Openness and developmental outcomes in applied e-Government research

Melissa Loudon[1] and Ulrike Rivett[1]

[1]Department of Civil Engineering, University of Cape Town

Ms Melissa Loudon / Prof. Ulrike Rivett

Department of Civil Engineering

University of Cape Town

Private bag

Rondebosch 7709

South Africa

Abstract

This paper considers the role of openness, understood as an active process of engagement, knowledge-sharing and co-creation, in developing research practices that generate "actionable knowledge" (Hearn & Foth 2005) for ICT-enabled development. Experiences from two ICT for service delivery projects in South Africa, one in HIV/AIDS and one in drinking water quality, demonstrate barriers to openness but also important successes. Cell-Life, started in 2001 as a university research collaboration to investigate the possibilities of using converging technologies within the HIV/AIDS sector. It became a separate not-for-profit organisation in 2006. The organization currently implements ICT systems which (as of mid-2009) manage the dispensation of antiretroviral drugs to approximately 50 000 patients. In the Aquatest Project, an international collaboration looking at water quality management in the developing world, our team is working with local government to develop a cellphone application to communicate water test results. In both projects, we have tried to enact a shift toward openness in the technologies with work with - preferring open source and open standards - and in the system development process through the use of iterative and incremental methods, evolutionary prototyping and participatory design. We have also engaged with the research process itself, trying to establish a developmental understanding of our work as information systems researchers that presents openness as a vital enabler.

Introduction

Responding to the theme of openness in ICT-enabled development, this paper reflects on the role of university-based e-Government research. As researchers working in and writing about the global South, our experiences demonstrate a clear need to problematize the research process, particularly if (as we believe) its primary goal is to develop knowledge that contributes to developmental outcomes. The theme of openness is attractive because many of the problems we see, both in research and in the implementation of public sector information systems, link directly to exclusion – whether of ideas, or people or of different ways of seeing the world.

Experiences from two ICT for service delivery projects in South Africa, one in HIV/AIDS and one in drinking water quality, demonstrate barriers to openness but also important successes. Cell-Life started in 2001 as a university research collaboration to investigate the possibilities of using converging technologies within the HIV/AIDS sector. It became a separate not-for-profit organisation in 2006, and currently implements ICT systems which (as of mid-2009) manage the dispensation of antiretroviral drugs to approximately 70 000 patients each month. In the Aquatest Project, an international collaboration investigating tools to support water quality management in the developing world, our team is working with local government to develop a cellphone application to communicate water test results. In both projects, we have tried to enact a shift toward openness in the technologies we work with - preferring open source and open standards - and in the system development process through the use of iterative and incremental methods, evolutionary prototyping and participatory design. We have also engaged with the research process itself, trying to establish a developmental understanding of our work as information systems researchers that presents openness as a vital enabler.

The discussion presented here is grounded in experience, reflective, and part of our ongoing learning. Interpretation of the theme of openness is guided by a diverse body of literature, drawing on development studies and information systems as well as work on research methods, presented in part one of the paper. In part two, the two cases are discussed and related to points emerging from the literature. Our research stance recalls action research, and both authors have been directly involved in various aspects of the work.

Characterizing the need: project failure, relevance and development goals

Research in e-Government has a normative orientation, seeking to influence policy or practice in the ultimate service of development goals. Heeks and Bailur's study of the literature (Heeks & Bailur 2007) reveals an academic discourse of overwhelming optimism about the potential of e-

Government for development. Yet, in over a decade of e-Government research, most government information systems projects in the developing world have ended in either partial or total failure (Heeks 2003).

There is a vast body of work in information systems (IS) dealing with IS project failure, including many examples from the developing world. We know that systems have failed because they try to force an unwanted or contentious change in organisational processes. Another reported reason has been that the technology requirements, such as hardware and connectivity, did not exist or were not maintainable due to limited human, technical and financial resources. In general, the literature on information systems failure suggests that failure occurs because some aspect of the system context - social, technical or political - is inadequately understood.

The premise of the work described in this paper is that, whilst such reasons are valid, the stubborn persistence of information systems failure suggests a broader systemic problem. The structure and realisation of the ICT 'ecosystem' – from technologies, implementation and development processes to ICT research and teaching - does not appear to promote success in public sector IS projects. If e-Government research is intended to support to development, information systems failure needs to be understood holistically.

The issue of relevance is also important. Despite massive investments in government information systems, e-Government research has largely failed to provide actionable guidance to practitioners as well as to derive learning from practice (Rose & van Rossum 2005, Heeks & Bailur 2007). In a fundamentally applied field, 'echo chamber' research has little value - as evidenced by the persistence of failure in public sector information systems in the developing world.

Lastly, there is little consideration in the e-Government literature of the contentious nature of IS project success. For example, is a project successful if it helps government to carry out a function more effectively, but results in job losses or redundancy in specific social groups? e-Government projects are situated overwhelmingly within the development-as-modernisation discourse (Moodley 2005, Gurumurthy & Singh 2009) – highly contested terrain in development studies, but taken virtually for granted in the world view of public sector IS projects. Most projects follow a top-down, "functionalist" model (Hirschheim & Klein 1989), with ICTs as instrumental and essentially value-free. The ultimate goal of e-government is seen as the creation of efficient and effective technical systems, exemplifying what Avegerou (2000) calls the "techno-economic rationality of western modernity". Wilson (1997), drawing on Habermas, sees positivist IS research as essentially supportive of this perspective, providing a scientific gloss that allows the implementation of technical systems to be presented as politically neutral.

This is not to underestimate the value of efficient and effective technical systems. For example, most people would agree that a system that improves the delivery of basic services, or helps citizens hold public bodies to account, supports development and is broadly desirable. Rather, the challenge for e-government research lies in moving beyond simplistic, apolitical explanations for information systems failure to an engaged understanding that actively promotes (and problematizes) success. The concept of an enabling environment for information systems success has the potential to link diverse observations in diverse contexts. Our aim in this paper is to use the concept of openness to explore an enabling environment might entail.

A proposal for openness

In this paper, we propose an understanding of our role as e-Government researchers that is centred on the pursuit of openness. Smith et al (2008) propose the concept of openness as follows:

"A way of organizing social activities for development benefits that favours:

- universal over restricted access to communication tools and information;

- universal over restricted participation in informal and formal groups/institutions;

- collaborative over centralized production of cultural, economic, or other content."

(Smith et al 2008)

Translated onto the landscape of university-based academic research, we understand openness a way of doing research that actively promotes:

- universal over restricted access to research products

- universal over restricted participation in the research process

- collaborative over centralized production of knowledge, and recognition of diversity in knowledge systems

Many of the theoretical ingredients for a research concept based on openness are already available. Higher education, development and information systems have all engaged with the issue of participation, whether from a pragmatic standpoint (arguing that involving more stakeholders achieves better outcomes) or an ideological one. The open access movement promotes universal access to research products, as do research initiatives with am ideological commitment to open source software. There is also an established critique of the monolithic and exclusionary nature of traditional academic knowledge production, which methodological approaches such as Action Research explicitly confront. These will be explored in the section that follows.

Contributing theory

Participatory methods have a long history in development studies, from Chambers (1995) through virtual ubiquity in mainstream development discourse (if not practice) and the "tyranny" of participation (Cooke & Kothari 2001). Information systems design has seen a parallel rise in user-centred methods, discernible as early as 1979 in Mumford's ETHICS methodology (Mumford & Weir 1979). Most mainstream work has emphasized the technical utility of user participation in IS, but there are also authors (including Mumford as well as Hirschheim & Klein 1994, Bryne & Sahay 2007, Blake & Tucker 2006) who take the more radical view. Participation is also not a panacea: Heeks' (1999) cautionary article is emphatic on the difficulties of achieving equitable and effective participation. The important point here is that, despite differing views on its purpose and regardless of the practical challenges it poses, the idea of participation enjoys broad support in both IS and development studies.

Research approaches privileging participation have also emerged, particularly connected to the ideas of socially responsive research and "democratizing knowledge" (Vaillancourt 2005). Action research, which is carried out through continuous engagement with the study community and encourages redefining research objectives based on their self-definition of needs (Rabinovitch 2004), is clearly aligned with participation. Here, too, there are both pragmatic and ideological justifications for increasing participation. Crewe & Young (2002), for example, take a pragmatic stance, arguing that wider participation may increase the relevance of research to policy by helping build "legitimacy chains" to informants. For Reason & Bradbury (2001) , on the other hand action research is:

> "a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes, grounded in a participatory worldview which we believe is emerging at this historical moment [..] in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities."

> Reason & Bradbury 2001

This definition recognizes action research as an expression of a specific worldview. It also makes explicit the normative orientation of this type of work, where the primary goal of the research is to effect change. Against positivist claims of an objective reality that exists apart from the research process, action research aims to influence the shifting, subjective 'reality' that is uncovered. Participation is a driver of change, but also a democratic means of allowing the frame of the people who will be directly affected to determine the kind of change that is desirable.

This shift away from the positivist paradigm of traditional scientific knowledge production is inherently political. Action research, in its rejection of monolithic knowledge claims, also rejects the objectivity claim of technical expertise. The "legitimating discourse" (Rojo van Dijk in Thompson 2004) of interventions based on a supposedly neutral technical goal (Wilson 1997) is similarly denied. In its place, Wilson (2006) imagines a continuous striving towards Habermas's "ideal speech situation", with "genuine dialogue between actors, where different knowledges are valued as a source of creative learning and hence new knowledge". The primary goal of the researcher becomes progressive attainment of the ideal speech situation.

There is also increasing recognition that knowledge is developed and used - and should be understood - within a particular context. Speaking to applied fields generally, Gibbons et al (1996) acknowledge context in their concept of "Mode 2" knowledge production - "socially distributed, application-oriented, trans-disciplinary, and subject to multiple accountabilities". Unlike in information systems design or the planning of development interventions, the assumption here is not simply that context should be taken into account as part of the design process. The context of knowledge production shapes the knowledge that is produced.

Incentive structures and unequal participation are as important as the way knowledge is communicated and disseminated. As Nowotny et al (2003) recognize in a follow-up article on the 'Mode 2' thesis, the reciprocity of "science speaking to society" and "society speaking back to science" is irrevocably marked by exclusion, and by global networks of wealth and power. In familiar dependency terms, Chambers (1999) laments the existence of "cores and peripheries of knowledge", with a devastating "centripetal force" that shapes knowledge production according to the priorities of the core.

A parallel body of work in science and technology studies is concerned with the social shaping of technology artefacts. The social shaping movement is concerned with the context and process of technology development, and with exposing the power structures it reflects and reinforces. Williams & Edge (1996) describe social shaping in terms of 'choices':

> Central to SST is the concept that there are 'choices' (though not necessarily conscious choices)inherent in both the design of individual artefacts and systems, and in the direction or *trajectory* of innovation programmes. If technology does not emerge from the unfolding of a predetermined logic or a single determinant, then innovation is a 'garden of forking paths'. Different routes are available, potentially leading to different technological outcomes. Significantly, these choices could have differing implications for society and for particular social groups.

(Williams & Edge 1996:866)

From the point of view of exclusion and 'capture' of innovation by the global core, this last point is key. The World Bank's Development Gateway project (Thompson 2004) is an unfortunate example of social shaping by a powerful development actor, to the detriment of local knowledge and local groups. The Development Gateway website, which includes approved, syndicated news as well as country profiles and edited lists of development organisations in each country, is derided by Thompson as "nothing less than an attempt to control the development discourse itself".

According to social shaping theory, an open system of innovation that enables effective primary control of technology by marginalised groups would result in better outcomes for these groups. This is likely unattainable, however, and even if it were, technology development never takes place in isolation. Kallinikos (2004) observes that human inventions "solidify over time" as they become socially embedded, and malleable along fewer and few dimensions as they increasingly impose their own logic. The choices we have now are determined by those who walked the path before us, and the long history of technology as a tool in the exercise of political and economic power.

Cases

This section draws concepts from the literature into a discussion of two ICT for service delivery projects in which the authors have been involved. The aim is to derive learning from practice in projects which, in various ways and with varying degrees of success, have tried to implement aspects of an open approach to e-government research.

Following brief descriptions of the cases, the discussion is organized into five areas. Four are inward-looking - namely knowledge production in academic research, social responsiveness and universities, system design and development, and teaching - while the final section on engagement with government and the private sector offers preliminary thoughts on the role of openness in wider networks.

Cell-Life and the iDART system

Cell-Life started in 2001 as a research collaboration between staff of the Engineering Faculty of the University of Cape Town (UCT) and the Cape Peninsula University of Technology (CPUT). As HIV prevalence rocketed, it became clear that the primary health sector would need extensive support to be able to provide sustainable treatment options for HIV positive people, particularly in under-resourced and rural areas. ICTs were identified as possible solution for creating a "virtual infrastructure" between the patient and the medical staff.

During the initial research phase, Cell-Life investigated the use of readily available technologies

(particularly mobile phones) to support the provision and distribution of medication, continuous patient monitoring, and communication of relevant administrative and evaluation data. The two main systems developed during this period were a mobile data collection tool for home-based carers (Skinner et al 2006, Natrass et al 2007) and iDART, a pharmacy management system for clinics dispensing antiretroviral drugs (ARVs) (Brown et al 2006, Brown et al 2007, Wood et al 2008). The research focus was the development of appropriate tools in new settings – for example, a large-scale rollout of antiretroviral drugs, which have strict compliance and treatment education requirements – as well as on understanding work processes and information flow. This was accomplished through techniques of paticipatory action research (PAR) and evolutionary software development, which in combination form basis of Blake & Tucker's Socially Aware Software Engineering approach (Blake & Tucker 2006).

In 2006 Cell-Life became a not-for-profit organisation and was spun out of the University of Cape Town. This coincided with a shift in focus from being primarily a research organisation to a mix of research and implementation support, prompted partly by the growing number of sites using the software and requiring such support. iDART currently (as of late 2009) manages the dispensation of ARVs to approximately 70 000 patients, representing one-sixth of South Africans on state- or donor-sponsored ART.

All software developed by Cell-Life is released under an open source license. This has enabled the rapid growth of the iDART system, which has several sites that have downloaded the software and are managing it independently. A strong reputation in the open source community has also led to collaborative work on other projects, including the JavaRosa consortium, which develops standards-based tools for mobile data collection.

Funding for development and implementation has come from various sources over the years, including an initial grant from the Vodacom Foundation to support technology development. Funding from donor with a focus on HIV/AIDS, including the Doris Duke Foundation and the Elton John AIDS Foundation, supported the implementation of the iDART system. Apart from a small initial grant from the National Research Foundation in South Africa, none of Cell-Life's funding sources have been traditional funders of research projects.

Mobile phones and drinking water quality: the Aquatest project

Aquatest is an international collaboration to develop a low-cost water test for the developing world. Initiated in 2006 under the EU sixth framework programme, the project secured funding from the Gates Foundation in 2007 for the period 2008-2011. The project consortium includes various British and American universities, the World Health Organization (WHO), to US-based non-profits who work in the water sector, and the Spatial Data Management group at the University of Cape

Town.

Our work in the Aquatest project involves investigating the potential uses of mobile technologies in drinking water quality monitoring, including communicating test results and providing emergency warning and follow-up in case of water quality problems. Like the earlier projects at Cell-Life, this is undertaken as a participatory action research, with functional prototype software being developed, used and evaluated in iterative and incremental process. Particular emphasis is placed on supporting evaluation and design by software users themselves. To do this, we are using unstructured narrative interviews ("tell me a story of how you have been using the system") and actively and opportunistically soliciting input into the concept and design of software features. There are currently four local municipalities participating in the project, with about 35 municipal foremen, environmental health professionals and community borehole caretakers reporting water test results on a regular basis.

Discussion

Knowledge production and communities of practice

Academic knowledge production is plagued by information silos, both in the way research is produced and in the dissemination process. Action research, in is rejection of positivist claims of independence and emphasis of consensus-building and co-ownership of the research process, aims to address the former. The emerging concept of communities of practice, based on shared experience and aligned goals (Soeftestad 2001), provides a lever to understanding the latter. In both production and dissemination, the researcher is understood as embedded within a wide community of information systems stakeholders (Blake & Tucker 2006; Byrne & Sahay 2007), with the ultimate aim of the research process to develop "actionable knowledge" (Hearn & Foth 2005) for a diverse group.

Openness in the research process, enacted in the collaborative development of software artefacts (as in Blake and Tucker's Socially Aware software engineering) but also in the broader context of the design and implementation of research projects, has been a key factor in developing long-term relationships between developers, implementers, researchers and stakeholder at project sites for both Cell-Life's work and the Aquatest project. In the case of Cell-Life's iDART system, Rivett and Tapson (2009) describe multi-stakeholder collaboration in the stakeholder community:

> "One of the key partners of the iDART development was the Reproductive Health Research Unit (RHRU) of the University of Witwatersrand. RHRU, being at the forefront of the newest developments in side effects, drug dispensing and other related matters, requested changes to

> iDART on a regular basis. The changes to the system would subsequently result in Cell-Life offering the updates to all other clinics, which benefitted in return from the knowledge of RHRU. A pharmacy assistant in a rural clinic in the North West province described iDART as 'a knowledge transfer system between universities and community clinics'."

(Rivett & Tapson 2009)

In the Aquatest project, the UCT Spatial Data Management team has become part of an existing collaboration, this time in the form of an open source projected developing tools for standards-based mobile data collection. The JavaRosa consortium, of which Cell-Life is one of the original members along with university groups, non-profit sector software companies and implementer organisations, works primarily in m-health, but develops generic, highly-customisable tools. Our involvement has given us the benefit of a wealth of knowledge in a field where cellphone systems have already been extensively tested. While collaborative software development is the primary activity of the community, its existence supports much broader knowledge sharing – both formally through mailing lists and project meetings, and informally through relationships between individuals and organisations.

Both situations fit well with the concept of communities of practice, but also highlight their heterogeneous nature. What constitutes "actionable knowledge" for a health sciences research group, a small IT-sector NGO and a pharmacy assistant at the frontlines of the HIV/AIDS epidemic is likely quite different. The success of iDART lies in the way the process (the implementation of a software system for ARV dispensing) and the artefact (the software itself) have been able to serve and engage diverse stakeholders. Being able to engage over an extended period, long enough for trust to be built and relationships to develop, has been a significant factor in allowing this to happen. The same applies to the JavaRosa consortium, which while a more technical group, is nevertheless heterogeneous in application area and in the kinds of organisations that contribute to the project. Over time, the co-development of the software system provides a concrete basis and a common point of reference for knowledge sharing.

The position of Cell-Life as an enduring organisation with multiple sources of funding is also noteworthy. Unlike most university-based research groups, where highly structured research projects are undertaken predetermined activities and goals, Cell-Life has been able to undertake small pieces of implementation work which bring experience and build the community. Acting as custodians of the iDART system has also given the organisation a formal intermediary role, facilitating knowledge sharing between between heterogeneous groups. Several core groups in the JavaRosa project are in a similar position, with the added advantage of wider geographical reach.

The concept of communities of practice is useful in understanding the interplay between research and practice, but also between e-government research and IS policy. Development research in general is undesirably disconnected from policy, and traditional academic work, delineated by narrow specialisations, offers no incentive to consider the complex political and structural/institutional limits under which policymakers work (Crewe & Young 2002). In the same way, the practical, inward-looking orientation of e-Government obscures a discord between isolated study cases and the ICT ecosystem in which they emerge. Academic work on failed e-government projects is often highly critical, particularly where questions of expenditure and returns are concerned. This may be useful in accountability terms (although the persistence of expensive and contentious failures suggests some limitations), but does little to promote mutually influential relationships between researchers and policymakers.

To our minds, this remains an open question. Case-based e-government research is clearly important because it allows the context of specific cases to emerge. However, researchers' interpretations of the context can still be singularly unhelpful in the constricted world of government policy. This is turn fosters negative perceptions of the potential contribution of academic research. Action research, in which the researcher has a stake in delivering a solution that 'works' for all participants, may provide more useful incentives in this regard. The challenge then becomes balancing academic rigour with the awkward compromises that arise from a process where everything is understood to be less than ideal.

Social responsiveness in universities

Despite being defined by their role as producers and disseminators of knowledge, the position of universities in socially responsive research is often fraught. The challenge of university research is that whilst being publicly funded it does not necessarily in the first instance respond to societies needs. Research projects developed within one discipline and disseminated through discipline-specific peer-reviewed publications in journals are still the accepted norm in universities throughout the world. The success of a university is defined by its position on league tables, however contentious this may be (Usher et al. 2006, Strathern 2000), and journal publications determine league table rankings. This dominant system of producing and dissemination knowledge is often wholly unhelpful in thinking about social problems, which by nature are multidisciplinary and seldom experienced by readers of academic journals.

To reconceptualise our role and to address the challenges highlighted above it is important to grapple with what an enabling environment for e-government research would look like. Arguably, universities are still best positioned to develop such an enabling environment, if they can address

the barriers to knowledge sharing that currently exist. Partnerships across disciplines are key to the success of redefining research. A particularly concrete barrier is the cost centre approach to research projects, resulting in all projects being hosted within one department or faculty for financial reason therefore tacitly discouraging cross- and multi-disciplinary research. Cell-Life, which ran projects between the faculties of health science, engineering and commerce at various stages, constantly encountered barriers to inter-faculty collaboration.

Knowledge sharing as well as the dissemination of knowledge is another area that requires re-thinking. The current focus on publication in journals, as well as IP policies that seem to bedevil the ability to share knowledge require formal mechanisms to exempt certain research and initiatives from the stringent criteria (Rivett & Tapson 2009). The concept of collaborative open source development, where ownership of the codebase is sometimes shared among many groups, is often poorly understood by university IP departments, and poorly addressed in existing guidelines. In the case of the Aquatest project, prior work done by Cell-Life in engaging with university management on IP issues was of clear benefit, as the major concerns of both sides had already been aired and addressed.

A further shift is required in the move from a closed system of expertise, with the researcher as the expert and research participants as subjects, to open collaboration and co-ownership of the research process. This requires challenging the traditional role of the researcher at a profound level. Instead of setting the agenda, deciding on the survey methodologies and the analysis tool, the emphasis would move to a shared learning approach. This fundamental shift results in the researcher giving up control and becoming a facilitator rather than a "principal investigator". It also requires that the attitude of extracting information from a research subject becomes an engaging attitude that results in benefitting both, the researcher and the community.

One of the potential pitfalls of this type of approach could be that a high level of attention has to be given to the "positionalities and subjectivities" inherent in social research (Kindon et al.,2007). The "facilitator" role of the researcher raises the question of how research and its impact are evaluated. Currently evaluations of research projects often go hand-in-hand with the requirements of funders to ensure quality and to measure impact of the provided funding. Another challenge is that evaluations are similarly to research methodology designed in the beginning of a project, which leaves little room or flexibility for evaluation to change whilst the process of the research project unfolds. The process of research is therefore pre-defined and does not allow an "emerging" and evolutionary development of the evaluation method.

In addition, the research subjects or participants in the study get evaluated rather than doing the

evaluations, i.e. the feedback is a single stream of information in one direction. A good example for this is the extensive evaluations of the PEPFAR programme, which require approximately 40 performance indicators from each research collaborator to be reported on. The reporting itself does not require patient input, it is a mere exercise of counting (Navario 2009). In some of the work we have done in the Aquatest project, we have tried to get participants to walk through an evaluation questionnaire that prompts them to form their own evaluation of what works and what doesn't. This has been successful and valuable in a small project, but would data collection and analysis would obviously be difficult to take to scale. Nevertheless, an open approach to evaluation does seem to demand a more diverse set of voices, and wider access to the results and process of the evaluation.

Two final points on the position of universities emerges from Chambers' concept of 'cores and peripheries' of knowledge. Barriers to access thrown up by academic publishing, vocally condemned by the open access movement, meant that many of the books and articles flagged during our literature search for this article were not available in local libraries or as part of our institution's electronic journal subscription. Cost is a major barrier, but infrastructure is another. In late 2008, Amazon suspended delivery to South Africa by all methods other than extremely expensive premium courier services, apparently because of unacceptable losses through the local postal service. At the same time, Amazon was setting up a South African office, hiring highly skilled IT professionals trained by local universities. Communication networks – in this case the postal service – maintain the separation between the core and the periphery, will simultaneously enabling selective incorporation of knowledge resources.

System design and development

In the vast majority of cases, IT systems are acquired by management, developed by technologists and provided to passive 'users' of systems and services. The software development process is closed off to context, with failure a frequent consequence. Developing world systems design methodologies and the products and business models of commercial vendors emulate western, business-oriented models. Progress, narrowly conceived, is premised on the acquisition of 'modern' technology and overseas expertise.

In Cell-Life and the Aquatest project, we have tried to enact a shift toward openness in the technologies with work with - preferring open source and open standards - and in the system development process through the use of iterative and incremental methods, evolutionary prototyping and participatory design. This requires a shift in attitude from both the developers of the system and the various user groups. Developers, schooled as technical experts, they must learn to be guided by the experience of people who are often profoundly different to themselves. Users, for

whom previous engagement with software systems is almost always as passive recipients, need to work with concepts that are often poorly defined or explained, and must balance their involvement with all their existing work responsibilities.

This last point has been key to our decision to use working prototypes, which allow users to form opinions based on actual experience of the system, which can then feed into iteratively revised design. Where software users experience the system as malleable, they are more likely to provide constructive feedback on changes to the initial design. Similarly, designers and developers who have spent time with system users, soliciting feedback with a mandate to respond to and explore their needs, have become an important proxy for users in prioritizing problem areas.

This is, of course, a balancing act, and one that becomes particularly difficult once the research aspect of a project becomes secondary to considerations of scale. In the iDART project, pressure to make small, individually-requested changes to the system to protect personal relationships combined with the need to maintain the technical integrity of the code base and to align development priorities with funding, placing significant strain on the development team. At the same time, relationships have immense value in building and maintaining communities of practice, which in sustain knowledge sharing far beyond the software itself. This suggests the need for a broader view of the goals of the software development process, as well as the skills required to manage it.

Teaching

The perspective shift described in the previous sections has highlighted a need to reconsider the skill set of researchers and practitioners of e-government. At the level of universities, this means reviewing what is currently taught across a wide range of disciplines, as well as critical consideration of areas in which, as with research, disciplinary boundaries to teaching are limited in their ability to promote socially responsive approaches. Unfortunately, curricula reviews of existing programmes are often biased towards integrating new developments from the developed world. The phrase 'world-class' epitomises the pressure on educators to keep up with global advances, regardless of what is most appropriate in the local context. Attempts to re-define curricula based on local needs faces immense barriers, not least in the attitudes of students themselves. Accreditation processes, which specify fixed requirements for curriculum content, impose additional limitations.

The area in which both Aquatest and Cell-Life have been most successful at influencing teaching and learning is the supervision of student research projects. Both iDART and the Aquatest cellphone

system were developed in the initial stages as student research. Students benefit by engaging in research within a diverse community of stakeholders, many of whom have very different experiences to their own. Our experience has also been that students who are exposed to socially responsive research often continue to incorporate a development orientation in future work. If the role of universities to serve the public good, sensitising students to the development potential of their field is extremely valuable.

Engagement with government and the private sector

Government information systems, essential to service delivery yet prone to expensive failure, are an important subject for socially responsive research. Appropriate and sustainable information systems cannot, however, be developed through research alone. Engagement with multiple levels of government is essential to ensure not only the fit of the system in its immediate context, but also its position in relation to other systems and policy directions. Engagement with the private sector is needed to establish support for the system and the community beyond the existence of a research project. To generate 'actionable knowledge' for the entire scope and life cycle of public sector IS projects, government, business and academia, operating on differing assumptions and often with quite different worldviews, need to find ways to work together.

Here again, we are indebted to the process focus of action research, and its role in the development of multi-stakeholder communities of practice. The e-government literature has explored productive engagement with government, but perhaps failed to emphasise the long timelines necessitated by approval processes, staffing constraints and budget processes. Where aspects of the system are new and poorly specified, a research group may be better placed than a private company to facilitate the early stages of this process. This was the case in Cell-Life's iDART project, with the initial research focus allowing the systems requirements of a new field – antiretroviral dispensing – to emerge (Brown et al 2006). As the focus shifted to broader implementation, the need for flexibility beyond what was available in a university environment resulted in Cell-Life being spun off as a separate non-profit entity. IP policies (in Cell-Life's case, the university's acceptance of an open source model) also need to be flexible enough to accommodate the shift.

In the Aquatest project, we have worked with a private company (Emanti Management) to ensure that the systems we are testing fit with their work in implementing water quality information systems, which they are contracted by government to undertake. This engagement has also has interesting learnings about openness and the relationship between universities and private companies. Significant initial work went into defining our role as researchers, which was initially perceived as using grant money to compete in their field. Over the course of the engagement the

concept of openness has allowed both parties to define their roles more clearly – us as developers of open source software and innovators in the field, and them as beneficiaries of innovation, and key informants of pathways to sustainability.

Conclusion

The ideal of open research practice translates imperfectly onto the complex landscape of government service delivery – a 'problem situation' in the development sense, with multiple stakeholders and differing rationalities. In both system design and research, attempts to engage using participatory methods are both highly valuable, and severely constrained by the time-limited nature of participants work. At the same time, evolutionary prototyping has proven a valuable way of eliciting user participation in system design (Brown et al 2007), and participatory action research has contributed to the development of communities of practice with diverse stakeholder involvement.

We have also established the value of a longitudinal action research approach, where projects are developed over the course of several years, and narrative methods that help to build a shared, context-sensitive understanding of the system (Greenhalgh et al 2005; Lopez-Garay 2002). Openness and co-creation is impossible without relationships at ground level, built in increments as trust is established and in turn fundamental to the process of shared development. The concept of openness is useful in itself as a way for stakeholders to understand their relationship to eachother, and the roles, responsibilities and potential benefits this entails. Openness also supports flexible systems and communities, able to reconfigure themselves over the life cycle of the system.

Socially responsive research in government informations systems requires a far wider range of expertise than is usually available in the limited fields of information systems and computer science. University structures also need to accommodate projects that span across disciplines and have long timelines, diverse stakeholders and non-traditional knowledge outcomes. Experience within the university in managing these kinds of projects can lead to productive engagement, as can efforts to increase awareness of open approaches to research.

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