Crowdsourcing ICTD Best Practices

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Abstract. A large number of projects in ICT for development include software development to a certain degree. A review of the literature highlights how most of these projects ultimately fail to be sustainable. In this paper, we expose our views on the need for a more structured approach to software development in ICTD and we present our plan to collect best practices from software project managers through a crowdsourcing web portal. This will provide input to a broader study that aims at adapting existing software development processes to the ICTD context.

Keywords: ICT for Development, software engineering, software development process, crowdsourcing.

1 Introduction

Information and Communication Technologies for Development (ICTD) [1] is an emerging discipline that studies how ICTs can stimulate socio-economic development in marginalized communities. This generally means developing projects aimed at improving the quality of life of people living in rural areas in Third World countries. This segment of the world's population is often called the "Bottom Billion" [2].

ICTD is a highly interdisciplinary field that brings together competences from technical (e.g., engineering, computer science) and non-technical (e.g., social sciences) disciplines to address the numerous challenges of bringing ICTs to communities in which resources are scarce by definition and most of the population is illiterate. Some notable areas of research are e-Health, e-Agriculture, e-Learning, communications and infrastructure and e-Governance, addressed by various disciplines such as UI design, user studies, accessibility and localization [3].

As the recent growth in penetration of mobile technologies in developing countries (especially in Sub-Saharan Africa and India) sparked a so-called "mobile revolution" [4], the access to ICTs has become even more crucial in guaranteeing inclusion. As Heeks [5] points out, an already marginalized community lacking ICT access risks being further excluded from the rest of society. As a result, ICTD initiatives based on low-end mobile phones that harness the often unconventional usages of such devices in developing countries have spread [6].

Despite the evidently strong connection with mobile technologies (up to the point that the World Wide Web Consortium has activated an interest group

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in Mobile Web for Development [7]), ICTD project development should not be technology driven but it should include the input of end-users in all phases [5, 8]. However, the trend of considering the technical aspects secondary has led to a lack of documentation, metrics and tools to evaluate solutions. As a result, customizable, reusable and sustainable methodologies to address the problems of the "Bottom Billion" are not available, leading to a continuous re-implementation and repetition of very similar projects that die when their donor funding period is over. Therefore, a high failure rate due to limited or lack of sustainability strategies can be observed [9–11].

Although it is impossible to find a unified recipe, we argue that defining a structured approach to software development for the "Bottom Billion" can reduce the probability of failure of ICTD projects. However, simply copy&pasting techniques from "First World" environments (e.g. customizing the Rational Unified Process [12]) does not work [13]. We thus need to investigate how we can learn from best field practices in ICTD and from First World best practices to formalize an appropriate and customizable development process.

In this paper, we present our observations of the results of several surveys of ICTD projects to motivate the need for a structured approach to software design and development in the ICTD context. We then present our idea to incrementally build a knowledge base of software development best practices in ICTD by developing a web portal to collect and share such information.

In section 2 we present the background of this work and the ICTD experiences we are aware of with a strongly structured computer science approach. In section 3 we discuss our motivations stemming from our considerations on the state-of-the-art of ICTD practice and in section 4 we outline a proposed crowdsourcing web portal to share and collect information about ICTD software projects. In section 5 we present some related works of mapping and surveying such projects. We finally draw our conclusions and outline possible future directions in section 6.

2 Background

The rural areas of developing regions often lack appropriate access to ICTs due to poor infrastructure, illiteracy and – in general – scarcity of resources. As business and social interactions become more an more dependent on digital transactions, providing access to ICTs to the people of such areas is becoming critical to stimulate socio-economic development and prevent their further exclusion from economic, social and political life [5].

Telecenters have represented the archetypal implementation of ICTD in the 90s and in the first decade of the 21st century [3, 5]. Their goal was to overcome the digital divide by providing a common place for a group of people to use and be trained in the use of ICTs. However, several surveys and studies [3, 5, 14] have shown that most telecenters lacked sustainability, scalability and evaluation of benefits.

With the recent skyrocketing of the penetration of mobile technologies in emerging economies, most ICTD initiatives have switched to mobile service

delivery [4, 6, 9, 15–17]. The focus of ICTD has thus switched from providing infrastructure to providing services based on actually used technologies [5].

Gakuru et al. [10] produced an extensive report on innovative farmers advisory systems) [18] and identified the top-down approach mentioned above as the main reason for project failures. In fact, most of the systems developed by NGOs do not involve the end-users in the requirements elicitation process. Another analysis of the same inventory [11] points out how the short life-cycle for which projects are designed seriously hinders their possibility of surviving the pilot period. Moreover, no project deals with the whole agricultural cycle and is not interoperable with other solution, thus resulting in a significant overlapping of services and a lack of reuse of effective solutions. For example, new market prices information systems are continuously developed even though very effective systems already exist [19]. Furthermore, only a very small number of these systems are integrated with other services, such as logistics [20], resulting in significant fragmentation and confusion among the end-users.

In a survey of the usage of mobile technologies in East Africa [17], the authors describe the revolution that is happening in countries like Kenya, Tanzania, Uganda and Rwanda, especially with respect to the adoption of mobile banking. However, the authors point out how there is a need for marketing, education and scalability from a technological point of view in order for mobile technologies to truly take off.

More extensive surveys [6] highlight an almost complete lack of communication among different project groups, a lack of documentation and almost no reusability of either the technologies and the methodologies. The current literature on ICTD projects "lacks descriptions of research problems, requirements and definitions" and it is essentially based on assumptions [8]. Moreover, solutions are not always able to adapt to a heterogeneous infrastructure quality, despite being multi-channel and targeting low-end mobile phones. Lack of quality control, standardization and irregular updates of the data sources strongly affect most projects [17, 19].

Only a few examples of clearly defined methodologies [8, 21] and architectures [13, 22] can be found in ICTD practice. Dörflinger [8] advocates the use of user-centric design through all the development phases, drawing from Mobile HCI (Human Computer Interaction) and proposing a tight interaction with real users through participatory design. The methodology includes the use of Living Labs [23, 24] and "local champions" to continuously test functional prototypes at the end of each iteration. The involvement of a "local champion" – or Infopreneur^{TM}– should go along with a hub-node-satellite development mode of implementation [25].

Evaluation and monitoring through direct observation, workshops and logging is also envisaged as a critical tool to adjust requirements at runtime. This has been applied at Sekhukhune Rural Living Lab (SRLL) [24] to implement a mobile procurement system for Spaza shops in South Africa [13]. However, these recommendations are in contrast with most of the rest of the literature in ICTD,

which is more concerned with the social impact of a given project rather than its requirements, design and evaluation [8].

Another architectural solution worth mentioning is the CAM framework [22], which is based on barcodes captured using a phone's camera. The CAM framework addresses technical limitations commonly found in rural areas, such as intermittent power, intermittent connectivity, and lack of secure storage. Limited education and limited disposable income are among the user limitations that CAM intends to overcome. The CAM architecture includes a mobile phone application used to assist form-based data entry. Data is initially recorded on paper forms from which it is processed by the CAM application with the aid of barcodes placed near each field of the form. CAM has been designed to transmit data asynchronously and to be applicable to multiple use cases, generally connected to data collection.

3 Motivation

We conceptualize an ICT for Development (or rather, "ICT for Good" [26]) solution as a system that directly or indirectly affects a (marginalized) community, improving its quality of life. This can be achieved by a variety of technologies, policies and interventions widely described in literature [3]. In our work, we focus on the subset of these solutions, i.e. those that impact societies by developing and deploying new software systems.

Most projects fail or have low to zero impact on the target communities [27, 28]. Lack of documentation, lack of reuse of common solutions and lack of end-user involvement seem to be among the main shortcomings of most of the current ICTD projects. While this is a recognized fact among scholars, we believe that the field has become too focused on the social aspects of ICTD endeavors rather than on the technical aspects. This is due to the fact that at the beginning of ICTD, projects were mainly technocentric, while now the trend has been reversed with an almost completely sociological approach in which software development is done with a "just do it" philosophy. We do not suggest reversing this trend again, but rather follow the multidisciplinarity idea proposed in [5], in which ICTD is a conceptual merger of computer science, information systems and development studies.

Well documented success stories are hard to find [29] and publicly available documentation on methodologies applied, development processes, sustainability plans, or the solutions themselves is essentially unavailable. By contrast, the social impact of projects is often documented and several frameworks for impact assessment have been applied and proposed to evaluate projects (see, for example, [30]). ICTD projects are in fact unbalanced towards describing the target environment and assessing the impact of the solutions. A clear cut process that goes from a problem of a target community to the delivery of a solution and ultimately impact the community is missing.

The available documentation is limited to surveys conducted by researchers looking for qualitative data about mostly sociological aspects of projects, almost

completely ignoring technical (e.g. technologies adopted, software/hardware architectures, etc.), procedural (e.g. design process, time management, team management, project management, etc.) and quantitative aspects (e.g. team size, software metrics, adoption, etc.).

We observe that projects often apply an unstructured approach to software development, likely due to an unbalance of technical and non-technical competences involved. This results in frequent unsustainability issues that could be prevented by adapting software engineering and software project management techniques.

However, "First World techniques" cannot be applied as-is [13]. We claim that ICTD software projects are fundamentally different from any software project by types of stakeholders (typically with a large cultural gap with developers), environmental and technical constraints, and objective (the improvement of the quality of life is not easily measurable, unlike more traditional objectives). Therefore, a custom development process adapted from well established best practices in software engineering must be devised. Such process needs to include both the best practices of software engineering and the best practices of ICTD, with a strong focus on requirements collection, monitoring and sustainability planning.

Requirements collection and sustainability play a key role in the process. The collection of requirements is particularly critical when there is a large cultural gap between the development team and the end users. User-centric design, rapid prototyping and field testing can be of great help in ensuring that the wants of the target community are met. With respect to sustainability, an ICTD software development process has to include support activities not directly concerned with the production of software artifacts or documentation. These activities can create the appropriate environment in which the project is expected to be deployed, for example by building capacity through knowledge transfer.

We have evidence that the Living Lab open innovation model [31] and Agile methodologies such as SCRUM can be successfully applied in ICTD [24]. However, we intend to investigate the best practices that can contribute to the success of a project to include them in a set of custom activities to be performed inside an ICTD software development process. Moreover, the open source development and innovation model can be of further benefit to the ICTD community as it increases the possibility to reuse effective technologies and it is based on collaboration [32].

4 Collecting ICTD Best Practices

While ICTD may have a long history of failures, a number of successful and trendsetting experiencing can be found. See, for example, FrontlineSMS[1], txtEagle[2] and Esoko[3] [20].

[1] http://www.frontlinesms.com
[2] http://txteagle.com
[3] http://www.esoko.com

In order to devise an appropriate development process for ICTD software projects, we need to collect lessons learned and best practices from successful examples. This is not an easy task, as collaboration and reuse are rarely seen in the field and most of the sharing of ideas currently happens through informal channels such as Twitter[4]. As a result, success stories are mostly anecdotal and without a technical perspective.

Surveys and questionnaires are frequently used in ICTD practice to understand the target community. Therefore, we plan to use a similar system to reach project managers and teams and collect quantitative and qualitative data about projects. We propose an online crowdsourcing website – called *ict4gHub* – to allow project managers and developers involved in ICTD software projects to share their practices and information about their projects. In this way, we expect to start a continuously growing knowledge base that will benefit not only our study, but the whole community. *ict4gHub* will primarily support data collection. This is what will allow us to obtain information to design our software development process. However, in order to become an added value for the whole community, *ict4gHub* will also work as a showcase of ICTD projects and techniques. This will help increase visibility of initiatives and collaboration among different groups.

The goal of this data collection is to identify the critical success factors and failure factors in ICTD project development to build a set of recommendations that will ultimately constitute a customizable software development process. We are well aware that ICTD cannot be standardized. However, we argue that several commonalities can be found among different projects, therefore paving the way for the design of a customizable development process or a set of development processes.

Table 1 summarizes the data that we want to collect as an ICTD project's factsheet and that we expect to be ultimately able to produce as output. We plan to complement the data collected through *ict4gHub* with direct interviews and questionnaires with the managers of particularly active initiatives.

Figure 1 shows an early mockup of how *ict4gHub* will look like. We intend to show aggregated statistics on the homepage and publicize particularly active projects as "featured projects". All the other projects will be presented in a catalog.

5 Related Work

Several surveys have described ICTD projects in the recent years [6, 10, 11, 19], with particular interest towards mobile technologies and their application in rural contexts (see, for example, [17]). These surveys cover about 200 projects and identify several common aspects of all projects and discuss the reasons behind project failures.

Patra et al. [3] compiled probably the most complete survey of ICTD projects to describe the general direction of ICTD work and its validity. The survey

[4] `http://twitter.com/#!/search/%23ict4d%20OR%20%23ictd`

Table 1. ICTD project factsheet template

Quantitative Data	
Software metrics	Development time
Team size	Adoption (# of users)
Target community demographics	
Qualitative Data	
Project phases	Technologies
Team	Lessons learned
Sustainability plan	Target community
Estimation techniques	Tools (e.g. for planning, designing)

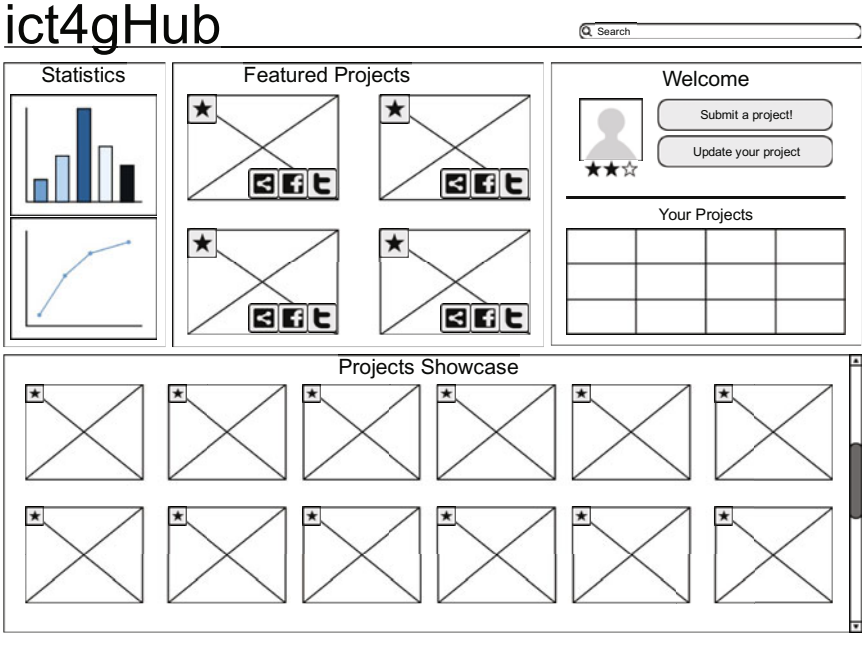

Fig. 1. Mockup of *ict4gHub*

analyzes projects in different areas, providing data about the role of governements in their development, the impact achieved and articles published at conferences.

A more local attempt at mapping ICTD projects has been carried out in the Philippines by Tiglao & Alampay [33] using a well defined taxonomy by Curtain [29]. Curtain describes a checklist of key components for best practices in ICTD. However, while the checklist is fairly extensive and can be applied to project management, it fails to address the specific and concrete issues of ICTD software projects.

Van Reijswoud presented in [34] the concept of "appropriate ICT" and some tools and methodologies to support design and development of ICTD solutions.

Methodologies such as Mobile HCI, user-centric design and Agile methodologies have been applied at Sekhukhune Living Lab [8, 13, 24], which is currently the only environment where software engineering techniques are applied to ICTD and documented.

Our work differs from previous attempts to categorize ICTD projects by taking a software engineering perspective, based on the hypothesis that the analysis can provide us with insights on how to tailor a software development process to the ICTD domain. Furthermore, our work adds value to the survey by making a knowledge base available to ICTD practitioners.

A similar approach has been adopted by eHub for web applications[5] and by MobileActive[6] for mobile tools for social change. More recently, the portal "SMS in action" was set up to map projects based on SMS platforms, using the Ushahidi crowdsourcing platform [35]. The portal we propose aims at taking a more technical perspective, mapping techniques rather than single projects.

6 Conclusion

In this paper, we have presented our views on the shortcomings of software projects in ICTD. We believe that an unstructured approach to software development is among the main causes of failure and we claim that applying software engineering and software project management techniques, without shifting to a completely technocentric approach, can greatly improve the quality of solutions for marginalized communities.

However, the limited documentation available and the lack of concreteness in most ICTD publications require us to devise a method to collect quantitative data on top of the more generally available qualitative data to understand the success factors of solutions in terms of software process.

We have presented the concept for *ict4gHub*, a crowdsourcing web portal to collect data about projects and to facilitate sharing of common solutions and best practices among ICTD researchers and practitioners. Our goals are:

- to classify projects by means of measurable properties.
- to identify a set of best practices and recommendations in ICTD software design and development.
- to provide added value to practitioners and researchers by creating a publicly available knowledge base, therefore encouraging participation to the survey.

We plan to use the results of this survey to design a software development process for the ICTD domain, based on best practices collected through *ict4gHub* and consolidated software engineering techniques.

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