

Sustainability Factors for Information Systems in Developing Countries – Academic Registry Information System in Mozambique

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Abstract: The Ph. D. thesis shall investigate ways to develop and implement information systems in a sustainable way in developing economies, where resources are scarce. The goal is to identify relevant entities and stakeholders, their goals, and how their actions influence these goals. This will enable us to understand the problems typically encountered in information system implementation. The goal is to discover the factors which are most relevant in different forms of information system development and implementation methodologies.

The focus is on the “outside” view of the system. So we perceive the information system as an entity with a number of properties that can react on a number of requests in a well-defined way. We will concentrate on organizational, managerial aspects as well as technical aspects in terms of manageability and acceptance of the information system. We will focus on these aspects in order to describe the behavior of the system in its environment.

The environment in developing economy contexts is characterized by scarce infrastructural and human resources, as well as unclear and quickly changing policies. Scarce resources and policy volatility are major hurdles to a stable and reliable information system and the organizations supporting it.

In order to implement information systems in a sustainable way the challenge is to establish the right environment for information system implementation and to ensure that the people who are using, managing and developing these systems receive the proper guidance so that implementation meets expectations.

Keywords: Information systems , ICT in developing countries, Development cooperation, Participation of target groups, Software Support, Open Source

Problem statement

When implementing information systems in developing countries a lot can go wrong. To avoid getting lost in a myriad of interwoven problems, it is essential to be aware of pitfalls and minimize risks. It is easy to lose user acceptance during the process of implementation, and once it is lost it can be hard to regain it.

A particular challenge is to sustain working informations system over long periods of time. Hence, the purpose of this study is to identify factors to improve sustainability in information system development and implementation in developing countries. More precisely, the term sustainability is viewed as to sustain ICT-based projects over long periods of time with appropriate resources, including money and people (Walsham & Sahay, 2006).

According to Heeks (2002) it is difficult to assess the amount of information system failure in developing countries, but there is some evidence that failure rates are considerably higher than in industrialized countries. And information system failure is a real problem for developing countries for several reasons, including the absence of learning from failure and the high opportunity costs because of the limited availability of capital and skilled labour. These failures further deepen the digital divide.

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It is not possible to list all possible failure sources, but many fall into one of three kinds: organizational issues, system development issues, and management issues. Given the scarcity of local resources, information systems are often implemented within development cooperation projects between a partner from an industrialized country (typically referred to as donor) and an organization or a group of organizations in the developing country. There are special chances, but also challenges associated with this constellation.

At the beginning of an information system project the implementing organization is challenged with selecting a proper implementation process and preparing the necessary conditions within the organization. Both processes can be difficult. Organizations in some cases start over again several times searching for the right information system for a particular task when first attempts do not work satisfactorily and are considered failures. The introduction of a new information system often needs organizational development like human resources capacity building. But which and how much competency is needed within the organization and how much is a realistic goal given local conditions?

Especially in developing cooperation projects there is typically a difference not only in knowledge but in culture. In this context, participation by local stakeholders and knowledge transfer between the cooperation partners becomes a difficult task. Furthermore, when the project's cooperation phase ends, local stakeholders are too often not prepared to take over the responsibilities to provide for a smooth functioning of the information system after it has been implemented.

In the design of an information system, the context of resource scarcity needs to be taken into account so that it is easy to manage the system in the future and develop it further. Unfortunately, if the design is not well done it makes it less probable that the system will be used well and further developed given the situation of limited availability of skilled human resources. But which are the design issues that can lower the burden on human resources?

Critical to the acceptance of the users as well as to the probability of survival of the information system as such is the provision of effective support. Different organizations have different internal capacity and while some might be able to resolve problems internally, others need to rely on external support. Ensuring effective support needs to be part of most development cooperation projects, but is hard enough to ensure success.

The document is organized as follows. Subsequently follow descriptions of the context in which the study is carried out and the conceptual framework. After that the research objectives, the scope, the justification and the significance of the study are elaborated. Then the research objectives are broken down into more particular research questions. Another chapter deals with relevant related literature. Finally, the chosen research methodology is presented.

Context of the study

This section shall give an overview of the context in which the study is carried out. The research is situated in Mozambique and deals with the challenge of introducing an academic management information system into the Mozambican Higher Education system. To achieve this goal, several stakeholders are involved: On the Mozambican side there are several Mozambican universities and the Ministry of Education and Culture. Two Dutch universities are involved through a development cooperation project sponsored by the Dutch government. The inter-connection of the various stakeholders is shown in the following section.

Important cornerstones of the project started with initial contacts between the various involved stakeholders by workshops held at the Ministry of Education and Culture involving stakeholders from the Mozambican universities as well as from the Dutch universities. These were repeated several times for activities such as requirements gathering, prototyping, user training and technical training.

The author of the study is situated at one of the Mozambican universities, at the Catholic University of Mozambique, a university with the aim to bring higher education to the

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traditionally disadvantaged people outside Mozambique's capital Maputo, located in the center and the north of the country. At this particular university he is responsible for introducing the system.

The objective of the introduction of the academic information system is to improve the management of academic registry information for as many Mozambican universities as possible, with five focus universities which are directly supported through the funds of the development cooperation project.

Because of the number of involved stakeholders, several key issues arise in different contexts. On the personal level, local users of the system need to be addressed – they need to accept the new system. Within the university certain preconditions should be met with respect to staff availability and development. The national level plays an important role for sustainability by keeping the system alive after initial implementation at the universities. The development cooperation at international level plays a major role in designing the system in a way that will be useful for the Mozambican universities.

The study takes place during almost the whole cycle of the development and implementation of the information system. The author was present and involved in many activities of software development, adaptation of the system to the particular needs of the Catholic University of Mozambique, implementation of the system and training of local users at this university.

The hypothesis is that all of these key issues should be addressed in order to raise the probability for success, not only for the short term but to keep the system being used and useful for the local stakeholders. These key issues are named sustainability factors and are one of the research objectives of this study.

Conceptual framework

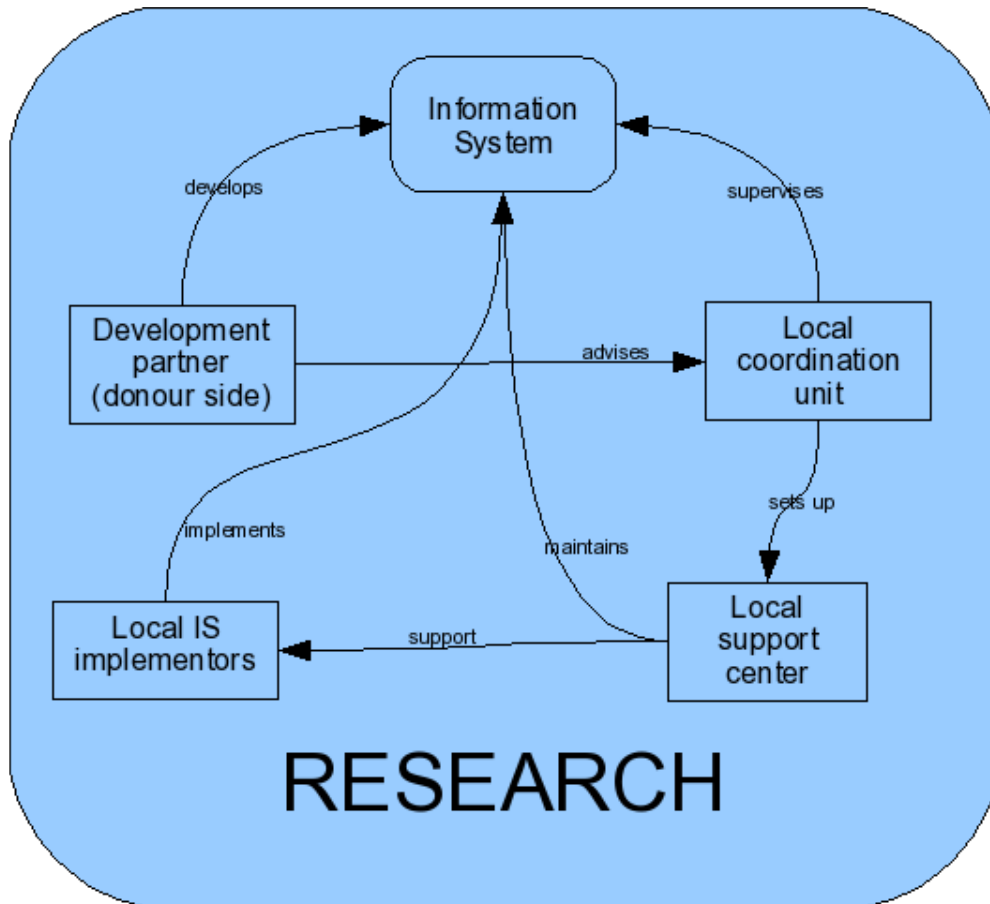


Illustration 1: Conceptual framework

In the implementation of an information system in the context of a development cooperation project there are several partners who work together. Software development can be done on the donor side as well as on the local side, possibly with the donor side starting with its high expertise and involving the local stakeholders increasingly as the project unfolds.

Typically, a local coordination unit coordinates between the local IS implementors and the donor side.

Local support can be organized by the establishment of a local support center which also can take over the further maintenance of the information system.

This shows a typical setup which forms the framework for this research.

Research objectives

The main objective of the research is to investigate a model for developing and implementing information systems in the context of scarce resources typically found in developing countries.

The research is based on these specific areas of investigation:

1. Sustainability factors for information systems in the context of scarce resources
2. Organizational setup for information system support

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3. Structure for putting an information system into the Open Source tradition
4. Proof of concept

One of the main objectives is to identify critical factors for sustainability during the project implementation of the ARIS, the academic registry information system. User support is an important factor for the sustainability of an information system and is expected to be essential for the ARIS as well. One of the objectives of this research is to work out a concrete setup how the system can enter the Open Source as one pillar for improved sustainability.

Scope

The practical problem-solving aspect is driven by questions arising from the concrete case of the implementation of an Academic Registry and Information System (ARIS) which can be classified as an Interorganizational Information System (Wierda 1991). Research is conducted with particular focus on the viewpoint of the implementing organization.

The theoretical aspect focuses on problem-solving tasks that arise in Interorganizational Information Systems in the context of development cooperation projects.

Justification

Walsham & Sahay (2006) give an overview of the current landscape and future prospects of research on information systems in developing countries. There is an increasing visibility and importance of ICTs in developing countries which is mirrored by a growth in the information system research literature in this area.

Their analysis concludes that sustainability is an important but neglected topic. Open source and free software is considered to be a technological area which needs more research.

The practical project of implementing an academic registry information system will give primary data for research.

The research focuses on factors which have been identified as critical for the success of information system implementation in development countries, a topic which has heretofore received insufficient research attention (Heeks 2002). However, the goal is not to create another methodology for information systems implementation covering all stages of system implementation. Rather, the goal is to concentrate on specific factors encountered during the implementation of a concrete system and to find answers in a scientific manner, referencing current scientific literature.

Significance of the study

Investigation of different factors leading to successful implementation of information systems in developing countries will contribute to three of the areas of information system research identified by Avgerou (2000):

- Organizational application of information technology
- The process of systems development
- IS management
- The organizational value of IS
- The societal impact of IS

Based on this classification the contributions can be grouped as follows:

Classification of IS research	Research Questions (RQ)
Organizational application of information technology	RQ1: When to choose IIS? RQ2: Organizational conditions for IS implementation

	RQ3: Participation and knowledge transfer
The process of systems development	RQ4: Technological concepts
IS management	RQ5: Information System Support RQ6: Open Source

Research questions

The following research questions are all to be interpreted in the context of scarce resources of developing countries.

1 – When to choose to implement an Inter-organizational Information System (IIS) and are there restrictions for eligible IS development processes?

Various information system options are available for any given particular organizational objective. In some cases, off-the-shelf systems are the best choice, in other cases there might be no feasible system available. Still, developing a new system alone does not need to be the only solution. Cooperation between organizations can be an option. Inter-organizational Information Systems (IIS) are defined by Wierda (1991) as information systems that are jointly developed, operated and / or used by two or more organizations that have no joint executive.

This research question shall answer the question of under which circumstances it can be worthwhile to develop the needed information system from scratch, and how the different options compare in terms of funds, human resources and other factors.

Additionally, it shall provide answers as to which IS development processes (i. e. IS development methodologies, approaches and models) are or are not feasible for an IIS setting in the context of developing countries, taking into account the context of a development project and the role of the donor. This question shall be answered to set the context for the further investigation of the success factors which are investigated in the other research questions.

2 – What are the necessary conditions within the organization for the introduction of an information system?

Whether an information system has to be developed first or bought off the shelf, the organization needs a certain capacity to be able to receive and use a new information system. Besides basic requirements of equipment, human resources and finances, the introduction of information systems always goes along with a minimum of organizational change, changes in work flows and work behaviour and new challenges for the technical maintenance, all of which needs to be supported by top-level management.

At the personal level the local users have to accept the new system and need to be able to make sense out of it.

A specific question is: What kind of competence, e. g. in software development, is needed within the organization and which kind of competence is better provided by external support, under the limitation that external support might not always be available? In organizations in developing countries these conditions are often not fulfilled and need careful attention in order to make the new information system a success. Big gaps between donor design and local reality lower the probability of success (Heeks, 2001).

The human resources situation can be distinguished into the currently available human resources as well as the resources who can be expected in the mid-term. There are special dynamics in the context of scarce resources: The willingness of staff members to train colleagues well is low, since only few people possess the necessary knowledge and are therefore in a power position. If they train other colleagues then their power may diminish.

Another effect of scarce human resources and cultural patterns is the limited willingness to admit errors.

3 – How to facilitate the participation of and how to transfer knowledge to future stakeholders?

For several reasons the integration of future users and maintainers of a new information system is an important factor in the process of creation and design of the system. The reasons include e. g. user acceptance, getting the right requirements, building local competence. In the special circumstance of a development cooperation project, the input from one of the partners (the donor) will stop at a certain phase in the project, and from then on the local partner has to take over what has been done before by the donor. Transferring knowledge to developing country stakeholders and handing over management of the information system is a difficult task and many development cooperation projects have not succeeded in this respect.

Heeks (1999) points out that participative approaches have reached the status of a 'magic bullet' technique that is always relevant, but are often beset with problems, and he distinguishes different problematic aspects. Avgerou (2001) highlights cultural differences between the contexts of industrialized and developing countries. According to Molla & Loukis (2005) in the transfer of applications like Enterprise Resource Planning (ERP) there are possible problems of mismatch between the culture embedded in the ERP software and the culture reflecting the views of the implementing organization's project team. They present a framework that allows the analysis of these two cultures and their impact on success and failure.

4 – How can technological concepts help in information system success?

In the context of scarce resources human resources and infrastructure are often not available in the quantity and quality as would be in industrialized countries. So technological concepts need to be employed in order to use the given resources optimally and to lower the burden for the organization in terms of both IS management and IS development.

Technological concepts to be investigated in this respect are:

- Modularization
- Automatic installers and updaters
- Agile software development methods
- Long-distance team work
- Using open standards like e-framework
- Service oriented approaches

5 – How to provide efficient support for the information system?

In setting up a development cooperation project there are at least two sides: the donor and the local organization. If there are several local organizations implementing the information system then there is an additional level (the country scope) in which support can be provided. The research question is about how to best organize the support on these 3 levels: within the organization, within a country-wide support center and within the support center in the industrialized country. Well-organized support structures can minimize the necessary capacity within the organization.

The issue of support is essential for the sustainability of the information system itself, so a model should be worked out which offers support with adequate levels of quality and costs for the implementing organizations. But while it might be easier to recover costs of an external support unit for software packages use in many organizations and companies like accounting, it is more difficult to provide quality support for more specialized software packages like the academic registry software at a university where only few organizations use the same software package within a certain regional scope.

6 – What role can Open Source play in sustainability and how to build an Open Source community?

To keep the information system alive after initial development and eventual handover it is important that further development and maintenance is done on the system. While Open Source alone cannot be any guarantee that this will happen, it might give some options to lower the risk that the information system gets abandoned when combined with other measures like the availability of effective support.

If Open Source can be identified as a tool to lower the risk of failure for the IS, then this is only the starting point for solving the question of how to form a community which is stable and prepared for input from third parties. At the same time of being able to absorb third party input, the community setup must not mean a notable burden to the core team as compared to a situation without an Open Source structure.

Literature overview

Walsham & Sahay (2006) give an overview of the current research on information systems in developing countries. They developed a classification approach for literature in this area which will be used here to give an structure to the overview of current approaches relevant to this study. Their classification distinguishes

- Key challenges for the use of ICTs
- The role of technology
- Theory and methodology

Key challenges for the use of ICTs

The classification scheme developed by Walsham and Sahay further distinguishes the key challenges for the use of ICTs into four categories, ranging from broad issues of (1) globalization and economic development at the national level, through (2) organizations engaged in cross-cultural working and (3) attempts at local adaptation, to (4) efforts to help particular groups.

Ad (1): How can ICTs promote “development”?

Articles in this category deal with broad contributions of ICTs to development, sometimes in the context of a specific country. In some cases the meaning of the term development itself is discussed. Articles in this category often draw on secondary data, in contrast to the more micro-level studies which in the majority of the cases draw on primary data.

For example, Madon (2000) examines the use of the Internet in sectors such as health and education and in domains such as economic productivity and sustainable development. Their message is that the attainment of development goals does not depend on the existence of Internet connections alone, but on the acquisition, usage and dissemination of relevant information and knowledge.

The world development report (1999) begins with the realization that economies are built not merely through the accumulation of physical capital, but on a foundation of learning and adaptation.

Silva and Figueroa (2002) deal with a specific country, Chile, and discuss how to promote the improved use of ICTs in this particular institutional context, drawing from institutional theory, including particular adaptations of the theory to the IS field. In terms of technology they emphasize the importance of standards and telecommunications infrastructure in supporting ICT applications.

Sayed and Westrup (2003) address the question how ICTs are mobilized to achieve networks that link global organizations, the government and local companies. The research is based on an example of the installation of an ERP system in an Egyptian company. They argue that ICT facilitated development has led to the formation of new, more complex networks of relations.

Ad (2) Promoting cross-cultural working

Myers and Tan (2002) noted that much of the literature concerned with cultural and cross-cultural issues in the IS field has relied on the work of Hofstede. Hofstede describes cultural difference in terms of scores on five dimensions. Walsham (2002) recognizes the importance of the work of Hofstede as alerting us to the importance of cultural difference, but he is rather critical in the sense that Hofstede's work being rather crude and simplistic for the study of

cultural aspects related to IS. Myers and Tan (2002) note that the very concept of national culture is problematic on several grounds.

Taking into account the observations made by Hofstede, Walsham (2002) builds and examines cross-cultural issues in software production and use with the goal of developing a theoretical basis for analysis in this area. The output is a model of the processes involved, drawing mainly from structuration theory.

Liu and Westrup (2003) examine a case study of coordination and control between UK and China in a multinational corporation. In spite the existence of e-mail and fax, ICT-enabled coordination is only effective when linked with other approaches such as the use of expatriates and face-to-face contacts.

Braa, Monteiro and Sahay (2004) look at sustainable health information systems in developing countries, and more particularly to the case of the transfer of a district health information system from South Africa and Mozambique. Their focus is on South-South rather than North-South contexts.

Ad (3): Local adaptation and cultivation

Bringing a technology to a new local context involves elements of cultural transfer and mutual learning. Local knowledge is often required to be combined with the knowledge and technology being brought in from abroad.

Bada (2002) describes local adaptations in a case study about a Nigerian banks which implemented a business process reengineering (BPR) project, as a form of IT-enabled change initiative. He emphasizes the importance of the local context of adapting IT-based practices when implementing them in developing countries, arguing that globalization in general is perceived differently in different parts of the world, and that IT is associated with management solutions and organizational models and therefore calls for local customization.

Macome (2007) looks at the transfer of an invoice information system designed by a French company to the Mozambican electricity company EDM. Like Bada she concludes that the local context should be considered in the implementation of information systems designed for contexts different to the local implementation context. Furthermore she advocates to involve local stakeholders in the entire process.

Ad (4): Focusing on particular groups

Some studies have concentrated on people and groups which are suffering because they live outside the margins of the digital divide.

The study by Mosse and Sahay (2003) is located in Mozambique where the introduction of a health information system is supposed to improve the health provision to poor districts. They consider important the building of a so called counter network, a term developed by Manuel Castells. The role of communication is highlighted as playing an important basis in the strengthening of the network.

Some research has been carried out about research in developing countries itself, looking at difficulties for researchers to have access to scientific material.

Ahmed (2007) assesses and evaluates the Open Access movement as a proposed solution to give better scientific resources access to researchers in development countries. OA are strongly linked with Open Source. Therefore, some of the problems of implementing Open Source have a direct impact on the implementation of OA. In order to tap the potential of OA for Africa, some key success factors shall be considered, which include the need to produce economic value within the region and the need for intensive training of users and developers of OA solutions.

Another study about access to knowledge sources was done by Okunoye and Karsten (2003). They looked at how researchers in West Africa and Sub-Saharan Africa use communication technologies such as e-mail and databases to manage knowledge. They analyze the benefits and issues of the different technologies for knowledge creation, transfer and storage in the context of scarce resources.

The role of technology

Only a subset of studies on IS in developing countries articulate details of technology and how it affects the outcomes. Those studies which do go into detail, are grouped by Walsham and Sahay into three distinct groups:

(1) Standardization versus localization: Papers in this group deal with the conflict between global best practices and the difficulty of imposing these standards on different local contexts.

Braa and Hedberg (2002) describe the initial period of an action research study about a health information system project (HISP) to support health management at the district level in South Africa. The reconstruction of the health sector in post apartheid South Africa asked for a decentralized structure based on health districts. In terms of information systems this translates into a need to balance local control and standardization. They develop a modular hierarchy of standards to address tensions between standardization and localization. The HISP software was designed to be able to tailor to local needs. Furthermore a “participatory prototyping” approach was chosen with frequent develop/deploy cycles, giving local stakeholders regularly the possibility to give feedback and adjust requirements. The software was released under an Open Source licence. Parts of the health information system was translated into Portuguese and implemented in Mozambique.

Thompson (2002) as well did an action research study related to the same health information system project as Braa and Hedberg. Even though many stakeholders considered the project successful, one particular obstacle remained: the continuing inability of certain of the most disadvantaged clinics to collect and use health data which they found meaningful, resulting in the submission of inaccurate, often meaningless data to the department. Because of these observed difficulties Thompson looks at the generation of meaning at the individual level (low-level), by observing how raw data is generated, mostly through manual forms. He notes that difficulties arise due to a mismatch between the needs of the system and the local knowledge of the nurses and others who create the data, and argues for the need for locally relevant data collection methods such as simple counters and forms.

(2) Alignment of Actors in Networks:

Some papers make use of the the actor-network theory (ANT), a relatively popular theory in IS literature, not only in developing countries, as a way to conceptualize technology as one of the actors in actor-networks. Examples of papers which draw on ANT are Mosse and Sahay (2003) and Sayed and Westrup (2003). Braa and Hedberg (2002) referenced ANT involving elements such as people, organizations, software and standards.

Rolland and Monteiro (2002) elaborate the particular complexities of an information system which has to be implemented in a large distributed shipping company located in 300 sites in 100 countries. They recognize the need to take the local context into account, but given the number of different sites, there needs to be balance between sensitiveness to local contexts and the need to standardize across contexts. Because of the global dimension of the information system they prefer the term information infrastructure with which they want to express the complexity of actors including technology. This complexity calls for different methods of development and management. Their design implications and concepts are also relevant in the context of developing countries.

(3) Particular technologies include Internet, ERP and Free and Open Source Software. The studies rarely go into great detail about the technologies. Braa and Hedberg (2002) mention that their software has been designed under an Open Source licence but do not provide further details.

Weerawarana and Weeratunga (2004) have examined the Open Source phenomenon in general, and in particular as it relates to developing countries. They present possible developing country business models, a strategy framework of how developing countries can take advantage of Open Source and how a donor agency can assist towards exploiting open source to create value in the economy.

Theory and methodology

A wide range of theories are being drawn on by researchers of IS in developing countries, from fields such as globalization, development and sociology. Theories which derive directly from the IS field are less common (Walsham & Sahay, 2006). Some researchers have developed their own models such as the design-reality gap model described by Heeks (2002).

According to Avgerou (2001) many conceptual frameworks and normative models that guide IS practitioners are linked to "best practices" irrespective of the contextual particularities, such as Total Quality Management (TQM) or Business Process Re-engineering (BPR). It is therefore essential to take into account the context of information system innovation in developing countries.

Heeks (2002) introduced the ITPOSMO model to explain gaps between design and reality in various dimensions. ITPOSMO is short for the 7 dimensions in which gaps are likely to cause failure in information system projects: Information, technology, processes, objectives and values, staffing and skills, management systems and structures, and other resources. Building on this model, some suggestions are made to improve success rates.

Mulira (2007) presents the PADTR methodology for interorganizational service system implementation in volatile environments. PADTR stands for Preparation – Analysis – Development – Testing – Realization and is therefore a methodology which covers the whole software development process.

With respect to methodology, the majority of the studies claim to be interpretive. Few studies adopt a positivist approach with stated hypotheses, instruments for data collection, statistical inference etc. Many papers build upon in-depth case studies. Walsham & Sahay (2006) consider action as important in addressing issues of development, but find that there are only few action research studies. One example for action research is the study by Braa and Hedberg (2002).

Research Methodology

The characteristics of the Mozambican ARIS project and the situation of the researcher are as follows:

- Context: Organizational implementation of IT in a development country.
- Longitudinal: The duration of the study takes place during the development and implementation phase of the information system.
- Problem-solving component: The research has the objective of proposing solutions to practical problems which arise during development and implementation.
- Design perspective: The ARIS implementation can be seen as a search for a combination of technology-based artifacts (system conceptualizations, technical capabilities, etc.), organization-based artifacts (structures, reporting, relationships, etc.) and people-based artifacts (training, consensus-building, etc.).
- Interorganizational collaboration and organizational level: Both levels need attention to give an overall picture of IS introduction.

These characteristics translate into the following considerations regarding research methodologies:

- Action Research: Research outputs and problem-solving shall inform each other to improve the quality of outputs of both activities.
- Behavioral/design science cycle: Two activities build a knowledge generation cycle: On the one hand building of artifacts and theories (design activity), and on the other hand the justification and evaluation of the artifacts and theories (behavioral analysis). To answer the research questions and objectives of this study, both artifact building and theory building are necessary.

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- Case study: The context of IT implementation in a developing country and the longitudinal type of investigation suggest a case study. However, action research as the principal research method better reflects the reality and helps to distinguish the two interests of problem-solving and research. But a case study may be useful to be incorporated into the action research cycle, e.g. in theory testing.
- In the following, the methodologies are discussed in more detail with respect to the ARIS project.

Qualitative research methods in IS research

Qualitative methods often used in IS research are ethnography, action research, grounded theory and case study. All four qualitative approaches or methods examine phenomena in a natural setting and use similar data collection methods, but they differ in important ways (Dubé & Paré, 2001).

Ethnographic research comes from the discipline of social and cultural anthropology where an ethnographer is required to spend a significant amount of time in the field. Ethnographers immerse themselves in the lives of the people they study and seek to place the phenomena studied in their social and cultural context (Dubé & Paré, 2001).

Action research (AR) is a combination of action and research, in other words of practice and theory. AR is committed to the production of new knowledge through the seeking of solutions or improvements to “real-life” practical problem situations. One distinguishing feature of AR is, therefore, the active and deliberate self-involvement of the researcher in the context of his/her investigation (McKay & Marshall, 2001).

Grounded theory is a research method that seeks to develop theory that is grounded in data systematically gathered and analyzed (Dubé & Paré, 2001).

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 1994).

Action Research

Action Research (AR) consists of a research cycle and a problem-solving cycle which inform each other to improve research outcomes as well as solutions to practical problems (McKay and Marshall, 2001). The research cycle gives input to the problem-solving cycle in the form of knowledge application. The problem-solving cycle gives input to the research cycle in the form of knowledge discovery. Since the problem-solving activity was started earlier, the knowledge-discovery aspect is expected to be stronger.

In relation to the ARIS project, the main benefit of applying the concept of AR is to highlight the separation of interest and act as a guideline to distinguish between problem-solving interests and research interests. This shall help to avoid mixing the different interests and raise the quality of both the research as well as the problem-solving outcomes.

Within the ARIS project, problem-solving has been initiated first, and research joined in later. Chiasson et al (2008) call this the problem-solving dominant mixing approach to Action Research. This is not the ideal situation, however. Ideally, both activities would be planned together from the beginning.

Baskerville and Myers (2004) outline four premises for Action Research:

- The purpose of any action needs to be planned beforehand. Also the theory must be explicit before the action is taken. Otherwise there is a risk that the action is purposeless.
- There must be practical action in the problem setting.
- The practical action must inform theory; the theory needs to be adjusted according to the practical outcome of the action.
- The reasoning and action must be socially situated. The action research needs to be a participant observer. There must be a collaborative team involved in reasoning, action formulation and action taking.

The outcomes of dual cycle action research are shown in Illustration 2 (McKay & Marshall, 2001) which is composed of the following elements: (A) is a real-world problem situation of potential interest to a researcher. Prior to the intervention in A the research must declare a theoretical framework (F) and a method (M) which are used to guide the intervention and to make sense of the experience of the intervention. Subsequently, reflection takes place on these experiences, yielding findings about F, about M, about A and/or about the research themes. However, because of the dual cycle process there are two different M. One is the research method M_R which is Action Research. The other one is M_{PS} , the problem solving method, which is may or may not be an explicit method. Finally, P is a problem situation in the problem-solving cycle. P may be a specific, real-world example of any particular A, or it may be somewhat different, but allows the researcher to investigate A, so that there would be overlapping elements in P and A. The ownership of A rests with the researcher. By contrast, P remains in the ownership of participants or relevant stakeholders, and although the researcher is ethically bound to take an interest in P and to act to try to alleviate the problem, it is the participants who retain ownership throughout the research process.

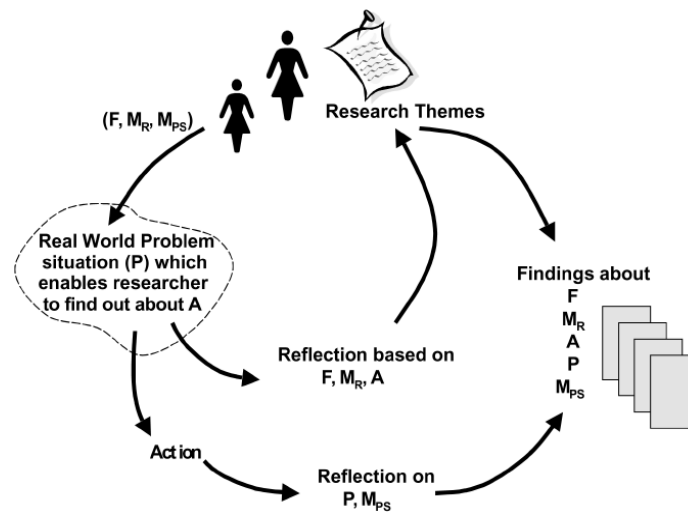


Illustration 2: Outcomes of dual cycle action research (McKay & Marshall, 2001)

For the ARIS project and related research the different variables can be defined as follows:

- F There are factors which can be identified to improve sustainability of information system development and implementation in developing countries, especially in the context of development cooperation projects.
- M_R Action research.
- M_{PS} No explicit method since the goal is not to discover a method but factors. A method for sustainable IS in developing countries could be the content of further studies.
- A Issues and challenges for sustainable IS in developing countries.
- P Develop and implement ARIS in Mozambican Higher Education context in a sustainable way.
Design support structure.
Design possibility to put ARIS into Open Source tradition.

Case study

A case study is defined by Yin (1994) as an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. The case study approach provides, at a first level, a descriptive model. Specifically, it can be used to identify the key factors beyond the IT system boundaries, i.e., the antecedent conditions, forces of change, forces of alignment, sequence of events and decisions, and outcomes over the course of the implementation (Montealegre, 1999).

At the second level, comparisons can be made by combining literature with own findings. Generalizations can be made from empirical data gathered towards theoretical propositions. This is also true for a single-case study.

According to Eisenhardt (1989) case studies can be used to achieve various aims: to provide description, test theory or generate theory. Theory-building from case study research is particularly appropriate when there is still little known about a phenomenon or there is not enough literature to engage in incremental theory building.

Although case study is not the primary research method in this study, it may be incorporated into the action research cycle which forms the main method of investigation, e. g. at the step of evaluation of action taking.

Design Science

Information systems research lies at the intersection of people, organizations and technology (Silver et al. 1995). It relies on and contributes to cognitive science, organizational theory, management sciences and computer science. It is both an organizational and a technical discipline that is concerned with the analysis, construction, deployment, use, evaluation, evolution and management of information system artifacts in organizational settings (Olikowski and Barley 2001).

Based on this, Hevner et al. (2004) present a framework (see Illustration 3) for understanding, executing and evaluating IS research combining behavioral science and design science paradigms. They recommend to engage the complementary research cycle between design-science and behavioral-science to address fundamental problems faced in the productive application of information technology. Technology and behavior are inseparable in information systems (Lee, 2000).

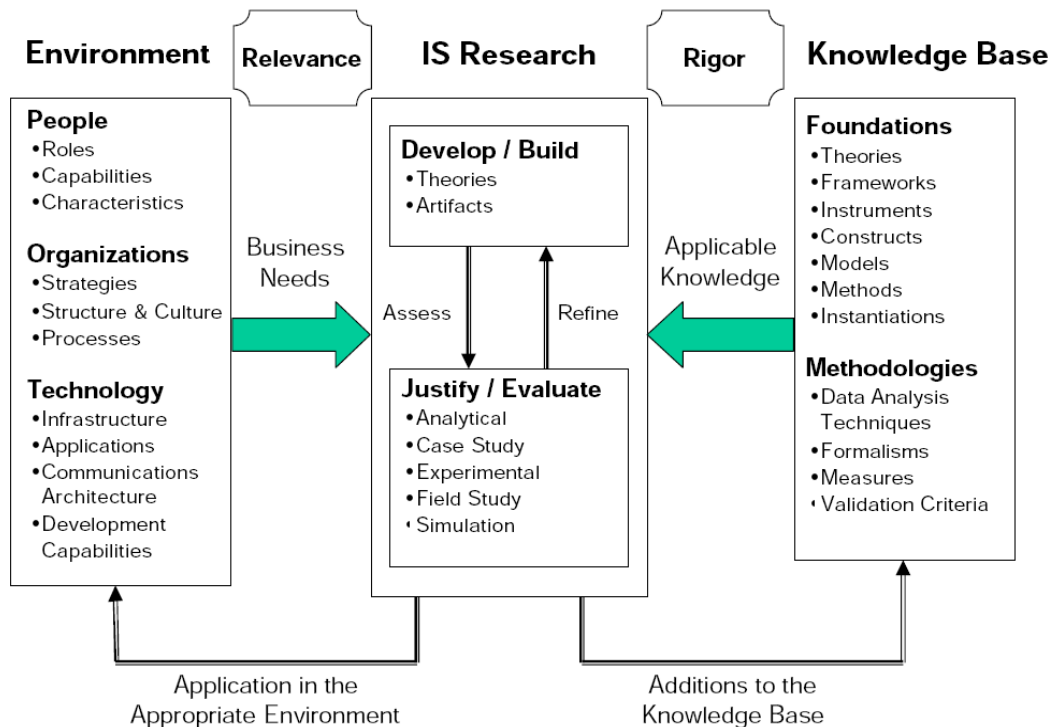


Illustration 3: Information System Research Framework, combining behavioral and design science (Hevner et al., 2004)

Design science creates and evaluates IT artifacts intended to solve identified organizational problems. In the case of the ARIS project it is useful to take advantage of the design science paradigm since the way in which software is set up and people work together is important to explain success, failure and sustainability of the information system. Some of the research questions concentrate on the particular setup of technology and people. In these cases the design science approach can help to develop scientific contributions, by applying the guidelines of Hevner et al. (2004) which focus amongst others on issues like problem relevance, design evaluation and research rigor (see Table 1).

Design science is a problem-solving process. The design method combines well with the action research cycle. Developing an artifact or a theory can be incorporated with the plan/action/evaluate cycle of action research in this research project. Furthermore, Illustration 3 shows the concepts of “Application in the appropriate environment” and “Additions to the knowledge base” which correspond with the problem-solving and the research interests of Action Research respectively.

The design-science research paradigm is proactive with respect to technology. It focuses on creating and evaluating innovative IT artifacts that enable organizations to address important information-related tasks. The behavioral-science research paradigm is reactive with respect to technology in the sense that it takes technology as “given”. It focuses on developing and justifying theories that explain and predict phenomena related to the acquisition, implementation, management and use of such technologies. The dangers of design-science research paradigm are an overemphasis on the technological artifacts and a failure to maintain an adequate theory base, potentially resulting in “well-designed” artifacts that are useless in real organizational settings. The dangers of a behavioral-science research paradigm are overemphasis on contextual theories and failure to adequately identify and anticipate technological capabilities, potentially resulting in theories and principles addressing outdated or ineffective technologies. Hevner et al. (2004) argue strongly that IS research must be both proactive and reactive with respect to technology. It needs a complete research cycle

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where design science creates artifacts for specific information problems based on relevant behavioral science theory and behavioral science anticipates and engages the created technology artifacts. Furthermore, they encourage collaborative industrial/academic research projects and state that results from such industrial experience can be framed in the context of the seven guidelines visible in Table 1 they developed for doing design-science research in the information systems field.

Guideline 1: Design as an artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Table 1: Design-Science Research Guidelines (Hevner et al., 2004)

As is the case in the field of IS implementation in developing countries, the existing knowledge base is often insufficient for design purposes and designers must rely on intuition, experience and trial-and-error methods. A constructed artifact embodies the designer's knowledge of the problem and solution. In new and emerging applications of technology the artifact itself represents an experiment. In its execution, we learn about the nature of the problem, the environment, and the possible solutions. With the ARIS system we can learn about specific problems and possible solutions in the context in which it is developed and implemented.

Summary of proposed methodology

The research is conducted in the following stages:

1. Definition of research interests and research questions
2. For each research question:
 1. Fact-finding in literature
 2. Propose theories and artifacts
 3. Plan and implement action steps (i. e. test theories and build artifacts)
 4. Evaluate effects of intervention
 5. Refine theories and artifacts
3. Combine answers to research question findings to satisfy research objectives

The final outcome to the research objective "sustainability factors" is supposed to be a combination of theories and artifacts.

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