Sustainability of collaborative information system development projects – a North-South case study

Abstract

There are attempts of developing countries to move from a predominant consumer-orientation to become more active producers of software and information systems (IS), thereby reaching a better, more self-determined position to solve local problems. To achieve success of IS development projects, sustainability plays a critical role. This paper examines the concept of sustainability and its common underlying characteristics, and then derives key principles of sustainability from a case study of a North-South IS development project. Collaborative IS development is characterized by several levels of interconnections and issues of ownership and control. IS development projects run through several phases and have to keep up with changing requirements of the implementing organization, hence external consultancy by donor projects typically covers only limited phases of the IS life cycle. Nevertheless, projects can facilitate sustainable outcomes by a focus on utility, capabilities and embedding.

1. Introduction

Software development has attracted a relatively limited degree as a way of solving local problems in developing country contexts. In a few countries, such as in India, software development has become more prominent, but often the focus is on export rather than on achieving local social and community objectives (Ezer, 2006). Despite certain efforts to facilitate local system development (Korpela, Mursu & Soriyan, 2000; Keats, 2007), many projects have been undertaken by transferring technology from industrialized countries to developing countries (Macome, 2007), with a visible interest in open source software (Reijswoud & Mulo, 2006). However, many consider foreign technology import on its own as not being optimal for local socio-economic development. For example, the African Information Society Initiative states that "Africa needs to enter into the information age as a developer, not as a consumer". Africa needs to become "less dependent on outside software producers and developers" and Africans have the "right to make [their] own choice" (UNECA, 2010, p. 3). Similarly, Gurstein (2003) argues that for development to occur and to overcome the digital divide, individuals and communities need to become producers, not only consumers, so that they can make "effective use" of ICTs. This implies developing a strong "local skills base" (NACI, 2002, p. 15) and supportive organizational structures. Nurturing conditions for local solutions is motivated for example in the following statement:

> "As the number of ICT projects in Africa increases, the skills of the internal workforce to implement all these projects become less and less sufficient. This calls for the development of strong skills internally, instead of a dominant external consultancy" (Massingue, 2003, proposition 4).

These perspectives are indications for both the relevance and the intention of becoming active participants in the information society, of becoming independent enough from foreign technology to locally take control of the future and be able to solve local issues.

Solutions to technology related problems can be rooted anywhere in the spectrum between 'make' and 'buy' (Baark & Heeks, 1999). Buying off-the-shelf packages can be a good choice if the required functionality is covered by existing packages, such as in the case of operating systems and office applications. If there are no appropriate packages available that cover full or part of the requirements, then some local software development may be inevitable to achieve intended goals. Local software development then can range from a few adaptations of existing software to full system development, either within a single organization or collaboration between several organizations and individuals. Baark and Heeks (1999) distinguish seven levels of technological capabilities. The scale ranges from level 1, "non-production operational capabilities", to level 7, "innovative production". Baark and Heeks (1999) evaluated four Chinese technology projects and observed that at best, local developments lay around level 5, "minor production modification".

There are strong roadblocks against local software development efforts. Standard software packages are often cheaper and higher quality than local development of such packages can provide, despite the potential of low-cost labor. This situation is intensified by widespread piracy. In addition, there is often a preference for foreign software. In sum, there is a domination of imported packages in many application areas (Heeks, 1999). But other types of systems are not as easily available, such as appropriate organizational information systems and custom applications. Moreover, systems often need to be adapted and extended. The absence of local software development activities then prevents local communities and organizations to progress and resolve pressing issues. Furthermore, local context is important to be taken into account (Avgerou, 2001), but the limitations of commercial off-the-shelf packages and methodologies in the context of developing countries is increasingly recognized (Reijswoud, 2009).

There is a discourse on success and failure of IS in developing countries (Avgerou, 2008). Sustainability is one relevant aspect of overall IS success in this context (Krishna & Walsham, 2005; Heeks, 2002b). The remainder of this paper firstly elaborates aspects of success of IS initiatives in developing countries. Thereafter, sustainability and its relationship to success are examined. Next, a case study looks at sustainability issues related to collaborative IS development. Finally, some conclusions are given.

2. IS success in developing countries

Heeks (2002b) defines success for an IS initiative in developing countries as one in which "most stakeholder groups attain their major goals and do not experience significant undesirable outcomes" (p. 102). Two key problems have been observed in successful implementation of IS (Sahay & Avgerou, 2002):

1. Many organizations have difficulties in nurturing and cultivating complex technology projects over the long periods of time that are typically required

2. Resulting systems may have little impact on the organizational weaknesses they were intended to alleviate.

In the IS field it has been understood that there are several dimensions to success. For examples, Bostrom and Heinan (1977) distinguished between social and technical issues, by viewing IS as socio-technical

systems. In the developing country context, Barrett, Sahay and Walsham (2001) have identified trust relationships as being important, both between stakeholders and towards new technology. Political and cultural issues have also been documented (Nicholson & Sahay, 2001).

There are two different approaches towards measuring success: On the one hand, normative models that seek to establish relationships between independent and dependent variables (DeLone & McLean, 1992). On the other hand, contingency models try to resolve criticism towards normative models about being too prescriptive and failing to take account of differing contexts. Contingency models try to avoid a single blueprint for success and change, so that situation-specific factors can be included in finding strategies for success. An example of a contingency based model is ITPOSMO (Heeks, 2002b), which declares several dimensions of gaps between reality and the design of a newly implemented information system. Larger design-reality gaps weaken the probability of success. When transferring industrialized country design to developing country realities, in many cases the gaps are large.

According to Krishna and Walsham (2005), factors that contribute to success of IS initiatives in developing countries are committed leadership, the involvement of multiple groups, and a people orientation that tries to work with existing skills in the given context. Bass (2009) argues that in cases where new skills have to be built, they should be built incrementally over time. If senior management support is given and the project coincides with the technical objectives of team members, then skills and confidence grow and the level of technical supervision declines. Joubert (2007) criticizes an excessive focus on social factors in the literature on IS success in developing countries and emphasizes "certain basic technical requirements that are non-negotiable". He recommends balancing two dimensions of capabilities, a technical skill set, and project management skills. Bridges.org (n.d.) recommends a set of 12 best practices ("habits") to realize highly effective ICT-enabled development initiatives, covering all phases of such interventions.

3. Sustainability

Sustainability is different from success. For example, it is possible to sustain a project that does not deliver goals for most stakeholders. On the other hand, failure to sustain a project after initial implementation is a form of sustainability failure (Heeks, 2002b). In other words, a completed project is a weaker measure of success than a sustainable project (Bass, 2009). In a developing country context, Krishna and Walsham (2005) have two criteria for successful IS implementation. First, most stakeholder groups attain their major goals and do not experience undesirable outcomes (Heeks, 2002b). The second criteria is sustainability of the IS initiative.

Sustainability is thus one factor contributing to success. Walsham and Sahay (2006) consider it an important, but neglected key issue. Only sustainable ICT projects can support long-term socio-economic development, and sustainability is a particularly important issue for developing countries, given the strong reliance on temporary donor funds. Such external support is eventually withdrawn and poses a risk for the continuity of projects (Heeks, 2005). Gomez, Martínez and Reilly (2001) emphasize that ICT4D solutions need to be "complementary to sustainable development" (p. 113).

But what do we mean generally with sustainability and sustainable development, and particularly in the context of IS projects in developing countries? Common underlying characteristics of many streams of thought concerning sustainable development are (SD Gateway, n.d.):

- Concern for equity and fairness: inclusion of less privileged and future stakeholders

- Long-term view: short-term view of project implementers versus long-term interests of beneficiaries

- System thinking: interrelations between all aspects of systems, and consequences of decisions

Brundtland (1987) is often cited for the definition of sustainable development as one that meets the needs of the present without compromising the ability of future generations to meet their own need. Although sustainability has been associated often with environmental concerns, the ideas of sustainability and sustainable development have entered many fields, such as human societies, cultural traditions or social institutions. Sustainability is therefore an "umbrella concept" (Loukola & Kyllönen, 2005). Hence, it is necessary to investigate what sustainability means in a particular scientific field. A context independent statement about sustainability is the following:

> "The key component of the concept of sustainability is a requirement for the sustenance, survival, or flourishing of a process, an organism, or a resource. The viewpoint here is broader than usual: the entity to be sustained often consists of a large variety of interacting factors in a complicated setting." (Loukola & Kyllönen, 2005, p. 2)

In the case of information systems, it is not trivial to state the entity to be sustained. Information systems are more than technical artifacts, but also comprise the people working with them and the processed information. A further perspective is that of sustainability being a property arising out of the interactions among stakeholders, sustainability as being negotiated (Batchelor & Norrish, 2002).

With the dominance of donor funded projects, some describe sustainability as 'the ability of a project or intervention to continue in existence after the implementing agency has departed' (Harris, Kumar & Balaji, 2003, p. 2; Bailey, 2009).

For ICT projects in developing country contexts a varying set of sustainability categories has been put forward (Batchelor and Norrish, 2002; Cisler, 2002; Kumar, 2004; Bailur, 2007):

- Financial sustainability

- Social/cultural sustainability: achieved when social exclusion is minimized and social equity maximized.

- Political/institutional sustainability: achieved when prevailing structures and processes have the capacity to continue to perform their functions over the long term; related to the phenomenon of resistance to change, particularly if vested interests are at stake.

- Technical sustainability

Heeks (2005) formulates a somewhat more tangible view of sustainability categories for what he calls e-

development projects, that is, projects that use electronic ICTs to support development (Heeks, 2002a):

- Capacity: Availability of resources such as money, skills, data and technology.

- Utility: continuously meet the needs of at least some stakeholders

- Embedding: institutionalization; embedding the system in local rules, norms, culture

In comparison with the previously listed categories, *capacity* has a broader scope than financial sustainability and includes also other resources. *Utility* and *embedding* represent core aspects of social and political sustainability, respectively, of particular relevance to the field of e-development projects. Of these three points, Heeks considers utility as pivotal, because "if some key local stakeholders continue to find the project useful, they are likely to facilitate the capacities, and support the embedding". Baark and Heeks (1999) emphasize sustainability of skills, because they are easily overlooked because "they are intangible and they may not be included in project objectives" (p. 193).

Best practices to sustain ICT enabled development initiatives in developing countries are for example given by Bridges.org (n.d.), who advises to either bring in sufficient income to be self-sustaining, or to deliver on a social mission that is worth of continued donor funding. Drawing from observations of a set of infoDev projects Batchelor and Norrish (2002) state that long-term development goals in ICT4D projects can be achieved with the provision of several capital assets, which comprise financial capital, physical capital, social capital, human capital and content capital. Munyua (2000) argues that sustainability should not only be considered right from the outset, but where possible, have support from government, community and the private sector.

An alternative approach is based on skepticism if sustainability is at all a worthwhile goal in e-development projects. Ali and Bailur (2007) prefer a focus on unintended consequences of technology and improvisation, and on embracing the resulting unintended innovations.

4. Case study

In this section, the case is analyzed with respect to the three aspects of sustainable development: equity and fairness, long-term view, and systems thinking. In order to achieve rigor, this paper follows Weber's (2009) recommendations to apply Eisenhardt's (1989) criteria for conducting case studies, and to apply Klein and Myers' (1999) principles for the analysis of qualitative data. In the following, the case study and data analysis method are described. Then, the project is analyzed.

4.1.   Case study design

Data collection was done mainly by participative observation during the project period. Basic quantitative evidence was collected such as the number of universities that successfully implemented the academic registry IS, and the number of users. Successful implementation is understood here in a sense that "the system is used frequently by organization members or that it is considered valuable for work activities or coordination" (Walsham, 1993, p. 210). This basic quantitative data was combined with qualitative data to

find explanations. While the project itself is a single case, its implementation at various Mozambican universities provides experiences and data from various sources. The set of investigators comprised a participant observer locally involved at a Mozambican university, an actively involved project manager located at a university in the Netherlands, and a researcher out of the field. This is a tactic described by Eisenhardt (1989) to bring a more objective eye to the evidence. The hypothesis was built iteratively through circles of observing data, analyzing data and discussions among investigators.

4.2.   Qualitative data analysis considerations

During several years as a participating researcher a vast amount of observations were made, and interpreting data is inevitably subjective. The principle of the hermeneutic circle is considered by Klein and Myers (1999) as the most fundamental principle upon which the others expand. The concept of the hermeneutic circle is that understanding a complex whole is achieved by iterating between considerations concerning the meaning of the parts and of the whole that they shape. This iterative form of understanding applies to a wide variety of items such as the interpretation of written text. In fact, it is suggested that all human understanding is achieved in this form.

Specific characteristics of the conduct of this study include the rather strong involvement of the researcher into practical project activities, and his European heritage. Both affect the interaction between researcher and subjects. Researchers as well as all other participants can be seen as interpreters, "as they alter their horizons by the appropriation of concepts used by IS researchers ... and other parties interacting with them" (Klein & Myers 1999, p. 74). This point weighs particularly strong since the researcher gave his input to, and thereby influenced, different people involved in the project on various topics such as software development, collaboration between distant participants in Africa and Europe, and on the implementation of the IS at Mozambican universities. To report on one's own role is particularly challenging as such an involved researcher (Walsham, 1995). But at the same time this deep involvement allowed rich observations in many aspects of the project, by having an insider view and being part of day-to-day activities (Prasad, 2009).

Data was primarily collected through participant observation and informal interviews. In contrast to Western culture, written documents play a less important role for project coordination and management in the given context. Mosse and Sahay (2003) noted in a case study in the health sector in Mozambique that co-location and face-to-face interaction are the basis of existing dominant ways of communication. Even though their study was located in a more rural setting, the same was also observed in this study. Hence, despite the existence of some formal project documentation, data was gathered mostly by direct communication, as well as during project workshops. Furthermore, email and Skype communication played a role.

4.3.   Project analysis

In the following, a description of project activities is given from a sustainability perspective. The project had the aim of developing an academic registry information system (ARIS). This includes the administration of data concerning students, study programs and exams.

4.3.1. Historic perspective

A need for appropriate administration of academic records became prevalent at Mozambican universities during the early 2000's when student numbers were rising throughout the country. Hence, a North-South project was initiated, with the aim of searching for possible solutions. Five Mozambican universities were invited to participate as direct project beneficiaries. The Ministry of Education and Culture (MEC) acted as the local coordinating unit. The project period was initially set to a period from 2005 to 2009. A few remaining activities are still under way during 2010.

Prior to this particular intervention project, Mozambican universities mostly used Excel sheets to administer student related information. In some cases, home-grown database systems were in place. Overall, these solutions did either not scale to the rising number of students, or had limited functionality.

4.3.2. IS development

The evaluation of already existing academic registry information systems, both commercial and free software systems, did not suggest a convincing candidate. Hence an IS development process was initiated. Requirements engineering and evaluation of system increments were done in a joint manner; these were occasions when participants from North and South gathered to exchange information, ideas and feedback, in order to steer design and development in a satisfactory direction for the participants. But although all participants agreed on the need for such as system, commitment remained low outside these workshops. 'Homework' style assignments for the time between joint meetings were hardly ever done, so that IS development largely remained with participants from the North. Also the adoption of a modular architecture did not have the intended effect of stimulating local involvement.

4.3.3. Implementation

IS design and development took up a large amount of the overall project time; therefore little time was left to guide the universities in their implementation. Universities had difficulties in effectively use the system in their organizations. At the same time, because the end of the North-South project had approached, the system could not be improved anymore by project partners from the North as a reaction to difficulties that emerged during system use at the workplaces.

Despite these difficulties, the system was implemented at two of the five universities. At one of the universities, this was facilitated by the presence of external consultants, which took the form of a "long-lived relationship between consultant and partner organization" (Bass, 2009). This constellation enabled establishing a small internal software development unit that was concerned with adapting and improving the information system as required. A series of system improvements were made, which were triggered by feedback from user experiences. Such feedback was acquired partly during training sessions at the work place, partly by users actively calling for support, and partly by consultants approaching users from time to time. The system improvements were done on the central code base, so that other implementing universities could benefit from these improvements.

4.3.4. Support and maintenance

In those universities and faculties where internal support was available and users were sufficiently approving of the new system, day-to-day use facilitated learning between users, so that certain skills were internalized. Similarly, where software developers were participating during considerable time spans, they gained skills and were even able to communicate with developers outside their institution, e.g. via mailing list.

To maintain the system and to support the universities in the long run, a support center was envisioned. The locally still underdeveloped private sector in the information system services sector was not considered a viable option. The decision making process of who would host such a support center, as well as its establishment, were both tedious. They were overshadowed by a pursuit of getting hold of certain project funds and eventually government and university funds for carrying out such support services.

4.3.5. Further issues

Another area of conflict concerned the ownership of the resulting source code. Certainly the money-making potential of the given, ready-to-use, information system played a role. However, there were several factors to be considered. First, despite low levels of local commitment towards active system development, a variety of participants from different organizations had made a contribution to the system, so transferring intellectual property rights could have been an issue – at least a moral one. Secondly, the system was chosen as a candidate to be further improved and adapted during a follow-up North-South project with two universities in neighboring Zambia. After discussions between stakeholders, eventually it was found that an open source model would be an acceptable compromise to everybody involved.

4.4. Discussion

This subsection discusses several aspects from the project analysis in the former subsection.

4.4.1. Long-term view

The project analysis shows that a single donor-funded project may not be able to guide all the stages of the information system's life cycle. Evaluation, design and development consumed almost all of the project time, so that there was hardly any time left for implementation, not to mention time for later stages. The intended beneficiaries did not receive much needed guidance during the implementation at their universities. Furthermore, information system development does not stop once a system has been implemented in organizations. Naturally, over time new requirements emerge in organizations, and information systems need to be adapted correspondingly. Intervention projects can only cover a limited period of this evolutionary process and should be concerned to leave behind proper conditions that enable the participants in the South to sustain the information system in subsequent life cycle stages.

4.4.2. Equity/Fairness

The academic registry information system has been jointly developed, because in-house solutions such as

Excel sheets and small databases were found to be insufficient, and a "better" solution was desired. Inevitably, issues of ownership and control emerged. The equity and fairness principle suggests including those less privileged to benefit from project outcomes. While an intervention project itself may be geared towards their inclusion, it remains an ongoing political issue to balance ownership and control of source code and possibly other resources. Furthermore, the differences in implementation success and the establishment of a local skills base in the different universities give some indications concerning the issue of catering for future users, who also need a chance to acquire the skills once it's their turn to use the system. Day-to-day work of the users played an important role in this respect. The free availability of the source code adds a further dimension to equity and fairness.

4.4.3. Systems thinking

Several interrelations could be observed. First, this is a system that is implemented at various organizations, but whose source code is maintained in a central repository. Although a modular architecture potentially facilitates collaborative development, other factors can impede active participation, as could be observed during the project, including an absence of technical skills as well as political issues.

Secondly, during the implementation phase it could be observed that there was interrelatedness between the act of embedding the system into local processes and norms, and corresponding system improvements. Such feedback cycles both improved the utility of the system and provided support to users.

4.4.4. Key points for utility, embedding and capacity

Table 1 lists a set of activities that affect sustainability categories of utility, embedding and capacity (Heeks, 2002a). Activities grouped under utility also drive activities in the other two categories, embedding and capacity. A focus on implementation not only makes the value of a new IS more visible to users, but is also a motivating factor to build local developer skills at implementing organizations.

Table 1. Key points for utility, embedding and capacity

Utility (social sustainability)	
Collaborative software development	Availability of IS that would not be feasible otherwise
Focus on implementation	IS shall be considered valuable for work activities and used frequently
Feedback cycles to guide system improvements	Minimize the gap between use information and system innovation
Modularity	Better adaptability of the system to specific characteristics of the organizational context
Embedding (political sustainability)	
Workplace based training	Train users in their working environment, solving real-world tasks
Make other beneficiaries users of the system (e.g. managers, teachers)	Involve also other beneficiaries to make the value of the system transparent to a broader set of

	stakeholders.
Open source licensing	Provide a framework for issues of ownership and control, and make available to a wide user base
Capacity (Skills, financial and other resources)	
Developers at local organization	To allow organizations to feedback user experience and make them self-sufficient concerning technical maintenance.
User training, including guidance in day-to-day use	A wide array of user training activities, including joint workshops and day-to-day guidance at their workplace.

5. Conclusions

The concept of sustainability has entered a wide range of scientific areas. There are certain common underlying characteristics of sustainability that are context-independent, but there is also considerable field-specific variation in how these underlying characteristics emerge. In ICT4D projects sustainability has often been subdivided into a set of categories, each of which needs to be sustained, e.g. Heeks' classification in sustaining capacity, utility and embedding.

For projects that include software development there are additional sustainability concerns, in comparison to projects that transfer foreign technology to local contexts without local innovation. For software development projects, code needs to be maintained and evolved, which adds complexity regarding ownership, control and coordination. But it also opens up possibilities for IS sustainability and success. Software developers need to create and blossom their skills base, which can be facilitated by the provision of access to the source code and collaboration on an inter-institutional level. The interrelations between user feedback and system quality improvements can be exploited with certain closeness between users and developers that have positive impact on utility and embedding.

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