Transfer of public sector information systems between developing countries: south-south cooperation

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Abstract

Technology transfer from north to south has been studied in several research projects. This paper describes a case of transfer of technology from one developing country to another. It describes the process of selection, installation, assimilation and adaptation of a district health information system for Mozambique based on the South African health information system. While north-south transfer has been hampered by problems related to economic and cultural differences, one might hope that south-south transfer avoids these problems. The case shows that also transfer between two neighbour countries in the south entails problems of assimilation and adaptation.

A model of donor funded transfer is adapted to fit the observed case.

1 Introduction

Many attempts at transfer of information technology (IT) from the Western world to developing countries have been carried out, and many failures have been reported due to lack of consideration of the context of the computer systems (Baark and Heeks, 1999). Too often the Western context in which the systems have been constructed is taken for granted. The systems do not match the needs, the organizational structures and the way work is carried out in the developing countries, and their scarcity of resources and competence makes the adaptation of the computer systems very difficult.

The issue raised in this paper concerns the transfer of information systems between two developing countries, which is an area of study that to our knowledge has not been documented yet. Considering factors like financial resources, educational level and infrastructure in developing countries versus the Western world, more similarities could be expected between two developing countries, hence less problematic transfer processes.

The case upon which the paper is based is an information system that was developed for the health sector in South Africa and recently transferred to

Mozambique (Braa and Hedberg, 2001). These two neighbouring countries have had much contact recently and also prior to Mozambique's independence in 1975.

1.1 Transfer of IT

Baark and Heeks (1999) provide a summary of earlier projects and present a model of donor funded transfer based on four projects in China. The transfer can be conceived as five processes, as illustrated in Figure 1.

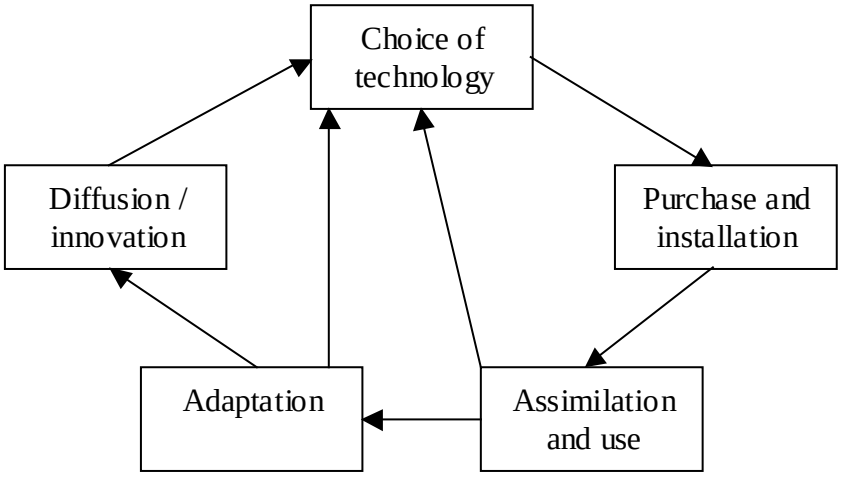

Figure 1. The information technology transfer life-cycle (Baark and Heeks, 1999, p.187)

The cycle starts out with choice of technology, which is often completed prior to project funding. Purchase and installation includes the procurement and the training needed to install the software and hardware. The purpose of assimilation and use is to make the users develop necessary competence to use the system for various purposes and maintain it. Adaptation concerns changing the system so that it fits the local needs better. In the final phase, diffusion, the recipient organization that has learnt to master the system can undertake diffusion to other organizations. Not all projects fulfil the complete cycle, as indicated by the three arrows back to "Choice of technology."

Baark and Heeks consider two types of technology to be transferred, general development projects and IT-specific projects. In the general development projects IT is a means to achieve other goals, which in the current south-south transfer project is improved health system management. The IT-specific projects aim at raising the technological level of the receivers. The current project also aims at improving IT competence in Mozambique, so that it has aspects of both types of projects.

Implementation studies indicate that challenges of installation, assimilation and adaptation are highly dependent on the kind of technology as well as other issues.

1.2 Types of technology

From the technological perspective, transfer can include infrastructure and applications. The information technology infrastructure constitutes networks, computer hardware and basic software like operating systems. Carrying out

installation and operation of the infrastructure requires skilled technicians and electricity. Although managerial or bureaucratic hurdles may create problems for successful transfer, there is little need to adapt the technology to the situation, except, possibly, for demands for uninterrupted power supplies.

Grudin (1994) distinguishes between three kinds of applications, tools, multi user systems and information systems, in his summary of challenges of implementation.

IT tools are regarded as single user programs like text processors, spreadsheets, browsers, e-mail, etc. Unlike other computing systems, the user has complete control over her or his tool. In addition to the requirement of a working infrastructure, successful implementation of tools also requires that the users have the necessary skills to manipulate the tools according to their intention. While the necessary computer literacy may constitute a larger challenge in developing countries (Venter and Blignaut, 1996), the tools are still implemented and used without being modified. Exceptions may occur when the user interface is translated to local languages not spoken in the industrialized world.

Compared to tools, multi user systems have to be adopted by a sufficient number of users in order to create benefits for each user and the organization (Orlikowski, 1993). General computer systems for cooperative work are more complex than individual tools, so more training, easily available support, and systematic motivation are required. The challenge of getting a sufficient number of users above the competence threshold thus makes the implementation of multi user systems a more demanding task than the individual tools.

Information systems constitute the fourth category of IT with regard to organizational implementation. In addition to being multi user systems, information systems concern a specific domain to be represented in the systems as well as providing functionality to the tasks and work chains of the organization. For an information system to be successfully implemented, there has to be alignment both between its data structures and the domain to be represented in the system, and between its functionality and the processes of the organization. To the extent that the systems prescribe specific action to be carried out, the systems impose structures, which may be in conflict with the organizational culture. If neither the organization nor the systems are adapted, no implementation will take place.

1.3 Organizational change

The assimilation process in the transfer model of Baark and Heeks (1999) mainly enhancement of the organizations' ability to utilize the systems, including computer literacy training for users and technical training of support personnel. While training is considered crucial for information systems implementation success, organizational changes usually also take place when information systems are implemented. Sometimes radical changes are intended, e.g., the business process reengineering (Hammer, 1990). Carrying out major organizational changes is a risky effort, and using an information system for promoting the changes increases the risk of the undertaking. A gradual change over a long period of time would be the normal case, e.g., like the organizational improvements carried out in a public corporation in Ghana (Tettey, 2000).

The transfer model of Baark and Heeks distinguishes between "adaptation," which

concerns changes to the computer system, and "assimilation and use," which captures the changes of the people and organization into which the computer system is going to be installed. Similar distinctions have also been made in other studies of computing use (e.g., Gasser, 1986), and two important lessons seem to have emerged: information systems implementation does not only consist of adapting the computer system, and the human side of the implementation process includes minor organizational adjustments and possibly also larger intended and unintended changes.

2 The heath information system in Mozambique

The national health information system in Mozambique consists of three levels of management and four levels of provision of health services shown in Figure 2. On other hand the national health information system consists of different vertical

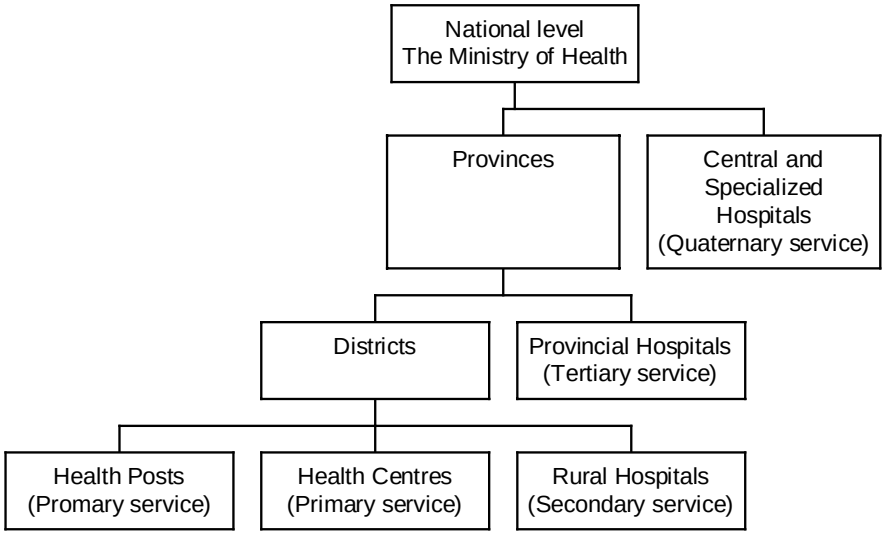

Figure 2. The health system in Mozambique.

subsystems:

- The national health information system which aggregates the main health indicators;
- Tuberculosis and leprosy information system;
- Epidemiological information subsystem for diseases of mandatory notification;
- Human resources management information system and
- Information subsystem for physical infrastructure management.

Of the above mentioned levels of provision of health services it covers only the primary and secondary ones. The subsystems cover the primary and secondary services, and they are paper based at the district and computer based at the provincial and national levels of management. They consist of a set of forms and data collection and reporting tools. The information is analysed in order to find health indicators of the population, measurements of health services, spending of resources, etc., in the various geographical areas.

A health unit (health post, heath center or rural hospital) collects and aggregates

health data, related to in-patients, community health, maternity, vaccination, diseases of mandatory notification and stock. The unit using special paper reporting form and according to the services provided sends it to the district. At this level, health data coming from different health units within the district, is collected, aggregated, analyzed and sent to the provincial level. This level is responsible for collecting data from the different districts within the province, enter it in the computer, perform possible analysis and send in an electronic format the provincial report to the central level. At the central level similar operations are performed on the data plus disclosure through national seminars especially organized with the representatives of the different districts and provinces.

An initial study of the system was carried out focusing on data flows. The system is essentially a top-down system, designed for fulfilling top levels needs. Consequently health information flows from the health units to the ministry of health, while instructions and directions are transferred downwards. The lower levels are seldom given feedback by the provincial and district levels, and the system therefore does not support a culture of informed decision making in the health facilities and districts.

The design, development and implementation of the health information system have been carried out mainly by the ministry of health, so the local authorities were excluded in the development process. The design assumptions were based on formal development goals and rigorous quantitative approaches, implicating a large-scale standardization.

Some operational issues related to data collection were observed:

- Fields in the forms that the personnel are required to fill are not filled.
- The same data are filled in different forms at the lower levels. Some data has to be copied from one form to other forms, and data is also copied from several forms into one. These copying procedures take place both in the health units and in the district offices.
- Lots of data is collected that is not relevant for the local needs or priorities.
- Reports are not delivered on a regular basis, often due to lack of transport. Instead, information is provided when asked for by higher authorities.
- One person carries out many tasks in the health units, and the crowd of patients waiting is often large. This situation puts pressure on the personnel, who often have to care for many tasks, e.g., one person act as medical technician, manager and information officer. Giving information work less priority seems to be a tendency in the stressing work environment.

3 The technology transfer process

Improved quality of health indicators and better service provision constituted main goals for changing the health information systems. Local analysis of data so that the personnel could get immediate feedback and also understand the usefulness of data collection was regarded as an important means. Because a choice of importing a software system was made, the way this change is carried out is therefore described according to the structure of IT technology transfer suggested by Baark and Heeks (1999).

3.1 Choice of technology

One option was to keep the structure and technology of the current system, and spend resources on more information work and improved transport. This would neither prevent the multiple copying with the inevitable creation of errors, nor would better tools for analysis of health data become available for health units and districts.

Another approach to improve the situation consisted of developing a computerized information system by implementing standardized methodologies to improve the practice of information system development based on traditional engineering disciplines. Such engineering approaches are perceived to be rigorous and predictable, for example, the ability to construct new systems from existing components, the use of standard analysis and design techniques across disciplines, the ability to rigorously define system and component functionality, and the ability to clearly delineate between system design and system manufacture. However despite considerable research in software, their successes are scarce in contexts as diverse as in developing countries.

Computer based systems can also be developed in an evolutionary fashion to suit the needs of the users at all levels. With better chances of success, the development process is still costly, and a long period of time is needed to design a system that fits all needs at the four levels and in the numerous units and districts.

The Ministry of Health decided that Mozambique should try to adapt an information system developed in South Africa for district health administration, and the donor would fund adaptation and pilot installation in three districts. The origin of the system being in a neighbouring developing country decreased the resistance against it amongst the decision makers. The technology choice thus became a software package already implemented in another developing country, including the experiences gained from its development and implementation there.

3.2 Purchase and installation

The District health information system (DHIS) is a database system developed during 1998 and 1999 at the University of Western Cape as an open source software package based on Microsoft Office 97 (Braa and Hedberg, 2001). The software is distributed free of charge on a CD from the developers in Cape Town. The open source code also provides free redistribution and ability to rework the source code.

While the commercial Microsoft platform is more expensive than Linux, the MS Office is already much used in Mozambique. This eased the installation and opens the possibility of using the local knowledge to shape the system.

Although problems occurred during installation, these do not seem to be related to the place of origin of the software.

3.3 Adaptation, assimilation and use processes

The strategy for the design of the District Health Information System in South Africa, was based on the following set of objectives and scenarios:

- Shift the control of the software and information system from the central to the local levels;

- Local utilization of information infrastructures;
- Local flexibility and user orientation. It should be easy to adapt the software to the local conditions;
- Support the health sector reform towards decentralization and the development of health districts;
- Empower local management, health workers and community;
- Horizontal flow of information and knowledge.

In order to achieve these objectives, the principles of the participatory design approach to systems development are recommended:

1. Mutual learning between system designer and skilled users.
2. Skilled users participate in the process of system design and development
3. Context sensitive and focuses on training for skill building or enhancement

The current case did not allow for development of a system from scratch, which is the basis of the participatory design principles. Nevertheless, the principles could be followed to some extent in the process of assimilating and adapting the system in Mozambique. Participatory design requires that adaptation of the software and assimilation of the system in the organization take place in close connection, and this could also be done in the three pilot districts in Mozambique. Baark's and Heeks's (1999) model of technology transfer places adaptation after assimilation in a sequential fashion. These two processes should rather be merged to accommodate to the project reported here.

The focus on mutual learning process enabled bridging the gaps between the designer and users understanding of the existing system and the envisagement of the new system. The learning process was initiated with a two weeks training course in computer use with the objective of getting the users and the designers to speak the same language in order to improve the knowledge upon which systems are built, enable people to develop realistic expectations, reducing resistance to change, and increase workplace democracy by giving the members of an organization the right to participate in decisions that are likely to affect their work. The developers and trainers were a team of computer specialists and medical doctors, such that those adapting the system already are somewhat familiar with the health system and learnt more during the training sessions.

The course was designed for a couple of district health information managers, the director of the district directorate of health, the medical chief of the district and the director of the rural hospital. This was the first time the participants of the course were getting in touch with computers. Initially the research group together with the local authorities planed to run the course especially and only for the information management staff. However, due to issues of control and risk of changing the power relation between the leadership and the subordinate staff, it was decided that both levels of people should be included in the training. The contents of the course consisted of basic concepts related to hardware of computers, text processors, spreadsheets and the computer-based district health information system.

The mutuality of the learning was achieved through recurring discussions on ways that the system should be adjusted to fit the health information processes, such that the

computer personnel learnt many facets of the health system activities during the course.

3.3.1 Translation

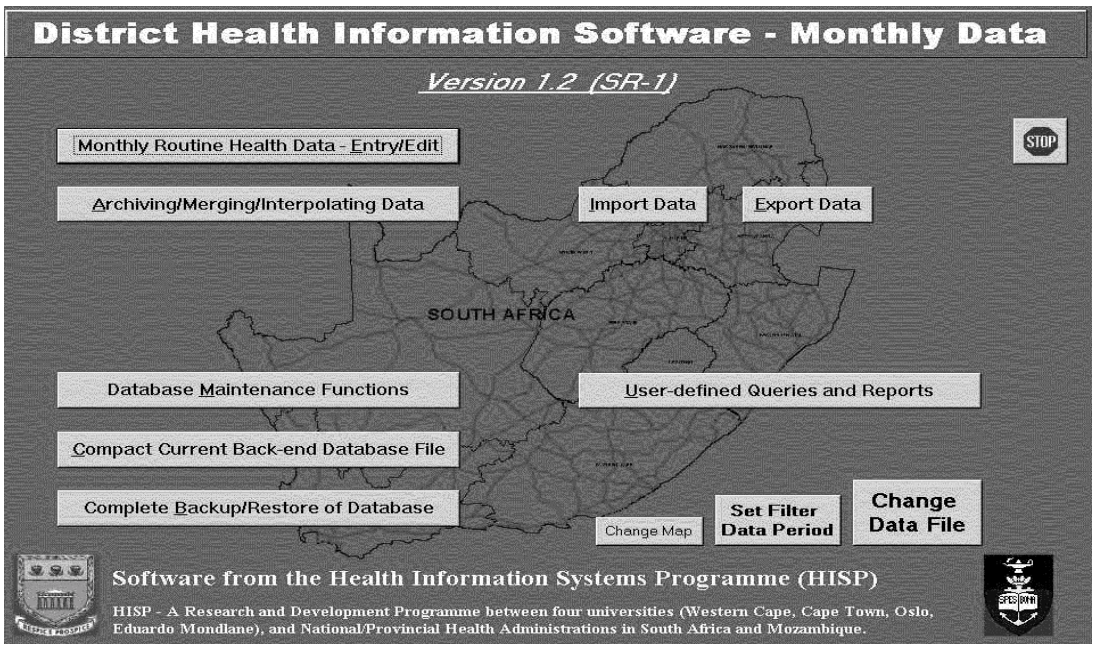

Figure 4. The main display of the South African version of the District Health Information Software.

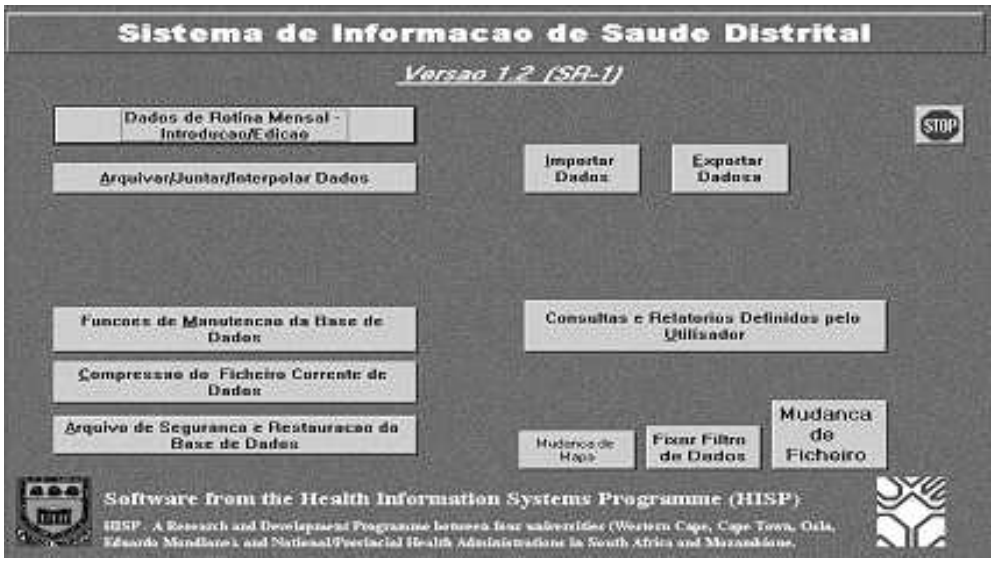

Figure 4. The Portuguese version of the District Health Information Software.

Portuguese is the official language in Mozambique, being used for communication in the different public and private sectors of the national economy. The district health information software was developed using English standards, implying that the application and its documentation are written in English. In order to start using the system in the Mozambican context, the translation from English to Portuguese is required. General language competence, computer skills, and medical terminology were required in the translation, and people with these qualifications were working in the project.

Monthly Data is the main module in the health information system, and hence this

module was translated first. The first translation was performed focusing on the technical terminology and aspects from the software point of view, rather than health terminology, in order to quickly have the first usable prototype of the system tested in the piloting sites. The English words had been hard coded in the software, therefore the translation used the tools available in the Ms-Access editor (cut, copy, replace, paste).

The user manual includes, apart from the computer configuration settings, the guide to monthly routine data module, the data mart and report generator, the tuberculosis module and the pivot tables description. The user guides had to be fully translated in order to provide a basis for learning to use the all the modules of the system.

The phrases translated from English to Portuguese tended to be longer in the target language. While this would not matter in the translation of prose, field names and button labels on a computer display have limited length, and too long names would clutter up the user interface. Consequently, the buttons had to be located in different positions or the long expressions had to be simplified in order to keep a reasonable layout and distributions of the buttons, compare Figures 3 and 4.

The first prototype was tested in the three pilot sites (Nhampossa, 2001). The first problem faced concerned the discrepancies between the meanings of the medical terminology with the ones visualized by the software. This issue was solved through several and long discussions between the medical staff and the researchers where both learned from each other.

3.3.2 Health system structure

In parallel with the translation process, some adaptation tasks were fulfilled. One consisted in entering data fields names from the paper forms used to collect, aggregate and report health data into computer system and the second in fitting the DHIS to the health system of Mozambique.

While the Mozambican system consists of three levels of management, South Africa has health regions between their district and province levels. The hierarchy must be configured to the Mozambican system in order to maintain the organizational units along with their parent district or province.

Changing the DHIS in this respect proved difficult, since the levels of South Africa were hard coded in the software. During design of the system, no one had imagined that it would be exported to another country with a different hierarchy. Instead of adapting the software, the project worked around the problem by adding a dummy organizational layer in the data, using the name of the district to name the region. In this case having 131 districts in Mozambique we get correspondingly 131 regions. The shift from the South African to Mozambican geographical structure is illustrated in Figure 5.

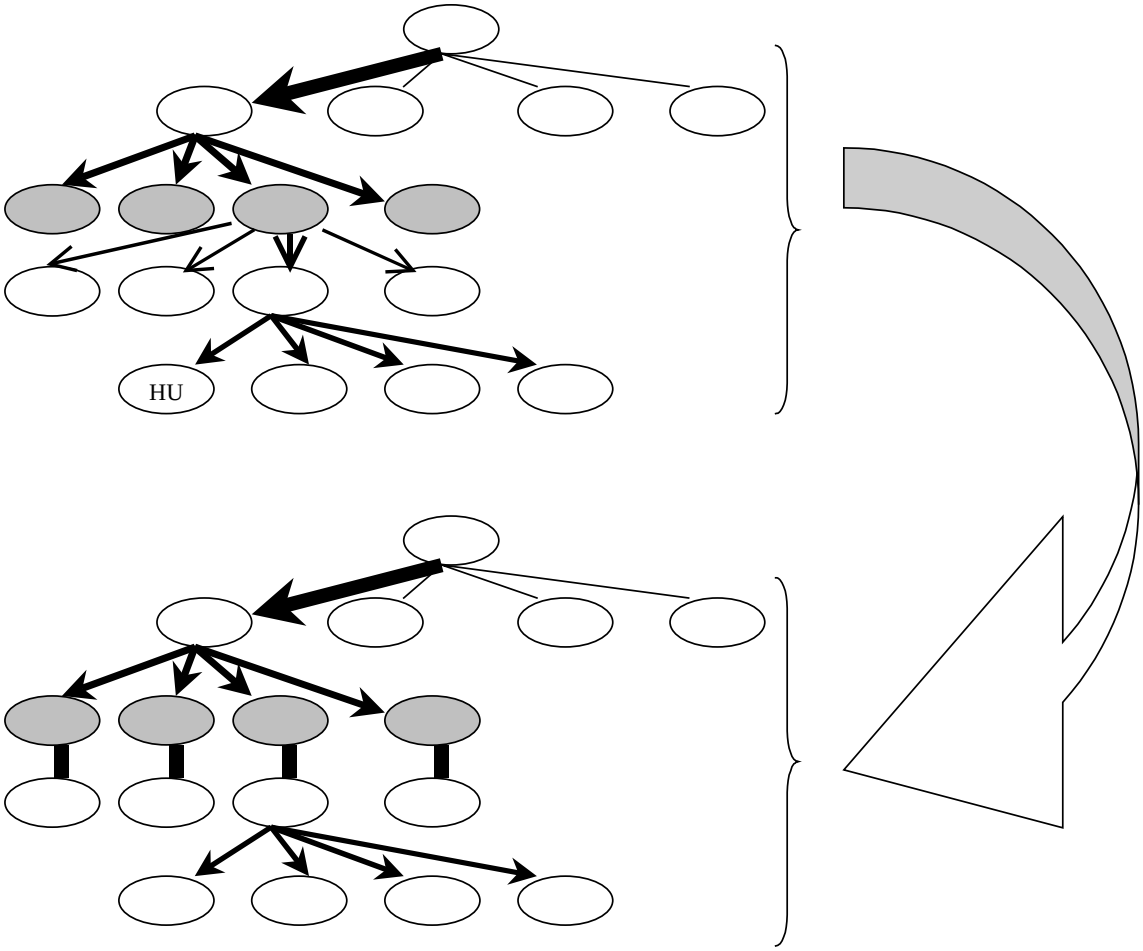

Figure 5. Inserting a dummy organizational layer in the data

3.3.3 Changing forms

Three major needs that emerged in the discussions between the end-users and developers were:

- New fields of data to be collected, relevant for the district authorities. For example, in the Niassa province in the north of Mozambique, people develop cancer due to eating mandioca, a vegetable root. While cancer is included in the data base, the system did not originally allow for also including the cause of diseases, which was needed in Niassa.
- New forms for data summary, relevant for the district decision making. The original forms made by the project team were about storing summarized information from the rural hospital and summarized information from the health centres and health posts.
- District specific data compilation forms. For example while trying to use the forms developed in one district in another districts, their data requirements was found to differ from the first district.

3.4 Diffusion/Innovation

This phase is about the spread of the information systems from one organization to others. In the present stage of the transfer of the system to Mozambique, diffusion is not yet a priority as presently the prototype is in the process of being developed and appropriated.

4 Transfer of IT between developing countries

Transfer of technology from the Western world to developing countries faces many problems both due to resource shortages in the developing countries and differing contexts in which the computer systems are installed. The District Health Information System was developed in South Africa in order to match the requirements of district based primary health care as recommended by the World Health Organization, and a similar health system has been developed in its neighbouring country Mozambique. The domain of the system is based on epidemiology, which comprises an internationally standardized system of medical data. Both the domain of the information systems and their required functionality in the two countries are therefore quite similar, with some exceptions mentioned in section 3. Without these similarities, the transfer would have seemed like a futile exercise.

Nevertheless, when transferring the information system to Mozambique, a sequence of problems occurred during installation, assimilation and adaptation, but also some advantages of getting the system from another developing country were found.

Purchasing the software posed no problem, since the system is free. It has been developed by means of donor funding, and no commercialisation has taken place. This constitutes an advantage that can partly be attributed to the software being transferred from another developing country.

The installation problems occurred mainly due to shortages of technical skills, i.e. an indication of the general shortages of resources that exists independently of the origin of the computer system to be installed. However, an advantage was that the system neither required sophisticated computing equipment nor a functioning data transmission network. Data communication can be done by messengers carrying floppy disks by foot.

Since district based health service may be more pronounced in developing than in industrialized countries, this match may be attributed to system’s country of origin. However, the user interface had to be adapted to the Portuguese language, the software structure had to be modified to match the levels of administration in Mozambique, and data fields had to be added to cater for local health problems. In addition, a large number of smaller adjustments were and will have to be made in order to meet requirements for reports.

The adaptation required a substantial effort of computer professionals, which is a scarce and costly resource in all parts of the world. The software is open source, which means that anyone can change the code. This permits students and other idealistic people to carry out the software changes, thereby reducing the need for paying huge consultancy fees to the vendor. The physical proximity and feeling of shared interests ease the cooperation between the original developers and the adapters.

The amount of work invested in adapting the system can be estimated to being in the magnitude of 10% of its original development cost.

User training constitutes a large effort in countries where not only computer illiteracy is abundant. However, transfer of technology from the South or the West makes no difference to the effort that has to be invested.

Only pilot installations have so far been achieved, so the changes of organizational routines cannot be observed yet. Implementing these changes constituted a difficult task in South Africa (Haga, 2001), and there is no indication that the situation in Mozambique will make it easier there. Being transferred from a developing country does not rule out these difficulties, but it may at least be possible to draw on the experiences that have been made in the neighbouring country.

4.1 The IT transfer model

The model of donor funded IT transfer from industrialized to developing countries suggested by Baark and Heeks (1999) provided a useful structure also for analysing donor funded transfer between developing countries. However, some modifications of the model seem appropriate when dealing with information system transfer.

While transfer of technological infrastructure and tools can happen without much adaptation, most information systems transfers require modifications to be made to the software. First, differences in the domains have to be catered for by changing data definitions and structures. Second, functionality and user interface have to be adapted to the specific needs of the target country and also to the local variations therein. Third, the user interface and the documentation have to be translated to the local language, if different from the country of origin.

The scope of the assimilation process in the model was mainly limited to training. The case studied pointed to the necessity of carrying out changes to the organizational routines and managerial practices. These kinds of changes happen in most implementations of information systems, so the “assimilation and use” process might be extended with “organizational change.”

The sequential nature of the model does not reflect the sequence of events in the transfer analysed. Specifically, adaptation of software happened partly before and also in close contact with the assimilation. Often, the adaptation is carried out in a trial and learning process similar to designing a new system by means of prototyping (Bødker et al, 1987). The sequence from assimilation to adaptation should therefore be replaced by one indicating that the two processes are carried out in parallel.

The revised model of transfer of information systems is illustrated in Figure 6.

5 Concluding remarks

Transfer of information systems between the public sectors of two developing countries was compared to transfer from an industrialized country. The transfer is feasible due to that the domain of the system followed international standards, in this case epidemiology. Even so, the data definitions had to be extended and changed to cope with local variations.

The information system software was transferred from South Africa to Mozambique, which are neighbouring countries. In most cases, neighbours tend to

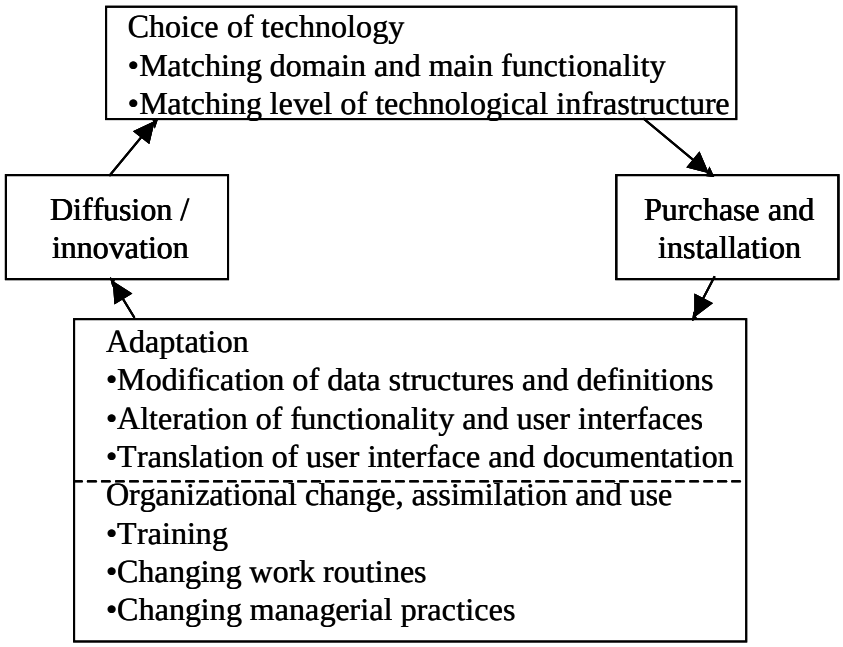

Figure 6. Model of transfer of information systems.

have more in common of culture, resources, legislation, governmental structure, resources, educational level and language than countries situated far apart. Considering that the target country is Portuguese speaking and has suffered prolonged civil war, while South Africa is comparably rich and English speaking, these substantial differences did not provide any insurmountable barrier for the transfer. Transferring from countries further away in several of the abovementioned aspects, like Western countries, could create more serious obstacles to implementation.

In all implementation of externally developed information systems, adaptations of the systems to the local organizational structure, routines and tasks have to be carried out. In the case studied, both countries have district based health systems, while the most pronounced difference was that there were more layers of administration in the country of origin. Unfortunately, this structure was initially hard coded, so a programming effort will be necessary for developing a flexible system. The similarity between the health systems may be due to their adherence to the World Health Organization suggestions for health organization. Importing a system from countries where this guideline has not been followed would have generated the need for major revisions and probably disabled the transfer completely.

Currently the system is transferred to India, which seems feasible because India also has a district health system. This transfer may provide more answers to the discrepancies caused by culture and resources.

The transferred system has been designed to run on low-tech PCs without any need for computer networking. This seems to be necessary in order to install the system on computing infrastructure that can be expected in developing countries.

Standardized domain, similar organizational structure and low tech solutions seem

to be favourable conditions for transfer of information systems to the public administration in developing countries, and these conditions may be met more often when the system has been developed in another developing country.

Since tools and technological infrastructure are not related to domains and organizational structure, fewer conditions need to be met for transfer of these kinds of IT.

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