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Designing for Sustainability: Involving Communities in Developing ICT Interventions to Support Water Resource Management

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Abstract: Rural Africans have poor access to clean and safe water compared to other developing areas. Many Information and Communication Technology (ICT) interventions have been implemented to address the information gaps that hinder improved service delivery but have subsequently failed. The inability to provide suitable content, failure to address priority needs of communities and foster local buy-in are seen as the main causes. The transition from developing technologies for users to developing with users has created the need to harness collective ideation. Developing community-based ICT interventions collaboratively with the user communities provides a better understanding of the cultural nuances that can easily affect the use and adoption of an intervention. In this paper, we present a landscape analysis of rural water supply management in Uganda and an ICT intervention implemented to support the community management model. We present findings and a justification for a more user-centred approach to developing sustainable ICT interventions through co-design.

Keywords: Rural Water Supply, ICT, community-based interventions, co-design.

1. Introduction

Access to clean water is considered a human right and not a privilege [1] but rural Africans have the lowest level of access compared to other developing areas in the world [2]. Approximately 884 million people in Africa do not have access to safe drinking water [1] and a third of water sources in rural areas are non-functional [3][4]. A considerable amount of effort has been put into the construction of new water sources in rural areas but continuous breakdowns resulting from poor operations and maintenance practices impede efforts to improve water access. Keeping water sources functional is key to ensuring continued access to clean and safe water for communities [4][5]. The issues in the water sector are complex and diverse and there is no single solution. However, addressing the underlying issue of governance by establishing systems or structures to develop, manage and deliver water services to rural communities is seen as critical if access to these services is to improve [6, pp.10]. Jiménez et al argues that water access problems in rural areas arise from social and political causes rather than technical or physical problems [3].

Although a number of African countries are implementing management models to keep rural water sources functional, a lack of shared and relevant information between communities and service providers (at national and local government level) and a lack of responsiveness by service authorities by using the information generated to inform their decisions or planning, hinders efforts to improve service delivery [6][7][8]. The proliferation of affordable Information and Communication Technologies (ICTs), principally in the form of mobile phones, presents opportunities to address information gaps by transforming the way information is generated and shared among stakeholders. ICTs have become ubiquitous and can therefore be exploited to support the establishment of reliable and inclusive information routines to facilitate the management of Rural Water Supply (RWS) and produce actionable information to achieve sustainable delivery of rural water services [9][3][6].

In this paper we present initial results of a needs assessment that is part of an on-going PhD study to explore the application of co-design in developing appropriate ICT interventions to support RWS management. The needs assessment study sought to assess the use of ICTs to support the management of RWS in Uganda. We analyse an ICT intervention implemented to improve transparency, participation and accountability in RWS. Our analysis focuses on issues of user involvement, design and sustainability of the intervention that are pertinent to continuous use of ICTs [10]. In the following section, we discuss the methodology used to undertake this study.

2. Methodology

The needs assessment study was carried out in July 2014 and involved two rural communities (Bugaaki and Kicwamba) in western Uganda. In assessing ICT use in RWS in these communities, the study focused on the Mobiles for Water (M4W) tool that has been actively used for more than one year. The tool supports operation and maintenance activities of the community management model and is meant to be used by rural community members. It was also reported to have facilitated user participation, accountability and transparency, which are key to improved governance.

The findings presented are based on information gathered through semi-structured interviews and focus group discussions with local government staff and community members during the field visit. A total of twenty six (26) participants were selected based on their roles within the community-based model [11]. Participants included: district water officers (DWOs), sub-county chiefs, mechanics, community development officers, health assistants, Water User Committee (WUC) representatives, water board representatives and representatives of the international organizations implementing the M4W project. Manual coding was used to analyse the data from this study. Pre-set codes included '*community engagement*', '*challenges with water access*', '*expectations*' and '*technology use*'. Emergent codes with regards to '*technology use*' included '*design*', '*user involvement*' and '*sustainability*'. These form the basis for the analysis presented in this paper.

3. Rural Water Governance and the Application of ICTs

Governance for this research is defined as the political, social, economic and administrative systems that have been put in place to develop and manage water resources and deliver water services to communities [6][3]. Sustainable rural water supply is tied to management practices that focus on improving operations and maintenance of water sources [12].

3.1 Management of Rural Water Supply (RWS) in Uganda

Uganda, like many other developing countries, has developed policies advocating a demand-driven approach to manage water sources [7][15][11][16]. This approach (also known as the Community based management model - CBM) has become the leading concept for implementing RWS supply management by the government and is promoted in an effort to create communal ownership of water services since the government continually sees itself as unable to build and maintain water supply infrastructure [17].

When a community expresses a need for a water source, local leaders call for community meetings where the community decides on the location of the water source and the type. The common water source technologies in rural communities are boreholes, shallow wells or gravity flow schemes (in mountainous areas). Communities are then requested to contribute funds to the capital cost of constructing the water source. After construction, the community is responsible for operating and maintaining the water facility. This is done by electing a WUC responsible for managing the water source on behalf of the community on a voluntary basis. A mechanic is assigned to the source and is responsible for maintenance and repair.

This model is meant to enable rural communities to take control of the management of their water supply [17][11][18]. It is viewed as critical and central to long term and sustainable operation and maintenance of RWS because of its underlying principles of participation, control over decision making, ownership and cost-sharing [17][11]. The model is meant to ensure and support the building of adequate and sustainable capacity at the community level to effectively manage communal water supplies. Lockwood argues that by being in control of the service delivery process, communities will be interested in the continuity of water services [17] and will strive to keep their water sources functional.

Whilst the CBM is the most widespread approach to rural water management, it has failed to deliver the expected functionality and level of sustainability. A key limitation of CBM is the inability of rural communities to maintain their water systems without external assistance [17][15]. The instability of community structures since members leave (and there is no mechanism for replacing them), loss of trust in WUCs as a result of failed transparency and accountability of user fees and failure of community members to pay user fees to support minor repairs [18] limit the model further. RWS management models can be enhanced and or supported using either technology or institutional frameworks to deliver sustainable rural water services. To strengthen the capacity for RWS management, a number of approaches have been suggested and some of these include; using participatory methods (with community members) in planning, decision making and construction of water facilities and establishing new management structures or strengthening existing ones [17]. A suitable management model is highly dependent on the context and should therefore address technical, managerial and social challenges of the community served.

3.2 ICT Use in Water Governance

According to the Joint Water and Environment Sector review [5], Uganda faces a capacity development challenge. Continuous splitting of districts for political gains has thinned the available human resources and caused an increase in administrative costs. This has affected service delivery as the overstretched officials (at the local government level) with limited resources are not able to effectively provide services to the underserved communities.

Advances in ICTs especially mobile technologies have presented a platform for affordable and sustainable information dissemination, communication between service providers and communities and monitoring of interventions in the water sector [8][7].

ICT tools such as M4W in Uganda are reported to having enabled service providers process and resolve complaints from communities faster and also helped users to voice their issues remotely by reporting problems and thus facilitating timely resolution of faults [12]. This has strengthened the management and regulation of water services by provisioning of better data [8][7]. Water source mapping tools have supported equitable distribution of water sources, functionality of RWS and are able to identify distortions in distribution and possible political interferences in the planning process [13]. The AkvoFLOW (Field Level Operations Watch) and M4W tools have been implemented to promote transparency through the generation of timely and accurate data for resource monitoring [12].

Although ICTs (mobile technologies) have become ubiquitous for communication in remote areas, interventions to improve access to water have not done much in addressing key issues of participation, meaningful use of data and long term sustainability [6, pp.30]. Many ICT interventions have been dominated by donor agencies and Non-Governmental Organizations without the contribution of the communities that shape water use behaviour [2]. These projects although aimed at providing developmental impact on the lives of communities, do so little to focus on the users and to understand how the interventions will impact them. These technology-centric initiatives focus on the technology as the design is externally conceived and completed long before the communities are engaged [10].

ICTs have facilitated data collection but also contributed to the increasing amounts of unused data. Interventions with the primary focus of data collection using smart phones or remote monitoring are on the rise [7], meaning that the amount of data collected will only increase but remain unused if responsive measures are considered during development. Furthermore, the potential of many interventions in RWS remains under exploited as information is not included in the planning process for water services and systems remain disconnected from institutional frameworks that could support [14] and provide the needed and critical momentum to encourage use [10].

It is important for community interventions to be integrated within existing government structures as a way of supporting their sustainability and reducing the need for monetary incentives [7]. It is imperative to note that if community development is the primary objective of an intervention, then the needs of the community users must be made priority in the design of the intervention [10] by actively engaging with them.

4. The M4W initiative in Uganda

In a bid to have more reliable information on the functionality of rural water sources, three International organizations (SNV, Water Aid and IRC/Triple-S), collaborated with Makerere University to develop and implement the M4W project in 2011. The objective was to reduce source downtime by alerting mechanics and DWOs of faults in the water supply. Since rural communities are expected to manage their water sources through regular operation and maintenance activities, they were expected to report breakdowns by sending an SMS to notify the mechanic who would in turn repair the source when the community was ready to pay for the repairs. This system was developed with the notion that reporting faulty water supplies reduces downtime of the water supply, triggers action by service providers and therefore contributes to functionality and continued access to water.

When a water source breaks down, a caretaker or community member with a mobile phone reports the problem by sending a structured SMS (m4w<space>water source ID<space>description of fault) to a short code (8888). The system logs the reported fault and alerts the mechanic assigned to the water source. The mechanic conducts an assessment of the fault and fixes the water source.

The mechanics were given Java-enabled mobile phones on which notifications on reported faults are received. On assessing the reported fault, the mechanic is expected to fill and submit an assessment form to the M4W platform, which is accessed by the DWO who then takes further action if necessary. To utilize the existing institutional structures, community development officers and health assistants were involved in this project to supervise the work of the mechanics. These extension staff were expected to verify all the information submitted by mechanics as a data quality measure.

To introduce the system to the users and communities, the project team consisting of the developers and community learning facilitators of the implementing organizations organized training workshops. The mechanics and district extension staff were given mobile phones loaded with the M4W application. Each community (sub-county) received two mobile phones, one for the mechanic and the other for the extension staff. Training manuals were distributed to these participants. The developers demonstrated how to use the phones to fill and submit forms as well as how to respond to an alert. DWOs were taught how to use the dash board to monitor reported faults and the activities of the mechanics in responding to the faults.

Although this system has been in use since 2011, the extent of use has been lower than anticipated. In the following sections, we present our findings from the study and a discussion on the key issues related to the use of the M4W tool.

5. Findings and Discussion

Data collected from the needs assessment study highlighted the issues that have contributed to the level of use of the tool. These emergent issues are analysed and discussed under the categories: *user involvement* (for participation), *design assumptions* (for appropriateness) and *sustainability* (for continued use).

5.1 User Involvement

At the design stage of the M4W system, consultative meetings were held by the project team with district water officers and mechanics. In these meetings, the developers introduced the designed workflows and participants were able to provide feedback based on what they do in their communities. The community members who were expected to report faults were not involved in these consultations. Mechanics were trained and expected to train the community members on how to interact with the system. The mechanics and DWOs who were trained when the system was being deployed are still struggling to use it.

"The reason for the low uptake of the tool among community members is the lack of sensitisation on how to report faults. There was no budget to cater for these activities". (M4W project implementer in Bugaaki, July 2014)

The tendency to implement pre-defined technology solutions often leads to missed priorities of communities. Involving eventual system users right from the project inception to implementation gives one an understanding of how best to implement and introduce an intervention to a rural community. Failure to involve the community users in the M4W deployment and understanding the training needs for the mechanics and district staff has resulted into delays to respond to faults because the water officers and mechanics are not sufficiently capable to operate the system and for the water officers to allocate work items to the mechanics.

5.2 Design Assumptions

To make use of the community management structures, the project implementers expected the WUCs to frequently use the system. It was assumed that at least one of the committee members would report a problem in case it was too costly for other community users. However, the realities were different as many sources did not have these WUCs in place. The community management model relies of the spirit of voluntarism in these communities. However, these community structures are very unstable as community members leave often and there is no mechanism for replacing them. "*Water Source Committees lack adequate support from Sub-county staff. Many of these members do not know their roles as a result of not being trained"*. (**District Water Officer, July 2014**).

The M4W system was implemented in English. However, the rural communities in which it was implemented have more semi-literate people than literate. Mechanics had difficulties using the English language and writing the required reports. Some mechanics did not know how to use the phones to fill and submit the forms. This means that sometimes the mechanics make repairs but do not submit the reports. Some of the mechanics do not know how to buy or load internet bundles or to check their balance on the phone. Several trainings facilitated by the project implementers have taken place but mechanics still need to be regularly retrained. In addition, mechanics have lost the phones and these have had to be replaced. Mechanics often remove the sim cards from the phones and this disrupts the internet settings. Due to the limited capacity at the community level for preventive maintenance, the phones have to be sent to Kampala to be fixed by the developers.

Community extension staff (health assistants and community development officers) who monitor service delivery activities at the community level were given phones to conduct water quality assessment and verify information submitted by the mechanics. However, these staff are also responsible for monitoring activities in other sectors like education, agriculture and health. Although the implementers anticipated that the extension staff would follow up on reports to check that repairs have been made, there has been no registered use of the system by these staff. The major cause of this is their increased workload in other sectors and poor facilitation to do the M4W tasks.

5.3 Sustainability of the Intervention at the Community Level

The system was developed to enable the community members report faults in order to trigger action by the mechanics and the community leaders. The community members were expected to send a structured SMS to a short code and this cost the sender 220 UGX. With the community management model, each household is expected to pay 1000 UGX per month as a water user fee to keep the water source functional. Many communities fail to raise this money and therefore paying 220 UGX to report a breakdown is significant. The cost of the SMS to report a problem has since become a barrier to using the system, resulting in people using the cheaper option of making phone calls to report their problem directly to the mechanic, meaning that the data is not logged.

The typical users of these water sources are older women and children. Therefore when a source breaks down, they are more affected and thus more likely to do the reporting of the fault. Texting however, is not the preferred method of communication amongst rural communities and many community users resort to calling the mechanics directly. Even among those who generally know how to send a text message, sending a structured SMS proved complicated. System logs from 2 districts indicated that only 715 SMS were sent to the system since 2011 and 187 water sources (about 26%) were repaired on the basis of these messages.

The M4W project has therefore not improved the functionality of water sources since the districts in which it is being implemented have not shown any significant change in functionality statistics. Kabarole district which has been considered one of the frequent users of the M4W system has a functionality statistic of 64% which is well below the national average of 81%. Furthermore, because of the poor uptake and incomplete data, the system has not been able to provide information on the downtime of water sources. It is therefore difficult to establish whether the system has or has not reduced downtime of rural water sources.

The M4W is still in use but to a small extent, providing information on rural water sources. Communities are unable to keep it running without the support of the implementers. Support is required to maintain the system and train the users.

6. Conclusion

Access to clean and safe water is a challenge and ICT interventions have the potential to contribute to the information gaps that exist by improving work flows, supporting decision making and empowering communities. For rural communities to have improved access to water supply, users must be empowered and allowed to make informed decisions. This is only possible if comprehensive information is provided to them. Attempts to introduce community-based ICT interventions to empower communities and improve their access to basic services fail due to their inability to provide suitable content, address community priority needs or poor sustainability in terms of affordability and institutional support.

Collaborating with communities to develop applicable and appropriate technologies for their contexts helps to build sustainable solutions with the potential to bring about improved service delivery and improved quality of life. Continuous community engagement helps to establish relationships, build trust and work with both formal and informal leadership to create processes that support community development. Furthermore, it creates awareness of aspects of community diversity that seem paramount when designing and implementing sustainable interventions. Failure to plan for sustainability of the ICT solution eventually affects use of the technology since providing technology does not automatically create a need for it and neither does it foster a culture of use. Furthermore, providing access to information through technology is equally inadequate to bring about development if genuine participation of users is not considered.

6.1 Creating Sustainability in Rural ICT Interventions through Co-Design

The findings from the M4W assessment highlight some of the challenges associated with the implementation of community-based ICT interventions. Participation is a key prerequisite to sustainability of not only rural water supplies [18] but also technological interventions [19][14]. More attention has often been paid to the availability and efficiency of technologies than the human and social systems that need to be adjusted or understood if the technology is to have impact on users [20]. The growth in opportunities for community participation has led to the development of tools and approaches to support the participatory process and the deployment of several ICT platforms [21]. The transition from informing users to engaging with them has created widespread implications for the design and deployment of appropriate tools to support the participation of users and service providers using technology. This shift has created the need to harness 'collective creativity' to support the sustainability of ICT solutions that are closer and more relevant to the needs of the users [22]. With the desired outcomes being information sharing, knowledge exchange, informed decision making and empowerment, the challenge created is that the designed applications whilst developed using established system development methodologies, are required to put into consideration issues of local context, usability, participation and transparency. The issue of local context is further influenced by social relationships between existing institutions and user communities involved in the participatory process.

User centred design approaches like co-design allow technology developers and implementers to focus on the user throughout the development process by putting into consideration the user's needs, wants and limitations [19]. Co-design is a user-centred approach that allows system designers to work with users as co-designers to identify the problem to be addressed, agree on the means to tackle the issue and together decide on how to measure success. Working with rural communities provides the opportunity of dealing with diverse categories of people that need to be given a voice in design to ensure that whatever is developed is relevant, usable and therefore has a higher chance of being used continually. Co-design provides a good framework for involving rural communities and introducing ICTs to them that meet their needs and therefore contribute to sustainable community development. Communities can be empowered using ICTs if meaningful approaches are used to develop locally relevant applications with appropriate content [14].

Moving on from this needs assessment study, our future work will involve collaborating with the study communities to explore the applicability and appropriateness of the co-design approach to design and develop an intervention that supports transparent water fees management – a main hindrance to functional rural water supply.

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