends itself to interactivity and can be followed easily.
- Meeting scheduled air time is difficult and requires much planning and rehearsal as well as professional actors.

- Computer administration: during a 'live' class, reliance on technology is greater. There is high risk as any technical failure may interrupt communication. Also a higher degree of adeptness of the computer personnel for handling situations in class is required.
- The mobile network does not always work as expected, e.g. the text messages are sometimes delayed in route.

Achieving all this would mean costs far beyond the budget of any university; it amounts to setting up a complete TV production unit. But even making pre-recorded TV lessons poses considerable challenges. The teachers themselves come from a background where teaching means guiding students on how to memorize. Model essays are memorized along with umpteen mistakes and reproduced in exams both at school and college levels. A challenge of the large-scale test phase, hence, was to make teachers learn how to teach in an interactive manner and organize teaching material for interactivity. Curriculums have to be revisited, lectures redesigned, and presentation and interaction practiced.

Interactivity in teaching has since long been found to be a success factor essential for learning (Bautista & Quimbo, 2007; Vreede & Mgaya, 2006; Zhang et al., 2004). Interactive teaching has developed since the late 1960s in the industrialized world, however, in most developing countries it is a novelty. Interactive teaching puts new demands on teachers, teacher training and education organizers, and full scale implementation will require much effort. The BVC project addresses these issues in a short-term practical perspective but an ICT project can only come so far. Addressing the demands for teacher training, change of pedagogical ideals, understanding the importance of enabling students rather than filling them with information is a much more far-reaching endeavour.

Table 1: Bangladesh Virtual Classroom challenges

Technical challenges	While there is still a need to develop innovative and simple tools for education there are no major problems with technology use and access.
Organizational challenges	Organizing operation and technical support for the SMS server. Teacher education (how to use the technology)

	Revised process model for production of courses.
Professional challenges	Teachers must learn to interact with students in new ways. Focus must be on learning, not teaching, and teachers must reformulate their role accordingly
Social challenges	Role of students changes. They must become more independent in their search for knowledge. However, technology may help as the mode of interaction that comes with ICT is readily taken up by students.
Cultural challenges	Making learner-centred education the norm.

eduPhone

The eduPhone project started from a very simple idea, to present information relevant to people over the mobile phone, which our investigations had told us was in fact readily available and much used also among rural people in Bangladesh (Islam & Grönlund, 2008). The first eduPhone prototype was developed using an automated response system and concerned information on diagnosing and treating diarrhoea and handling arsenic-poisoned water respectively. Information was presented in very short chunks, designed to fit into the delivery format and meeting user requirements such as brevity and ease of understanding, then checked for accuracy with medical expertise. As user demands are conflicting – tradeoffs have to be made between logic of contents and logic of presentation – we made three different designs each implementing a particular trade-off. The diarrhoea case was tested in an experimental setting at Örebro University on students originating from developing countries. Based on the results we settled for one of the designs which were then used also for the arsenic case. Both cases have been tested in two Bangladeshi villages, using the same test method as in the lab test (Razzaq & Sayed, 2008).

The pre-test in a laboratory setting (using students from the target countries as test persons) gave positive results on usability but were clearly not conclusive as the test persons were overqualified. For the field test we had to change the design of the information as it proved too expensive to use a menu-based server system. Instead we used linear information and hence the test turned out not such a hard test for usability as we had hoped. This said, it was also a feasibility test and results were positive and encouraging for further work. The test

users were 60 people in two Bangladeshi villages, 40 male and 20 female. Ages ranged from 18 to 72. 50 % of the participants had school education and 50 % had not. 82 % had experience of using a mobile phone, so the ensuing result that they actually could use it was not too surprising; however the fact that so many had used a phone was a positive surprise (but confirmed and explained by the AMIS investigations, see below). More importantly, there was a positive learning effect. The pre-test results show that 35% participants had no knowledge about Diarrhoea and 60% participants no knowledge about arsenic before using the eduPhone system. After using the system, 92% of the participants improved their knowledge about diarrhea and use of saline, 100 % about arsenic. 97 % thought the mobile phone was a good medium for retrieving information. Our tests also showed that such little pieces of information can be very important – neither arsenic nor diarrhoea handling – both crucial in Bangladesh – was well known before our test.

Challenges for eduPhone

While our tests indicate that providing information this way is very likely to be well received at the user side, there are many challenges for provision. Who will package and provide all this information? Who will distribute it? And if much information is provided this way, how will people know where to find it? While there are some indications that users may be willing to pay for a phone call to find information, there is often resistance on the provider side. This is for many reasons. The cost of packaging information is one; another is the issue of responsibility – if a medical advice is not correctly understood maybe the provider can be blamed. Meeting challenges like these requires a reliable provider (so users can trust the information), marketing (so that people will know about the system), and information provision so that what people look for is actually available, a simple search system making it easy to find the right piece of object among a large number, and a business model so both production and distribution can happen. The eduPhone project is still in search of a suitable organization willing to adopt it into their operations.

Table 2: eduPhone challenges

Technical challenges	Large-scale supply requires search mechanisms to easily find the right information wanted (especially in urgent situations).
Organizational challenges	Business models for information production and dissemination including both quality and economic factors.

Professional challenges	This mode of delivery (mobile phone and automated response system) includes a change of professional roles. This has partially been tried already in developed countries but is still experimental.
Social challenges	(Nothing we have found yet, but this project is still at an early stage).
Cultural challenges	No data yet in this project to assess this point. Challenges will likely be different depending on the business involved (health care, government, etc.).

Agricultural Market Information System

The AMIS attempts to make market information available to farmers so as to improve their position in the value chain by increasing their knowledge so as to be able to make better informed decisions but also increase their bargaining power vis-à-vis local middlemen. The AMIS project is pursued in cooperation with the Department of Agricultural Marketing (DAM) under the Bangladesh Ministry of Agriculture. DAM has already developed an AMIS. This, however, is yet not functioning as hoped, mainly because of low outreach following inappropriate technical solutions – information is presented only on the web which is unavailable virtually all farmers (CIA, 2008; Islam & Grönlund, 2007) and deficiencies in local organisation of data collection.

The preconditions for implementing the system proposed were investigated by means of a survey to 1050 users among the local actors and interviews with stakeholders during early 2007 (Islam & Grönlund, 2007). In a second study, local social structures within the local markets were investigated to find critical points regarding information contents, availability, interpretability, and use and hence suggest alternative solutions regarding information contents, design availability, use, timing etc. The goals of this study were to understand local situations and the cultural, behavioural and motivational factors that affect uptake of mobile technology in general and particularly attitudes towards information pertaining to farming and marketing of produce. The sample was 420 farmers in 50 villages selected to cover the whole country. The overall research questions were; Can, and will, information by mobile technology be accessed by the majority of farmers?; What information is required by farmers?; What are the attitudes towards the new technology by the farmers of Bangladesh

that represent most of the developing countries?; What are the factors affecting the use of mobile phone technology by the farmers/rural community?; and How can information by mobile phone technology be accessed by the farmers?

The findings were:

- Mobile phones are used even among the poorest farmers. Income and wealth are not factors that predict mobile phone ownership and use.
- 2/3 of the farmers have easy access to a phone. While only 37 % had a mobile phone themselves another 29 % use one from family members, friends, a nearby shop or a village lady. Also the indirect users considered the mobile phone a medium readily usable and truly a part of their communication toolbox.
- Education is not a significant predicting factor. Even people with little or no formal education have and use mobile phones.
- Age is a statistically significant predictor. Younger people and people with children are more likely to have a phone.
- Mobile phones are used mainly for voice communication. Only 20 % use SMS, and even among them use is quite sparse – only 5 % are daily users. However, the number is up from 8 % in 2006 potentially indicating a trend that mobile phone users over time become more sophisticated.
- The role of the village ladies is no longer so important as private and community use has increased dramatically. Only 12 % of those who do not own a phone go to village ladies, the rest to family members or friends (49 %) or a nearby shop (37 %).
- Attitudes towards a mobile phone based AMIS are very favourable. While only 37 % actually have a phone of their own, twice as many would like to have agricultural information accessible by phone. This reflects the considerable community use (point 2).
- Information preferences include not only local market information, but also interest in district and capital ones, indicating interest in better knowledge of the whole market system. (Islam & Grönlund, 2008)

It seems that mobile phone ownership, and even more so use, does not depend on income, wealth, or education. Rather “modernity” – being young and having children – are predictors.

Challenges with AMIS

Already before the field investigations we had designed a prototype system. We took the prototype and the field findings to the DAM where the ideas were received with interest both from decision makers and people involved technically with the existing system. However, formal agreement on the use of real time information from the DAM system has been much delayed for reasons which have to do with the functioning of the Bangladeshi government bureaucracy rather than the idea itself. Proposals have to pass many desks, in particular if they involve overseas cooperation.

The eduPhone experience in combination with our AMIS field investigation has showed that information through mobile phone is certainly feasible; however we have still not been able to set up a business model using the available government data. One reason is of course that the bureaucracy is still at work to make a cooperation deal. But even beyond that it is not clear how the Bangladeshi government can appropriate a system like this. This is for reasons of both practical procedures and the business model for the operation. We have considered alternative information provision methods based on a ”community”, Wikipedia-style, model so far we have not proposed this to the government. Our first alternative is the hope that cooperation with the government will in the long run prove feasible. We can not afford to risk introducing conflict at this time – something which alternative data collection might do – as this might jeopardize access to data; setting up alternative data collection operation is quite an ambitious project which requires some strong alternative local actor, such as an NGO which has trustworthiness among farmers. For lack of muscle to do that, but also because our research was funded by Swedish government international development funds which are channelled through governments, we thought it would be best to give government a first choice to take part in the project. However, even if government data will be made available on a comprehensive scale there needs to be a business model for providing it to farmers. It is unlikely that the government will invest in this without some external motivation. Even though technical investment is not high, the distribution system must be maintained. This requires, technical control, working data communications, a system for fees and subscriptions, a call center, etc. This is, a business model has to be setup that can be contained within the government or outsources in some manner. There are several options. If government operations cannot be extended to cater for the system, information could be provided for a fee by an NGO or a company, but re-selling government data may be an issue

in Bangladesh which, unlike for example the EU, does not have regulations for this kind of business.

Table 3: AMIS challenges

Technical challenges	Information design for easy search and delivery, such as subscription profiles (i.e. providing the individual farmer with the exact information s/he requires).
Organizational challenges	Business model for information dissemination (who will pay for the service?). There may also be challenges in information collection - in most countries collection is already done, but there may be more effective models.
Professional challenges	There is no professional group in government who sees this service (delivery of the information to farmers) as their task. Neither are there NGOs or private businesses that see their role as refining and reselling government information.
Social challenges	There is a sensitive and asymmetric relationship between farmers and, in particular, local middlemen in which dependency and social pressure are factors.
Cultural challenges	The current system has developed from history and even though asymmetric it draws on some trust among parties. A new electronic system will have to prove itself at least equally trustworthy, which includes both quality of information and sustainability.

CONCLUSIONS: CHALLENGES AND OPPORTUNITIES

The above report has shown that while we have seen many positive signs from tests and enquiries, there are numerous challenges:

Technical challenges: Developing the software for all three cases has proven to be easy. The widespread usage of mobile phones in Bangladesh also means that most users are confident in the technology usage. The technological challenges are more related to design of the information, search functions etc.

Organizational challenges: For both the AMIS and the eduPhone project finding a suitable business model have proven a challenge and finding someone willing to pay for the service has been difficult. For the AMIS project there may also be a challenge in collecting the data for the system. The Department of Agricultural Marketing in Bangladesh already have a web based AMIS system however which mean that the data for the system is already being collected, but there may be more effective models.

Professional challenges: All three of the projects pose professional challenges since they require the actors to rethink how they work. For example, teachers at BOU are not used to interacting with the students whereas the BVC project is based around interactive teaching requiring the teachers to change their teaching practice as well at their professional role. The projects also introduce professional roles that previously were not present, e.g. there is no professional group in government who sees the AMIS service (delivery of the information to farmers) as their task. Neither are there NGOs or private businesses that see their role as refining and reselling government information.

Social challenges: The roles between stakeholders in BVC and the AMIS project change. For the AMIS project there is a sensitive and asymmetric relationship between farmers and, in particular, local middlemen in which dependency and social pressure are factors. These roles can potentially change due to the implementation of a functioning AMIS system. The role of the students' changes in the BVC project, they must become more independent in their learning. The use of ICT in this change has however proven successful since the ICT used is readily taken up by the students.

Cultural challenges: On a cultural level it is hard to change structures and processes that has been around and practiced for a long time. Making learner-centred teaching the norm is of course hard in a culture that practices a very teacher-centred education. The current practices also draw on some trust between the parties and if the practices are to be changed the new systems will have to prove them selves at least equally trustworthy.

The comparison shows that for all cases many of the challenges are at the high risk and long-term end of the spectrum of challenges. "Making learner-centred education the norm" is clearly a more complicated endeavour than complementing the existing set of learning tools for the mobile phone with yet another one. In BVC e.g. interactive teaching puts new demands on teachers, teacher training and education organizers, and full scale implementation will require much effort. For example, the BVC project has so far mainly

addressed these issues by a practical approach so as to get started, but clearly this is only the beginning of a long development. Even though we claim some success so far the list of challenges shows that this is only a small first step towards development as defined above.

To summarize this comparison we have found that challenges are only to a small part technical. To a larger part they are organizational, and to the largest part they have to do with what could be labelled a cultural change; there is a need for changing processes both of business (in government organizations) and of individuals, but as these are not determined but socially constructed they require not only determined action but also time and endurance. We have seen that meeting technological challenges has been comparatively easy and not very time consuming, whereas all the other challenges (professional, organizational, social and cultural) have required, and still do require, long-term engagement and time. This lesson is important to stress considering the dominant technical focus, and the short-term investments, in many ICT4D projects.

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