Living Lab Methodology as an Approach to Innovation in ICT4D: The Siyakhula Living Lab Experience

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Abstract: Underdevelopment and poverty represent key challenges faced by the modern world, which have attracted the attention of NGOs, civil society, government and multinationals. Various undertakings including the United Nations Millennium Development Goals articulation and the World Summit on Information Society highlight the global commitment towards addressing these problems. The solutions to these problems should be derived out of well-structured innovation systems that take into consideration the grassroot context and concerns. A number of innovation models have been formulated and utilized effectively in different industries, and some of these have equally been used effectively in community development contexts. This paper elaborates on the Living Lab methodology and its application in ICT4D contexts, highlighting the effectiveness of this model towards integrating end-users within their problem solving effort. This is discussed through the backdrop of the Siyakhula Living Lab, an ICT4D intervention. The embedding environment for this model, which enables key synergies with other stakeholders, is also discussed.

Keywords: Living Lab, ICT4D, community-driven innovation

1. Introduction

Information and Communication Technologies (ICT) are well recognized as an enabler for socio-economic development of communities [1]. Numerous ICT for Development (ICT4D) interventions are currently undertaken at national, regional and global level towards socio-economic development of marginalized communities. Innovation within ICT4D must be driven by grassroot impetus to ensure long-term impact (i.e. sustainable, relevant, context-sensitive outcomes) at the community level. "Grassroots innovation" as defined by Heeks [2] remains an ideal for a majority of ICT4D interventions, which in reality can be characterized as undertaking "laboratory innovation" or "collaborative innovation". Each of the various aforementioned stages of ICT4D innovation models highlights a key factor that is important for sustained and effective intervention: the importance of external resources and expertise in ICT4D; the need for meaningful engagement with the end-user community in developing the solutions; and finally the importance of empowering the communities with the tools and skills to facilitate self-actualization and appropriation of technology to their needs. A model that adequately

encapsulates these key considerations is the Living Lab model which has been utilized in various contexts, besides community development [3].

This paper discusses an ICT4D initiative that has been undertaken in a rural South African community. It highlights how this project, now called Siyakhula Living Lab[1] (SLL), is organized as a multi-stakeholder engagement through the quadruple-helix model, with the end-users at the core of the operations. The paper shows how the adoption of this model is enabling effective innovation within the ICT4D space. It also discusses the various components and entities that make up the full innovation ecosystem of the SLL and the key activities undertaken within those entities.

2. Pre Living Lab intervention

This section provides background for the research, highlighting the geographic context of the communities that are involved in this project. It then describes the state of the project prior to the adoption of the Living Lab Methodology.

Figure 1: Dwesa

2.1 Geographic and Demographic Context

The current case study is based in the Wild Coast area of the Eastern Cape Province in South Africa. More specifically, the field deployment of this initiative is located in the Mbashe local municipality, a deep rural area on the Wild Coast (Figure 1). The Wild Coast is the least developed area in the Eastern Cape, despite having the highest rainfall and most fertile grounds for agriculture [4]. The communities initially targeted by the project are adjacent to the Dwesa-Cwebe area which comprises a nature reserve and frontline communities which are extended over a land area of approximately 15254 hectares [5], with approximately 15,000 people in the area divided into roughly 2,000 households [6]. The natural environment consisting of the nature reserve and Marine Protected Area are assets of the communities since the early 2000s [5]. Until late 2009, the majority of the households did not have direct access to electricity or running water and the limited road infrastructure was rough and basic. The targeted communities, by sheer size and because of political dynamics, represent a strategic emergent ICT market.

2.2 Initial Phase

The Siyakhula Project (SP) was launched in 2005 as a large collaborative project between Rhodes University (RU), the University of Fort Hare (UFH), industry, government and community. This work was a result of a classical Triple Helix initiative by Telkom South

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[1] www.siyakhulall.com

Africa in the constitution of a network of Centres of Excellence (CoE) which brought together industry, academia and government through the Department of Trade and Industry [3, 7]. An existing relationship with researchers in the Anthropology Department at RU provided a connection and entry into the Dwesa community. In 2009, the SP adopted the Living Lab approach, and has since been referred to as the SLL [3]. A Living Lab can be described as "an approach that deals with user driven innovation of products and services that are introduced, tested and validated in real life environments" [8]. A user driven approach is essential to understand the local requirements and constraints associated with the rural environment, throughout the progressive development of the ICT project. This will be described in more detail in Section 3.1.

3. New Approaches to Innovation within ICT4D

Activities within the ICT4D space continue to proliferate and the thinking and philosophies of engagement continue to mature in this space. The key factors that underlie this project, which have been formulated with insights from the field experience and which to a large extent are novel and innovative, include: high end technology solutions for rural communities; context sensitivity; and understanding of the context/research group makeup.

3.1 Living Lab Methodology

This section offers an understanding of Living Lab methodology, as understood in our ICT context. Living Labs are initiatives that focus on the collaboration of multiple stakeholders (government, industry, research institutions and communities) in different stages of the research, development and innovation process. These stakeholders form of public-private-people-partnership to create mass impact and address societal challenges. Also, collaboration between stakeholders is an essential element to establish effective linkages and allows the production of services and applications using holistic approaches which allow research insights and innovation opportunities to be exchanged, validated and replicated.

3.2 SLL Ecosystem

Figure 2 represents the entities within the SLL ecosystem, their interactions and their dates of commencement.
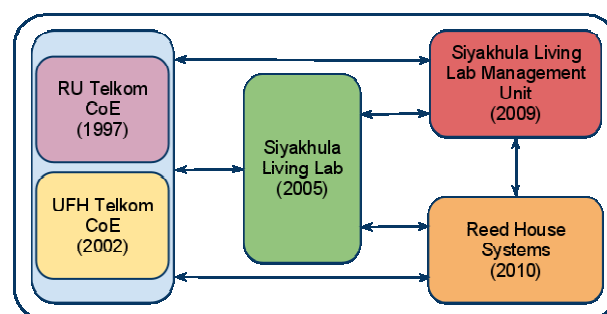

Figure 2: SLL Ecosystem

The Telkom CoEs hosted in the Computer Science Departments at RU and UFH are the lead partners in the establishment of the SLL. The primary objective of the SLL is to develop and field-test a distributed, multifunctional community communication platform, using localization through innovation, to deploy in marginalized communities in South Africa, where a large number, 42.5%, of the country's population live [7].

The communication platform was originally designed to support the marketing of local arts, craft and eco-tourism through e-commerce. It now includes a number of additional features such as e-health, e-government and e-learning. Local wireless connectivity, a connection to the Internet and ICT training form an integral component of the living lab. The SLL uses a well-known analogy which is; while at one level the project is already giving the community some fish (one has to eat while learning!), it is mainly developing the relevant tools for fishing and teaching the community to fish. Usually users are predominantly considered the consumers of services, but in this project the users are what have come to be known as "prosumers" (producers-consumers). While this metamorphosis has already been observed with the proliferation of Web 2.0 tools and with regard to information content, it hasn't proliferated much in the actual development of services.

The second objective of this project is to build technically skilled human resources in the field of developmental ICT, particularly in the context of supporting e-service activities in marginalized communities [7]. A key distinguishing (and innovative) aspect is the multidisciplinarity of the research team. This project involves researchers from departments of Anthropology, Education, Communication, African Languages, Information Systems, and Computer Science. The majority of the researchers in this project have a direct experience of the marginalized rural reality. This brings a crucial understanding of the rurality context to the project, allowing for services that are relevant and well positioned to meet the needs of the communities.

The e-services currently deployed by the SLL researchers have been developed in a disconnected manner, as is typically in many ICT4D interventions. Each service (e-commerce, e-government, and e-health) is disconnected from the other, as each are conducted as individual research projects. While this architecture is functional and operational, it was desirable to have a more flexible, efficient (i.e. from reusing and minimizing duplication) architecture, on a middleware platform which allows for greater service component interoperability. Reed House Systems[2] is the information technology business entity which develops (production-grade), bundles, and commercializes software based on SLL operations. Their first product, Teleweaver, is a service middleware environment which facilitates a greater interaction and interoperability between different e-service components by "weaving" them together to realize sustainability and efficient service provisioning. Teleweaver enables the implementation of features such as: single sign-on for the network services, coordinated usage accounting for network resources, extensibility of network services (e.g. access to the SMS gateway service for the network monitoring service etc.). Institutional and public bodies, both national (e.g. Department of Home Affairs) and provincial or local (e.g. municipalities) form the likely customers for the bundled ICT4D product or the individual e-services.

An additional novel aspect of the SLL is that it not only empowers the rural communities but also channels the innovative potential into the general national systems of innovation. The Cooperation Framework on Innovation Systems between Finland and South Africa (COFISA) has facilitated the process of integrating our work into the larger system of innovation. As a result, the SLL became a member of the European Network of Living Labs in 2008 and is one of the founding members of the Living Labs in Southern Africa network which was established at the beginning of 2009 [9][3].

The growth of the SLL and the increasing number of role players has added complexity to its management. A structured management, SiLLMU, has been established to makes use of the outcomes that are already achieved and make it possible to achieve the short and medium-term goals of the SLL in an efficient and useful manner.

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[2] www.reedhousesystems.com

4. SLL Current Themes

Within the SLL, the projects within the intervention can broadly be categorised as: user requirements elicitation; networking; e-service/m-service provisioning; monitoring and evaluation; and sustainability.

User Requirements Elicitation. Appropriate user requirement elicitation is the mainstay of building any successful IT system, and should be conducted prior to implementation of research projects. Users in communities such as Dwesa, previously left out of the ICT revolution, represent a group that not only has special requirements not represented in standard IT applications, but present a profile for which standard elicitation techniques do not work. As part of the research, existing elicitation techniques and frameworks were evaluated and it was found that none of them could be successfully applied to the context of rural software implementations. A new model was developed and evaluated that took into account the contribution of knowledge for stakeholders, problems and solutions for effective elicitation of requirements during the software development process [10, 11].

Networking. Connectivity is the first requirement for any ICT4D project. The model used in SLL is based on a wireless broadband island which connects the Living Lab points of presence (PoPs) to each other, and is attached to the internet through a satellite or a cellular link where possible. The wireless broadband island is realized through a mix of fixed and mobile WiMAX and WiFi links that also supports the roaming of WiMAX and WiFi mobile devices. This connectivity is augmented where possible, through the use of cellular phones already owned by the community.

The SLL network research can be divided into three components: deployment; increasing robustness and effectiveness; and network security. During the deployment of each technology that create the backbone of the wireless network telecommunications infrastructure, feasibility studies have been undertaken to investigate the suitability of the technologies for the rural context; deployment of the WiMAX backbone [12, 13]; extension to a converged WiMAX / WiFi Network [14]; and the viability of extending the network to include mobile WiMAX [13]. A system was developed to ensure fair usage of available bandwidth and billing for PoPs for their Internet usage [15].

The network is crucial in supporting all of the other activities (e-services, m-services) of the project, and long down times were found to undermine community members' confidence in the services. The reasons for the down-times were: difficulty in fault diagnosis; hardware failure; and social factors. A certain degree of computer literacy and competence are required to accurately diagnose networking faults. Although training was undertaken with community members on basic fault diagnosis there is still work to be done. Environmental conditions were found to be the source of some hardware failures: inadequate earthing of networking equipment; irregular power availability from grid; and dusty conditions. Perhaps most difficult to control were softer issues such as ensuring community members remember to plug equipment back in if they have unplugged it, and ensuring the labs have enough prepaid electricity. Behind most of these problems was the requirement for a backup system that could be used to access the Internet in case of network failure at critical nodes An investigation was undertaken to identify cost effective reinforcements to the current network [16].

The final area of research within the project's networking component was investigating security issues on the converged network. This is important, particularly when sensitive data such as credit card details are being sent between locations [17].

e-service / m-service provisioning. For the full details of e-services that have been piloted in SLL, refer to [18]. Initially, the focus of service delivery has been via desktop computers and fixed line telephony, however the SLL now also focuses on mobile phones

prevalent in rural South African communities. As mentioned, the initial service developed was an e-commerce platform. Extensions have been made to this service to include: investigations into m-commerce extensions implemented on SIM card to ensure portability of applications [19]; linguistic localisation of shop owner interfaces [20]; developing incentives for participation in services [21]; and the use of localized telephony interfaces for users who are not fluent in English [22].

An e-health service that uses ontologies to store indigenous knowledge regarding local practices and remedies to complement western medical information was created [23].

Within rural communities, traditional justice systems are in place to handle minor grievances that occur within a community. A weakness with these traditional justice systems is that there is no access to records of previous rulings and cases. This lack of information can lead to inconsistencies in rulings, vulnerability to partiality and corruption, a limit to enforceability of decisions and punishment for offenders. An e-judiciary service was created [24] as an interconnection between traditional justice systems and external judicial institutions such as local village courts and urban magistrate courts, for monitoring and controlling legal e-services for the region.

Another need that was highlighted by the community was access to government services. In order to access these services, community members travel great distances using limited public transport. When community members arrive at government offices they must queue for long periods of time just to retrieve application forms for identity documents, (at Home Affairs Department) or allocation of stands (at local Municipality); or to report crimes (at Police Departments). An e-government service was created to provide access to these application forms and then support remote submission of completed forms [25].

Implemented e-services need to be context-sensitive as far as the localization of the user interfaces (UI) is concerned, and to that end, software localization remains a key aspect/component of the SLL. In response to the rural socio-economic conditions and also to provide a closely aligned and increased user experience, audio-based user interaction on the e-services platform have been made more pervasive. The effect of this is two-fold: it allows for increased accessibility to the services for the illiterate sector of the community, and secondly, it increases the reach of the services to the mobile devices that are accessible to each household. The other key aspect of the contextualization effort is the integration of the local content (IK) onto the e-service platform. This increases the relevance of the services and allows for a systematic preservation of the IK in these communities.

Monitoring and Evaluation. Monitoring and evaluation is a continuous function in the SLL in order to make the interventions as effective and replicable as possible. Soon after transforming to a Living Lab, a baseline study was undertaken to assess the current status of the community in terms of: status of the community; quality of life; and attitudes towards being / becoming partners with SLL [26]. This study is used as a source of ideas for future developments to feed into the sustainability of the intervention, as well as a point to evaluate against to capture the impact of the SLL.

Sustainability. There are three different types of sustainability that this project is concerned with: financial, technical and cultural. Within the SLL we are experimenting with various models that could make the ICT infrastructure on the ground sustainable in the longer term and outside a project perspective. One idea is to activate financial streams from outside the community that are created through the presence of the ICT infrastructure. Each stream will not be able to carry the cost of the infrastructure, but a large enough number of streams could.

As mentioned earlier, a lack of technical training of community members complicates the resolution of technical problems within the infrastructure. A recent initiative has been to develop a help-desk to be used by community members as a first port-of-call when a technical problem occurs [27].

Perhaps the largest of the projects within the sustainability theme falls into cultural sustainability. Interventions within this theme include: localising shop-owner interfaces to the e-commerce service [20]; localising interfaces for voice over IP software; and creating concept maps to explain ICT terminology in isiXhosa [28]. The thinking around culturally and linguistically localising software has to a large extent focused on the UI components (linguistic localization, modifying the themes and styles). While context-sensitivity also underlies this project, it also includes: HCI metaphors that are relevant in these communities (i.e. replacing completely the traditional GUI desktop metaphor) [29]; and use of Indigenous knowledge to increase the relevance of the services to the particular community [30].

4. Discussion

The Living Lab methodology as an approach to innovation for ICT4D has demonstrated benefits to date for each of the stakeholders involved in its quadruple-helix model. To begin with, the model emphasises the key role of community members (influential people, elders, women and youth) within the project. As recognised stakeholders, they are given equal importance and weight to their views as academia, industry and government.

During the initial phase of the SLL, ICT training was a priority. A "champion" model was used in training, where teachers and community members who showed interest and competence in ICTs were mentored by RU and UFH researchers. When champions began teaching in their own language, we found that there was more uptake from community.

Up to this point in time, the SLL has experienced difficulty in embedding into the provincial system of innovation. It is hoped that the provincial eMonti Science and Technology Park or the proposed Eastern Cape eSkills Hub will provide a platform on which this may be done more effectively.

The impact to date of the SLL for each of the four stakeholder groups over the past six years will now be discussed. From a community perspective, the SLL provides opportunities for marginalised people to begin participating in the knowledge economy. With access to the Internet, community members no longer have to take the role of a consumer of information, but also to produce as well. One of the major contributions they have made to date is collaborating with researchers in creating services to meet their untapped needs. Also, in partnering with SLL, schools within the region have benefited from the ICT facilities within the PoPs, and a large number of teachers within the area have received in-service training from RU. One school in particular has been selected by the Eastern Cape Department of Education as a rural ICT Resource Centre.

From an academic perspective, there are continued calls for higher education institutions to become more responsive in their teaching and research in supporting South Africa in its' social and economic development [31]. The Living Lab methodology has facilitated responsive research in its emphasis on community engagement. The interaction with community, industry and government has provided a unique opportunity for researchers to undertake practical research that can have a positive impact on rural South Africa.

From a government perspective, the SLL provides an opportunity to fulfil their role as a catalyser of applied research carried out by academia and industry. It also provides government with a platform to work towards service delivery in under-serviced areas.

From an industry perspective, participants are afforded an opportunity to test ICT infrastructure within a rural context. The SLL also enable industry to pilot services created for a previously untapped market. Their social responsibility arm can be extended towards improving the human resource skill and towards uplifting neglected communities, such as Dwesa.

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5. Conclusion and Future Work

The SLL model emphasizes the importance of the multi-stakeholder operation that consists of academia, industry, government and the communities. Each of these entities plays a critical role in the development of solutions that meet the real needs of the users. In the case of this project, the multi-stakeholder arrangement of entities, allows for effectiveness and great synergy in providing solutions for the marginalized rural communities.

This paper has described the first three years of the SP and its transformation to the Living Lab methodology. It has demonstrated the benefit of activating communities as co-creators of services for marginalized environments. It discussed the various components and entities that make up the full innovation ecosystem of the SLL and the key activities undertaken within those entities.

Continued work in the SLL aims to focus on extending the footprint of the intervention to include surrounding communities. An extension is currently underway to investigate the applicability of the living lab methodology within other marginalized areas such as peri-urban communities. The SLL also aims to extend the direct involvement of the community within the service creation, and network infrastructure / maintenance phases.

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