

RE-THINKING TECHNOLOGY TRANSFER AS TECHNOLOGY
TRANSLATION: A CASE STUDY OF HEALTH INFORMATION
SYSTEMS IN MOZAMBIQUE

By

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Dedicated to
the everlasting and loving memory of my uncle tio Pedro Foliche Nhamossa
and
Nina, Érica, Sheila, and Láudia for their love, support and peacefulness.

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Acronyms

HIS	Health Information Systems
ICT	Information and Communication Technology
HMIS	Health Management Information Systems
IT	Information Technology
IS	Information Systems
WITFOR	World Information Technology Forum
IFIP	International Federation for Information Processing
PHC	Primary Health Care
GIS	Geographical Information Systems
TAM	Technology Acceptance Model
DFI	Direct Foreign Investment
GIS	Geographical Information Systems
WiFi	Wireless fidelity
AR	Action Research
MOU	Memorandum of Understanding
TAM	Technology Acceptance Model
TAM2	Enhancement of TAM
TRA	Theory of Reasoned Action
IDT	Innovation Diffusion Theory
GDSS	Group Decision Support Systems
MISAU (MoH)	Ministério da Saúde (Ministry of Health)
ANT	Actor Network Theory
SSADM	Structured Systems Analysis & Design Method
II	Information Infrastructure
LIS	Legacy Information Systems
RSA	Republic of South Africa

GBDA	General Business Domain Applications
SBDA	Special Business Domain Applications
CD	Compact Disk
JAD	Joint Application Design
BPR	Business Process Reengineering
WHO	World Health Organization
DHIS	District Health Information System
PARPA	Plan for the Reduction of Absolute Poverty
NHS	National Health System
MPF	Ministério do Plano e Finanças
SIP	Public Servants Information System
SISTAFE	State Financing Information System
CPD	Centro de Processamento de Dados
SIMP	Sistema Integrado de Monitorização e Planificação
SIP	Public Servants Information System
GACOPI	Gabinete de Coordenação de Projecto de Investimento
HISP	Health Information Systems Program
FOSS	Free Open Source Software
HISP	Health Information Systems Programme
UEM (EMU)	Universidade Eduardo Mondlane (Eduardo Mondlane University)
UiO	University of Oslo
LDE	Less Developed Economies

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I am strong-willed not to miss anyone here.

As a teenager and young man, I wrote poems, letters, and uncompleted narratives. I dreamed of being an author and shared my manuscripts with friends and colleagues. I never thought that my first book would be a thesis on *re-thinking technology transfer as technology translation: a case study of health information systems in Mozambique*, but here it is! This thesis grew out of five years of study which I have conducted on social movements and processes in various regions of the world, including Africa (Mozambique, South Africa, and Zimbabwe), Asia (India), Scandinavia (Norway and Sweden), Europe (Finland and United Kingdom), and North America (United States of America and Canada).

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Re-Thinking Technology Transfer as Technology Translation: A Case Study of Health Information Systems in Mozambique

ABSTRACT

This thesis presents a theoretically and empirically informed analysis of “technology transfer” of a computer-based HIS within a South-North-South network involving Mozambique, South Africa and Norway. Technology transfer from the North to the South has historically been problematic, including the domain of ICTs more broadly and Health Information Systems (HIS) in particular. It is argued that the diffusion perspective, the dominant approach employed to technology transfer, is inherently problematic, and there is the urgent need to identify alternative conceptualizations. Against this backdrop, this thesis addresses two research aims: (i) to develop a theoretical conceptualization of technology transfer based on a “translation perspective”; and, (ii) to understand and address the (empirical) challenges shaping the translation process of a computer-based HIS in South-North-South networks.

The theoretical foundation of the thesis is informed by translation perspective offered by Actor Network Theory. The concept of translation is adapted in this thesis to reflect a process of incremental change involving a socio-technical heterogeneous network, which leads to the development of sustainable network, implying that they are both institutionalized and flexible enough to change as per evolving institutional needs. Given this conceptualization of translation, a theoretical framework is developed which identifies four influences on this translation process, (1) of history: legacy systems and installed base; (2) of the role of adaptation: how software is adapted to the local context; (3) of the role of participation: how users exercise control over HIS; and, (4) of the process of customization: the balance between localization and internationalization.

The empirical foundation of the thesis is a South-North-South collaborative network case study of computer-based HIS adaptation in Mozambique, under an ongoing action research project called Health Information Systems Programme which was initiated in South Africa in 1994 and its subsequent “transfer” to Mozambique in 1998. The thesis examines the various challenges and opportunities that were involved in this process, based on empirical work carried out during the period from 2000 to 2003 in selected districts, provinces, and also at the national level. The research design is characterized by four key features, (1) action research; (2) longitudinal case study; (3) multiple level analysis; and, (4) interpretative approach. The research approach is primarily based on the principles of prototyping, which was applied as four iterative action research

cycles: (1) situation analysis; (2) selecting the minimum functionality; (3) matching the prototype with the context; and, (4) scaling up the DHIS.

The research findings are articulated in research papers presented as appendix of the thesis, which address the four themes identified above. In each of these four cases I have tried to elaborate upon the relationship between these conditions and their mutual relationships with respect to the process of translation as conceptualized in this thesis. For example, while working on the task of translating the software, I encountered various problems such as the meaning of words, the length of strings, the interaction with the South African development team. These practical experiences helped me to interpret how the language translation problem influenced and was influenced by the larger process of technology translation. This helped me to define the relation between software adaptation and technology translation as the need for sensitivity whilst moving software from one context by identifying the context free and dependent features of the technology through an ongoing process of cultivation.

The research makes both theoretical and practical contributions to the domain of IS research more generally, and to HIS in developing countries more specifically. Three theoretical contributions arising from the thesis are: an alternative conceptualization of this process as “technology translation” with particular emphasis on building local capacity, expertise, and creating a learning climate required to localize, maintain and evolve the technology over time in manner which is of value for the institution; enabling participation in non-western contexts involves dealing with unique challenges both with respect to the mechanisms and contents of participatory approaches; the need to respect history and take into account Legacy Information Systems, both in technical and institutional terms. The three practical contributions arising from this thesis are: the need to cultivate the installed base using gradual versus radical change strategies; to develop mediating mechanisms to enable participatory processes; and, the need to find a pragmatic balance between internationalization and localization with process rather than product orientation as the underlining objective.

‘Education is a progressive discovery of your own ignorance’

Will Durant

1. CHAPTER ONE: INTRODUCTION

1.1. The challenges of healthcare in the developing world

A great number of articles, speeches, reports and papers examine the issues and problems of Africa's underdevelopment. The majority of the countries classified by the United Nations as least developed are in Africa. Africa remains underdeveloped regardless of the immense potential of natural and human resources as well as great cultural, ecological and economic diversity. Various reasons are associated with Africa's development status quo, and they include among others the failure to provide basic health and education needs to its citizens. The basic health, nutritional and educational needs of the most vulnerable groups – the under-5s, pregnant women and nursing mothers – are still urgent and compelling. Infectious diseases, many of which are relatively easy to cure, remain the major killers in Africa. [...] Africa faces a huge burden of potentially preventable and treatable diseases that not only cause significant deaths and untold suffering; but also continue to block economic development and damage the continent's social fabric (Buch, 2003). For example, the challenge imposed by HIV/AIDS in Africa is reflected through this excerpt from a UNAIDS report:

At the end of 2003, an estimated 37.8 million (range 34.6-42.3 million) around the world were living with HIV, including the 4.8 million (range 4.2-6.3 million) people who acquired HIV in 2003. The epidemic claimed an estimated 2.9 million (range 2.6-3.3 million) lives in 2003. Sub-Saharan Africa remains the most affected region with 70% of people living with HIV (UNAIDS, 2004).

Africa represents a region where children, women and men, are increasingly vulnerable to life threatening malnutrition and endemic and epidemic diseases such as malaria, tuberculosis and HIV/AIDS. Poverty is endemic, and the area is devastated by AIDS, which is responsible for the high human mortality rate. The scarce resources available to the governments are often directed to fight emergencies rather than to make long-term investments in strengthening the health status of the population.

Recognizing these challenges to Africa's development, the international development community has over the years launched several initiatives to address these concerns including the *Alma Ata declaration*, the *Millennium Development Goals*, and the *G8 Africa Action Plan*¹. In the former USSR in 1978, it was concluded that a realistic objective of the World Health Organization (WHO) would be the provision of "health for all" by 2000. The *Alma Ata declaration*, which was endorsed by 134 countries, advocated for community-based approaches to health care, publicly funded, and free for all at the point of delivery (Werner & Sanders, 1997). This declaration presented the manifesto to attain global health for the 21st century by providing basic health care aimed at the urban and rural poor of the developing world. Indeed the majority of the citizens in developing countries, essentially the lower socio-economic group, rely on public health services, the provision of which are highly dependent on aid and require the collaboration of national authorities, international aid agencies and nongovernmental organizations.

More recently, in 2000, all 191 UN members' states signed the "Millennium Declaration". From this, the Millennium development goals² were derived and are

¹ The G8 Africa Action Plan contains commitments on promoting peace and security; strengthening institutions and governance; fostering trade, economic growth and sustainable development; implementing debt relief; expanding knowledge; improving health and confronting HIV/AIDS; increasing agricultural productivity; and improving water resource management (<http://www.g8.gov.uk/servlet/Front?pagename=OpenMarket/Xcelerate/ShowPage&c=Page&cid=1078995902703>).

² Goal 1: Eradicate extreme poverty and hunger; Goal 2: Achieve universal primary education; Goal 3: Promote gender equality and empower women; Goal 4: Reduce child mortality; Goal 5: Improve

mandated to be achieved by 2015. The goals include measurable, time-bound targets for addressing challenges of poverty and hunger, education, maternal and child health, the prevalence of diseases including HIV/AIDs, gender equality, the environment, debt, trade justice and aid. The goals also include a special item for Africa: *Meeting the special needs of Africa*. This item emphasizes that the international community, represented by the UN, commits to support the consolidation of democracy in Africa and assist Africans in their struggle for lasting peace, poverty eradication and sustainable development, thereby bringing Africa into the mainstream of the world economy.

Various international community commitments, exemplified in the above declarations, have been translated into a number of national health reform efforts in developing countries. This includes prioritizing public sector resource allocation using cost-effectiveness analysis, financing and providing reforms, building coordination mechanisms, and finally assisting with the integration of development programs into the so-called Poverty Reduction Strategy Papers. After 27 years, however, rather than "health for all," today we have millions of people who are still being denied access to basic healthcare, and the provision of appropriate health care to the poor is becoming increasingly problematic (Kvamme, Olesen and Samuelson, 2001; Goorman and Berg, 2000).

In this thesis, it is argued that contributing to the failure to achieve health sector provisioning goals is the lack of effective information to support decision making processes of planners, policy makers, and health programs and facility managers. In practice, public organizations in developing countries including the health sector generate voluminous amounts of data as an outcome of their daily activities and interactions with the millions of people they serve. Historically, large amounts of data on patient and community diagnosis, maternal and reproductive health, HIV/AIDs,

maternal health; Goal 6: Combat HIV/AIDs, malaria and other diseases; Goal 7: Ensure environmental sustainability; Goal 8: Develop a Global Partnership for Development.

TB, child health and nutrition, etc. are being collected in paper and stored in fragmented records in different departments. As a result, acquiring, disseminating or using the information in an effective and timely manner is extremely problematic. A significant proportion of the data ends up on the dusty shelves of an office in the Ministry of Health³ merely to serve the needs of the bureaucracy, rather than to be analyzed or put to use to support everyday activities and actions, such as the allocation of drugs or the opening of new health facilities in rural areas.

As the health sector faces ever increasing demands, including issues related to information, the need for improved health management and Health Information Systems (HIS) becomes increasingly pronounced (Braa and Blobel, 2003). It is in this context, that various developing countries are in the process of introducing Information and Communication Technology (ICT) projects to strengthen their Health Management Information Systems (HMIS), but with rather depressing results (Sahay, 2001).

A key reason contributing to these not so positive outcomes has been the ineffective mechanisms for “transferring” technology, typically from the richer Northern to the poorer Southern countries. This thesis seeks to contribute to understanding the reasons underlying these problems, and to analyze alternative ways of approaching the critical question of technology transfer. The empirical basis for the analysis comes from the study of the attempts by the Mozambican government to introduce a computer based HIS in the country.

In the following section, I discuss the potential of ICTs to support development in general and healthcare management in particular. Then, in section 1.3, a critical analysis on the claims about this role of ICTs is discussed. In section 1.4, traditional approaches to technology transfer are presented and critically discussed. Based on this

³ (Smith, Hansen & Karim, 1988; Becht, 1986; Frere, 1987; Ho, 1985; Kiaffi, 1988; WHO, 1988a; de Kadt, 1989 – In Theo Lippeveld, page 3)

critical analysis, the need to re-think the technology transfer process is highlighted in section 1.5. I present the research aims, the empirical basis, and the structure of the thesis in sections 1.6, 1.7, and 1.8 respectively.

1.2. The potential of ICTs to support health management

In this section, I first discuss the expressed potential of ICTs to support the socio-economic development in general, and the healthcare sector in particular.

Practitioners, academics, international agencies, the popular press, and even common citizens are increasingly recognizing the potential of ICTs to support processes of socio-economic growth in developing countries. The need for effective diffusion of ICTs as a potentially fundamental apparatus to support development and economic growth is also widely supported by researchers (Sahay and Walsham 1997; Mansell and Wehn 1998; Mejias et al. 1999; Madon 2000; Silva and Figueroa 2002) and by organizations such the UN (UNDP, 2001), the G-8, the World Bank and others (DOT Force, 2002).

Just to provide an example of this recognition of the potential of ICTs to support development, some quotes from political leaders in Africa and of the United Nations are presented in the box below.

Box 1.2.1 – Quotes from political leaders in Africa and of the United Nations.

Prime Minister of Mozambique - His Excellency Dr. Pascoal Mocumbi Italy, April 11, 2002 ...my country has recently adopted its national ICT policy, because we clearly see that ICTs have become an indispensable lever for a country's development. In today's world, it is the ability to efficiently and effectively use ICTs that plays an increasingly important role for a country's relevance and competitiveness in the global economy.

Lidia Brito, the Mozambican Minister for Higher Education, Science and Technology: [...] GovNet is a clear step forward in our efforts to make ICT a decisive tool to streamline Government operations to make service delivery more efficient and cost-effective, thus bringing Government closer to its clients: the citizens and businesses. This is in line with the letter and spirit of Mozambique's ICT Policy and Strategy as well as with that of the Public Sector Reform Program. My Government sees e-Government as a new window of development opportunity and will work [...] to make this project a resounding success. "Through this partnership, [...] the Development Gateway is helping to realize ICTs potential as a powerful enabler of development" (Development, 2003).

Tanzania's Development Vision 2025 states clearly that "The necessary condition for the nation to achieve rapid overall development to meet the development challenges of the 21st century is to ensure that all national sectors make full use of ICT" (Tanzania, 1999).

South Africa's President, Mr. Mbeki states that "Good IT infrastructure is present in South Africa, a country blessed with a Government that knows that the future will be based on information technology" (Daad, 2001, Braa and Monteiro, 1995).

In accordance with the World Economic Forum (2002, 2003, and 2004) reports, one of the main lessons of neoclassical growth theory is that, in the long run, an economy cannot grow unless technological progress occurs.

Road map towards the implementation of the United Nations Millennium Declaration of the Secretary-General of United Nation:To ensure that the benefits of new technologies, especially information and communication technologies, in conformity with the recommendations contained in the ministerial declaration adopted by the Economic and Social Council at the high-level segment of its substantive session of 2001 are available to all. Information and communication technologies

From the above, it is evident that the use of ICTs has initiated impacts in some developing countries and is opening new perspectives for development and economic growth. For example, the results of an IDRC funded project in Africa described some of the impacts of the use of ICTs as follows (Aiken et al., 1994, Jensen, 2001):

Today all of the 53 countries & territories in Africa have Internet access in the capital cities, Africa has currently five million internet subscribers (Steinberg, 2003) and these numbers tend to increase exponentially everyday. Another

example is related to Brazil, where computer industry accounted for more than 74.000 jobs and \$4 billion in revenue by 1990; in 1988 India launched a set of policies that fostered a software development industry whose exports grew to \$5.7 billion by 1999-2000 (ibid.).

ICTs are also argued to have the potential to diminish processes of marginalization, reflected in contemporary debates on the digital divide. The digital divide⁴ is conceptualized as the wide and increasing division between those who have access to ICTs and are using it effectively, and those who do not have these resources and capacities (Hartley, 2002, Rifkin, 2000, Bridges, 2003). It is argued by the international community that bridging the digital divide constitutes one of the preconditions to ensure that the benefits of the ICTs are distributed evenly both between and within countries. Such a position is expressed in the following quote by the World Summit on Sustainable Development:

Bridge the digital divide and create digital opportunity in terms of access infrastructure and technology transfer and application through integrated initiatives for Africa. Create an enabling environment to attract investment, accelerate existing and new programmes and projects to connect essential institutions and stimulate the adoption of information communication technologies in government and commerce programmes and other aspects of national economic and social life (WSSD,2002: 48).

⁴ Rice (2002: 106) defines the digital divide for instance as the 'differential access to and use of the Internet according to gender, income, race and location.' The definition used at the Digital Divide Network's website is again slightly different as the digital divide is seen here as the 'gap between those who can effectively use new information and communication tools, such as the Internet, and those who cannot.' A similar but still different definition can be found at the Digitaldivide.org website: here the digital divide is 'the gap between those able to benefit by digital technologies and those who are not.' Yet another definition can be found in the 'bringing the nation on-line'-report (Leadership Conference on Civil Rights Education Fund & Benton Foundation, 2002: 4), where it is stated that 'recognizing that no one should be left behind in the information age, both the executive and legislative branches of the federal government [...] have played important leadership roles in bridging the knowledge gap between the "information haves" and the "have-nots" — what some refer to as the digital divide.' (http://www.recreatievlaanderen.be/srv/pdf/srcvwp_200205.pdf).

As seen from the above examples and quotes, the promised potential of ICTs comes in terms of enhancing effectiveness, improving cost efficiencies of operations, serving as levers for economic and technological progress, reducing marginalization and providing the foundation for sustainable development. However, what is often missing in these discussions are the challenges in getting ICTs to work in practice, including the process of technology transfer, and how the benefits realized are systematically evaluated.

Similarly, in the domain of healthcare, the recognition of the potential of ICTs, has also been emphatically expressed by various groups including multinational agencies, politicians and researchers. For example, (Soriyan et al., 2001) argue that:

If the potential of the “African Information Society” is to be realized, IT should be used to enhance the effectiveness and efficiency of the highest-priority sectors for socio-economic development, for instance healthcare, by introducing appropriate information systems (Soriyan et al., 2001).

Other researchers from both Information Systems (IS) and public health, share similar views concerning this potential of ICTs. A study done in Mozambique found that internet connectivity acted as a tool to attract doctors and to get them to stay in the peripheral areas (Braa et al., 2001). Accordingly, Lippeveld et al. (2000) suggest that ICTs have the potential to enhance the HIS in terms of the range of informational inputs available to support quality with respect to planning, monitoring, and evaluation.

Similar claims are made by international agencies about the role of ICTs for health. The World Information Technology Forum (WITFOR) organized in 2003 by

International Federation for Information Processing (IFIP) under the auspices of UNESCO stated in its report:

Extensive Primary Health Care, a basic hospital structure and a decentralized district health system are the core global World Health Organization strategies addressing the main health problems, equity in health care delivery and “health for all”. As health systems around the world are being re-structured, the demand for sound information and the skills to manage and use information are increasing significantly. All countries need a national HMIS at least partially based on modern ICT technologies linking the various levels of the health system and addressing the information needs of policy makers, managers, health programs, service providers, staff, and increasingly patients (Braa and Blobel, 2003)

Similarly a World Bank report also described the successful use of ICTs in supporting healthcare management as follows:

[...] computers have played a vital role in controlling Onchocerciasis, or river blindness, in West Africa. Data collected by sensors along 50,000 km of rivers were fed into computers by local inhabitants. From the computers the information was [...] used to calculate the optimum time to spray against disease-carrying blackfly. River blindness has now been eliminated in seven countries, protecting 30 million rural people from the disease and opening up 25 million hectares of land to settlement and cultivation. Source: World Bank 2001.

As seen from the above examples and quotes, the key arguments being put forth for advancing the claims of the role of ICTs in the healthcare sector include:

- Improving availability and integration of health information; and,
- Increased networking and diminishing marginalization.

1.3. A critical view on the visions about the role of ICTs

There are good reasons to critically look at these above reported claims.

Improving availability and integration of health information

In a healthcare organization, a wide variety of information is needed to provide effective healthcare services. It includes information on disease surveillance, routine health information, private sector, health insurance, surveys, research, and community health information. Table 1 below summarizes some of the key types of health related information and their characteristics.

Table 1: key types of health information and their characteristics.

Type of health information	Characteristics of health information	Generated and/or used by
Disease surveillance	<ul style="list-style-type: none"> • Designed to provide early warning of disease outbreaks⁵ 	<ul style="list-style-type: none"> • Epidemiologists • (Vertical) programme managers • Planners and policy makers • Laboratory workers
Routine health information	<ul style="list-style-type: none"> • Quantity, distribution, reach and quality of health information and service provisioning • Data related to the performance of health services, to the management of resources for 	<ul style="list-style-type: none"> • Resource allocation authorities • HIS and case managers • Planners and programme managers • Healthcare providers (e.g.

⁵ E.g. Polio, Cholera, meningitis, Ebola, SARS. To illustrate patterns of disease spread of chronic conditions such as HIV/AIDS or cancer; To provide information relating to individual risk behaviours to health outcomes (e.g. smoking and cardiovascular diseases).

	health, and to the policy and legal framework.	doctors)
Information from the private for-profit and non-profit sectors, health insurance systems	Data/information on patterns of diseases and healthcare use.	<ul style="list-style-type: none"> • Policy makers • Pharmaceuticals • Employers
Surveys	<ul style="list-style-type: none"> • Surveys are the sole source of population-based information about use of health services or health-related behaviours⁶. 	<ul style="list-style-type: none"> • Planners • HIS managers • Department of national statistics • Decision/policy makers • Public/tourists • Donors/funding agencies
Research information	<ul style="list-style-type: none"> • Academic health information is generated as an outcome of research activities⁷. 	<ul style="list-style-type: none"> • Academic and research institutions • Donors/funding agencies • (H)IS researchers
Community health information	<ul style="list-style-type: none"> • Normally regarded as incomplete and non-representative⁸ 	<ul style="list-style-type: none"> • Community and municipal authorities • Ministries of the interior • Public/tourists
Other sectors	Data on vital events such as births, deaths and sex and age patterns of mortality. In many settings, the primary data producer for the ultimate health outcome, mortality, is not the health sector.	<ul style="list-style-type: none"> • Health civil registration authorities • Local and municipal authorities • Ministries of the interior or planning.

⁶ Household surveys are of particular importance in settings where vital registration is incomplete; Household surveys may be the sole source of population-based information on important health outcomes such as infant mortality.

⁷ Often supported by external funding, especially in context of developing countries; Researchers may develop new tools and methods for assessing different aspects of health and play a major role in evaluation of health interventions.

⁸ Qualitative information expressed in form of stakeholder's opinions and perceptions on disease surveillance, births and deaths, environmental issues, follow-up of patients, patterns of health seeking behaviour and perceptions of health services.

Typically, the deployment of ICTs for health is justified by the argument that they will radically increase the availability, integration, sharing, and use of information which will help improve healthcare management. Such an argument represents rationalistic assumptions, and ignores the social, cultural, political and institutional conditions that often impede the rational use of information and ICTs. Such analysis has been conducted by various IS and organizational studies researchers to identify particular impediments in situated settings. For example, Feldman and March have argued that:

Much of the information that is gathered and communicated by individuals and organizations has little decision relevance; much of the information that is used to justify a decision is collected and interpreted after the decision has been made, or substantially made; much of the information gathered in response to requests for information is not considered in the making of decisions for which it was requested; regardless of the information available at the time a decision is first considered, more information is requested (Feldman and March 1981:174).

Similarly, Sahay and Walsham (1996) have described how bureaucratic structures and political motivations hinder the use of spatial information in the context of a Geographical Information Systems (GIS) implementation in India. They argue that the mere identification of factors is inadequate as they tend to be decontextualized, and they need to be related with contextual conditions, such as those concerning societal traditions and institutional histories.

The above identified impediments are also evident in the health domain, contributing firstly, to the lack of health information of proper quality, and secondly, to the poor use of available information.

Often HIS applications focus primarily on routine information, ignoring the various other kinds of information required by health managers (see Table 1), such as related to infrastructure or epidemiology. This makes the supply and demand of health information unbalanced, and only partially available. The ineffective availability of information is also contributed to by poor information sharing practices within the Ministry of Health, and other producers and users of information. For example, to assess the performance of the Expanded Programme of Immunization, two important figures are needed, *population data* and *data on the number of immunized children* (Mavimbe, 2002). The availability of these figures is dependant on cooperation and sharing between authorities of the health department and national statistics which is often not forthcoming.

There are also problems related to the quality of data, making it largely unusable. Data quality errors come in many forms from missing data, to reports being untimely, or having calculation errors, to duplicate and redundant data, to data having conceptual problems such as reporting figures on “pregnant men”. As an outcome of this, data is not used because it is of poor quality, and vice versa, data is also of poor quality because is not used. However, it has been argued that the more data is used by people who collect it, the more accurate and useful it will become (Heywood and Rohde, 2000).

The multiplicity of reporting systems, both within particular health programs and across them, contributes to the uncoordinated nature of information flows and their use. As Figure 1 (from Mozambique) below suggests, firstly there are multiple programs including related to Expanded Program on Immunization, HIV/AIDS, TB, and Malaria. Secondly, within for example, the malaria program, there are other different and parallel reporting channels which impede a coordinated and rational use of information, even when it is available.

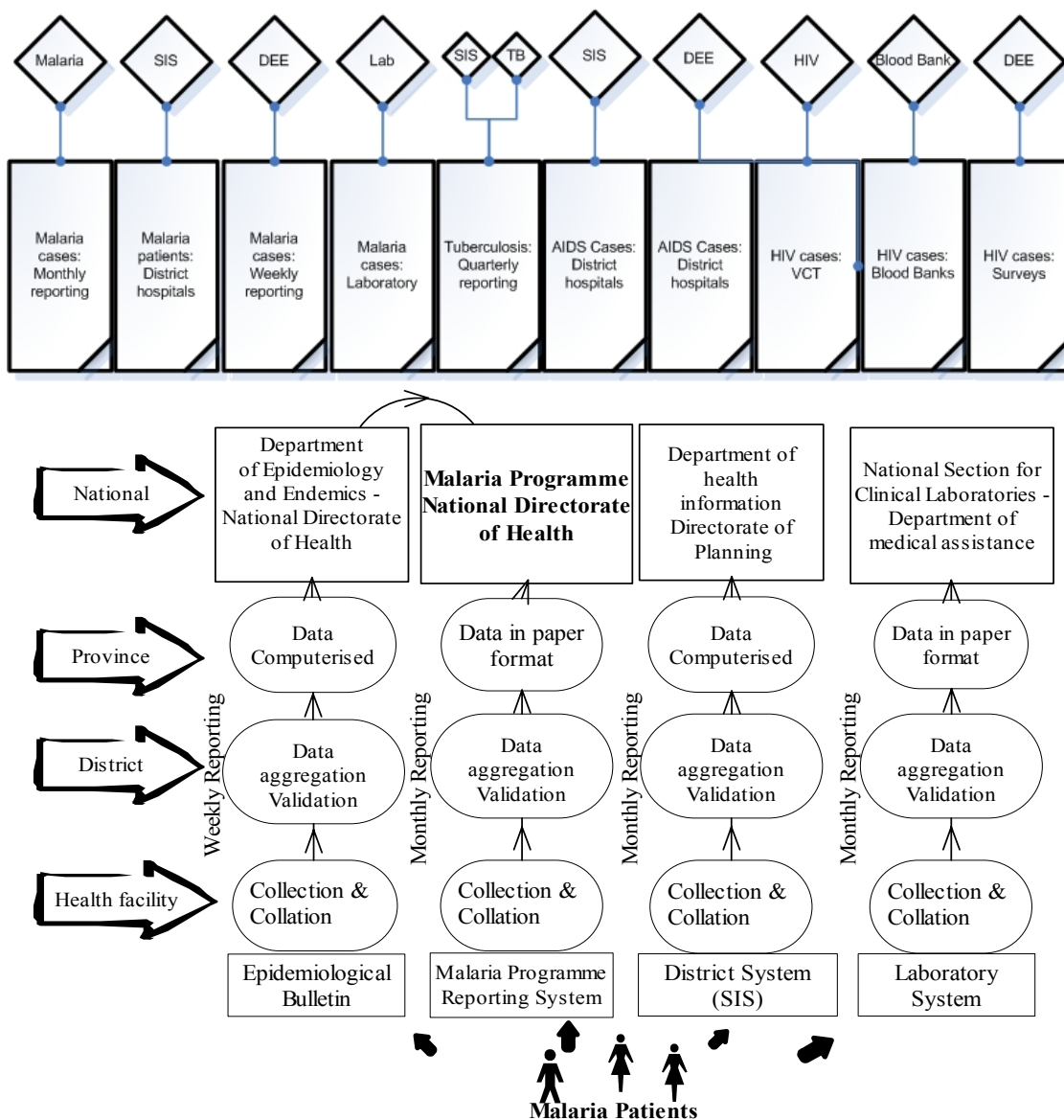


Figure 1: Multiplicity of reporting systems. Adapted from: Chilundo (2004).

Various researchers have commented on the culture of information in health departments to be primarily “data led” rather than “action led”(Heywood and Rohde, 2000, Lippeveld et al., 2000). This implies that vast amount of data are collected on a routine basis but with the primary aim of satisfying the needs of bureaucracy, focusing on the fact that a report needs to be sent, rather than on how it supports action. This focus on the form rather than the content of information is thus an important impediment to the effective use of health information. Information, when used, is

often towards fighting everyday “fires”, rather than for making systematic investments for the future. The following quote illustrates this point:

“...Given their previous experience, managers approach problems one by one, as they come, and do not spend much energy in formulating long-term visions. Further, the memory of the central planning failures is still fresh, making managers sceptical of plans. The perennial scarcity of accurate information has made them reliant on their direct experience, on common sense and intuition, rather than on hard data” (Pavignani and Durão, 1997:11).

In summary, various conditions have been identified that contribute firstly, to the lack of available information of adequate quality, and secondly, to the constraints in its effective use, which suggest that the ICTs are necessary but not sufficient to address/solve these challenges. The sufficiency condition can only be satisfied by more seriously taking into consideration the socio-political-institutional context (Walsham, 1993).

Increased networking and diminishing marginalization

The potential of ICTs to create technological networks is glorified in the literature, with examples from telemedicine, electronic patient records, automatic transfer of data and web enabled access. The power of these networks is seen as their ability to provide organizations the capacity to address historically existing problems of marginalization (Castells,1996) by developing informational linkages and increasing the visibility of health problems (Mosse, 2005). Arguments of how the creation of networks is often primarily equated with technical linkages are reflected in the Mozambican ICT policy implementation strategy document which states:

Box 1.2.2 – Extract on health from the Mozambican ICT policy implementation strategy document.

[...] project aimed at creating a technological infrastructure capable of interconnecting the country's main health units, the electronic management of patients' profiles and the management of pharmaceutical stocks. The implantation of this project will permit central, general and rural hospitals around the country to be interconnected, thus making it possible for all information, administrative and clinical alike, to be exchanged online.

Under this system, health care requests and services can be centralized, which will facilitate monitoring the evolution of patients' condition, even when they are transferred from one health unit to another, and give access to patients' profiles irrespective of where they were first recorded. A computerized ID card for patients will be introduced, which will make access to patients' profiles to be standardized, thus avoiding delays and inaccuracy in the provision of information regarding medical check-ups and analyses as well as ensuring the delivery of secure and reliable services. Through this system, it will also be possible to know the level of medicinal stocks nationwide, thus expediting access to them and allowing for substitution of out-of-stock drugs by others as needed.

In recent times, various authors have argued against looking at networks only in technical terms, and instead to conceptualize them as being socio-technical and heterogeneous in nature. Such a perspective helps to understand the complexities of healthcare provision, including the interaction of the various actors (people, artefacts, and institutions), and their roles and shifting relations. In a similar vein, Elden and Chisholm (1993:293) argue that seeing networks in socio-technical terms, helps to focus on how actors can struggle together to learn from each other in attempt to meet shared needs and goals.

A technical view on networks puts the challenges of getting the networks to work in practice in the background, and focuses primarily on how to get “technologically plugged in”. Such a criticism has been made by Barry (2001) about Castells’ view of networks; that he does not adequately take into account the challenges involved in making the networks work in practice. This criticism is reinforced by Kallinikos, who

argues that Castells' perspective on networks is rather technologically deterministic, and that it deemphasizes their historical and social embeddedness (Kallinikos 2003). Arguments around how marginalization and exclusion faced by the disadvantaged groups can be improved simply by developing their informational capacities through linking the "local" and "global" are rather problematic, as it assumes certain levels of infrastructure and capacity.

The PHC sector in developing countries is an example of an extremely marginalized context wherein the assumed infrastructure and capacities to be linked or networked are not given or present. Challenges in getting such a network to work are discussed by Mosse and Sahay (2004), whose work is empirically informed by the analysis of the health domain of Mozambique. They identified four adverse conditions impeding the introduction of computer based HIS, namely, inadequate resources, overworked health workers, policies of international agencies that tend to favour vertical rather than horizontal programs, and the centralized structure of the health administration. Mosse and Sahay propose the conceptual framework of "counter networks" to emphasize these adverse conditions and the challenges inherent in making these networks effective in practice. They argue:

[...] counter networks [...] helps to emphasize the very different contexts, and the need for very different and radical strategies to strengthen them. The strategies are not then about how to get the latest technologies and plug them in, but to develop sustained and intensive action over time across the multiple levels of the health sector [17]. While the counter aspect of the network helps to emphasize the need for action that goes beyond simply providing technological fixes, the network part underscores the need to consider the interconnectedness and multiple levels of action (Mosse and Sahay, 2004:6). [...] Trying to bridge the [design-reality] gaps, [...] will contribute to the development of effective counter networks around the Mozambique PHC

sector. Enabling such counter networks, [...] can contribute [...] to make more effective the health reality of areas that have been historically marginalized, [...] to help support the provision of focused and relevant action to help address health problems of these regions, [and finally] [...] to create mechanisms through which more effective flows (of people, information, experiences, etc.) can take place within different nodes of the network (Mosse and Sahay, 2004:17).

A socio-technical view also helps to emphasize the challenges in scaling up the networks and making them sustainable over time. While scalability refers to the question on how to make one working initiative spread to other sites and be successfully adapted there, sustainability concerns the challenge to make that [initiative] work in practice, over time in a given setting. These issues have been identified as major impediments to healthcare applications in developing countries (Braa et al., 2004; Kimaro and Nhampossa, 2005) for at least two reasons. Firstly, health managers do not get information at a scale which is useful for them to take effective decisions (for example of the whole region). Secondly, these applications die away as pilot projects with the exit of donors and their funding and expertise – the problem of sustainability. In trying to address these two problems, it is important to take a socio-technical view as they are both not only about technology but also the inherent socio-institutional complexity in which it is embedded (Sahay and Walsham, 2005).

This perspective on networks and their role in enabling sustainability is empirically supported by a study conducted in Mozambique, as suggested in the following quote by (Braa et al., 2001):

[...] development of ICT capacity and information systems at district and provincial levels in Mozambique needs to be an integrated effort across sectors. A

computer based district health information system cannot be developed in a void. Development in the health sector will rely upon the existence, or development, of a wider network of training and support of computer and communication software and hardware, which we will term an ICT infrastructure (e.g. Hanseth, 1996). Thus, development of information systems in the health sector needs to be integrated with efforts to develop an ICT-infrastructure across sectors, and vice versa.

In summary, I have in this sub-section tried to identify the gaps that exist between the claims being made about what ICTs can do for healthcare, and their realized potential. Table 2 provides a summary of this potential and its realization. I have also tried to point to some of the underlying reasons for these gaps.

Table 2: Summary of the Key arguments made about ICTs in healthcare management and suggested counter arguments.

Key arguments made about ICTs in healthcare management	In practice
ICTs have the potential to:	
1. Improve availability of health information	<ul style="list-style-type: none"> • Health information is available partially, with poor quality in not correct/standardized format. • The supply and demand on health information is unbalanced.
2. Improve visibility of health information	<ul style="list-style-type: none"> • Health information is reported across the hierarchical levels in aggregated form, whereas the details on specific unit are not visible at decision-making level. • Timely reporting of health information is hindered by the weak communication and transport infrastructure; as a result health information is seldom/randomly transmitted, mostly in accumulated form to decision making levels.
3. Improve integration of health information	<ul style="list-style-type: none"> • Health information systems are highly fragmented in task-oriented systems. • The lack of institutional ICT and information sharing of resources

	result s in duplication.
4. Improve the informational connectivity, create, support and strengthen the networks for information and knowledge sharing	<ul style="list-style-type: none"> • Given the adverse conditions of developing countries, who is included in the network, what they learn and what they do with their learning, is unclear. • The networks should not be seen as limited to technical linkages, but rather as socio-technical sets of actors with shared needs or goals. • ICTs (Hardware) can be given but not the networks. • Consideration on strategies on how to build and enable the networks needs to be taken seriously, not ignoring the involved contextual issues. • Once created, strategies to scale and sustain the networks need to be developed.

In this thesis, I will argue that contributing fundamentally to this design-reality gaps (Heeks et al., 1999), is the technology transfer process, and how it is conceptualized and implemented. If not seriously addressed, the danger of these gaps never being bridged will remain very real.

In the following section, I first discuss some of the traditional approaches to technology transfer and their inherent limitations. This provides the basis to argue for the need to re-conceptualize the technology transfer process, which is the objective of this thesis. The research questions and expected contributions from the thesis are then presented.

1.4. Traditional approaches

For the purpose of this thesis, technology transfer is conceptualized as the process by which technology, ICTs for healthcare in this case, is “transferred” typically from the richer Northern countries to the poorer Southern ones. This transfer includes not only the technological artefacts (for example, software) but also the know-how and funding to help institutionalize it within the setting of the recipient country.

In this section, I discuss three conceptualizations of the technology transfer process as have been emphasized in the literature:

- Technology transfer understood from the perspective of diffusion (Rogers, 1983, 1995)
- Technology transfer understood as taking place in channels (Odedra, 1991)
- Technology transfer understood as conceived within a life-cycle (Baark and Heeks, 1999).

1.4.1. Technology transfer understood from the perspective of diffusion

Rogers' (1983, 1995) Innovation Diffusion of Theory has been widely applied to the study of innovations and has provided insights into the adoption, implementation, infusion, and diffusion of technological innovations. Rogers conceptualizes technology transfer as a process by which an innovation is communicated through certain channels over time among the members of a social system. This theory has been a dominant approach to the conceptualization of technology transfer for technologies in general, and also within the IS domain.

Rogers conceptualizes the diffusion process to follow an "S" shaped curve⁹ (see Figure 2) implying the differential rates by which an innovation is taken up in a social setting.

⁹ The original diffusion research was done as early as 1903 by the French sociologist Gabriel Tarde who plotted the original S-shaped diffusion curve. Tardes' 1903 S-shaped curve is of current importance because "most innovations have an S-shaped rate of adoption". (Rogers, 1983) The variance lies in the slope of the "S". Some new innovations diffuse rapidly creating a steep S-curve; other innovations have a slower rate of adoption, creating a more gradual slope of the S-curve. The rate of adoption, or diffusion rate has become an important area of research to sociologists, and more specifically, to advertisers.

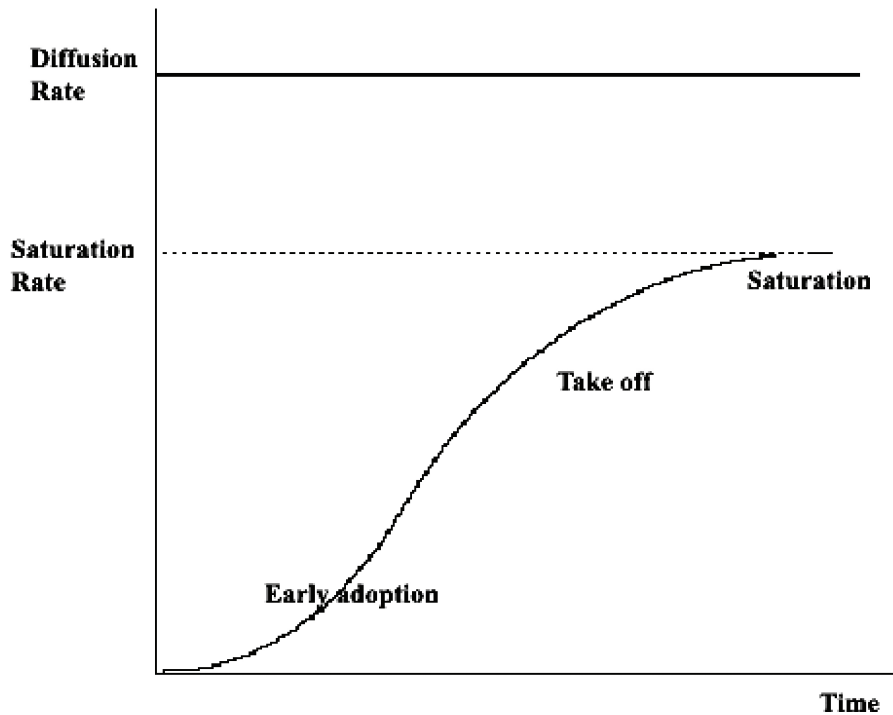


Figure 2: The S-Shaped Diffusion Curve.

The rate of adoption of technology by individuals/organizations tends to follow an S-shaped curve, characterized by a hazard function that specifies the likelihood of adoption against the remaining pool of potential adopters in a population. The most common form of the hazard function comes from the Bass specification (see e.g., Bass, 1969, Norton and Bass, 1987).

The model includes three key variables: (i) the coefficient of innovation, denoted by a , which captures the growth rate of a technology independent of the current level of adoption; (ii) the coefficient of imitation, denoted by b , which captures the influence of the current installed base on the rate of growth; and (iii) the saturation level N , representing the ultimate maximum penetration level of the technology. If the level of

penetration at time t is given by $S(t)$ and the rate of diffusion by $s(t)$, the basic Bass diffusion model of a single technology is specified as: $s(t) = \left[a + b \frac{S(t)}{N} \right] \cdot [N - S(t)]$.¹⁰

Here the adopters are distinguished as being early adopters (more educated and innovative individuals), followers (imitators or adopters who sees its success and want to join), and laggards (less-advanced individuals who either do not adopt or adopt very late). The S-shaped adoption curve is derived from a symmetric bell-shaped curve that describes the distribution of adopters over time. The S-shaped behaviour is in this case the outcome of imitation. While the interaction/contact among individuals is the driving force of diffusion, profitability of the technology, user- friendless and quality of technical support are factors that are assumed to enhance diffusion.

Key characteristics of the Rogers' diffusion theory are:

- Studies within this framework typically focus on determining factors that influence the rate of diffusion, especially beneficial innovations.
- They correlate the rates of adoption with characteristics of the technologies and their potential adopters in an attempt to explain the speed of diffusion and ultimate acceptance of the new innovation/product.
- The use of new technologies spreads gradually.
- There is a significant time lag between the time a new innovation is introduced and when it becomes widely used by producers or consumers.

¹⁰ The coefficient of innovation a is considered an external variable since its influence is driven by forces outside the diffusion level of the particular technology in question. The coefficient of imitation b reflects an internal influence since it accounts for the “network effects” that drive growth. N represents the eventual saturation level and is a factor of both the shape of the curve, as derived from a and b , and the scale of the actual penetration values $S(t)$. The coefficient a can be interpreted as the starting level of the diffusion process, or the leftward skew of the curve, and b as the strength of the internal network effects influencing the diffusion curve.

- Adoption is a decision by a specific individual to use a technology, while diffusion is the aggregate process of product penetration: It is measured by the percentage of potential users who actually adopt a technology.
- Diffusion curves measure aggregate adoption as a function of time. They tend to be S-shaped.

Rogers' theory of diffusion of innovation has been criticized by various scholars for the following reasons:

- It fails to account for complex technological innovations (such as ICTs) and treats technology as a material object lacking the social element (Lyytinen and Damsgaard, 2001).
- It overlooks the aspects of use and organizational impact of the innovation, which are dependent on social, political, economic and structural elements.
- It emphasizes the individuals (or adopters) rather than the social system in which the diffusion takes place. Three categories of adopters (early¹¹, followers¹² and laggards¹³) are identified based primarily on their timing of adoption, which ignores for example how unanticipated events may bring in new adopters or exclude existing ones.
- Success or failure of technology introduction is attributed to individuals rather than to social structures.
- It tends to deemphasize problems of social nature, such as politics, power, education, culture and lack of capital among the potential adopters of the innovation.

¹¹ The more educated and innovative individuals.

¹² The imitators or adopters who sees its success and want to join.

¹³ The less-advanced individuals who either do not adopt or adopt very late.

In chapter two, I further discuss how Rogers' diffusion perspective has been applied in IS research, primarily through the Technology Acceptance Model (TAM), and some of the associated strengths and weaknesses of this approach.

1.4.2. Technology transfer understood as taking place in channels

This perspective is developed by Mayuri Odedra, in her analysis of ICT in Africa and the inherent challenges of its transfer to developing countries. Odedra (1991) defines ICT transfer as being a problem of the transfer of knowledge about a number of aspects including about how a particular system works, its operation, maintenance and upgrading over time. Odedra describes technology transfer as being facilitated through the following five channels:

Acquisition of technology: Some transfer takes place with the sale of equipment or software to an organization or country (software packages are imported by vendors and customized according to the client's needs). Skills transferred may just be operational, programming or maintenance in nature, but this grows with increasing awareness of the technology and with human capital formation.

Education and training: Technological know-how transferred through education and training is subject to certain constraints, such as the availability of facilities, lecturers and books. The often unsuitable course syllabus, the limited access to books and computers, and lack of training facilities, reduces the effectiveness of technology transfer through the channel of education and training.

Technical assistance: Some technology transfer takes place through technical assistance. Effectiveness of this is limited as assistants usually come to recipient countries for a short time and leave without fully training the users. In other cases, they may not be familiar with the job they are supposed to do due to the organizational problems in the

recipient country. They therefore often spend more time trying to understand and overcome these problems, instead of transferring technology.

Licensing and direct foreign investment: Licensing is also known to enable the transfer of product or process know-how. As an instrument for technology transfer, licensing is applied singly or in combination with other instruments such as foreign investment, import of machinery or/and technicians. As with most experiences of assembly, little technology is transferred especially where all components are imported and reverse engineering capabilities are limited. Licensing does not play an important role in Africa in general, and the effect it has on the transfer process of ICTs is therefore minimal. Direct Foreign Investment (DFI) in branches or subsidiaries of multinational corporations is also a way of obtaining technology from abroad. This can ensure a rapid transfer of technological information and means, but not necessarily of the understanding or know-how. DFI can be either export oriented or local market oriented. However, the latter is only possible in countries with large markets or where the gross domestic product is high, which is often not the case in most African countries.

Odedra's conceptualization of technology transfer can be criticized on the following points:

- While providing a systematic way to study technology transfer process, it suggests analyzing the success or failure of the [ICT] transfer process in terms of the effectiveness of the different transfer channels. This is a limited view as it largely ignores the process involved in institutionalizing the transfer.
- It emphasizes primarily the one way transfer of technology/artefacts and knowledge from the North to the South, assuming that people are willing and able to understand and apply the technology and related knowledge. This is often not the case as the transfer decisions are taken at the level of the ministries, ignoring the field level staff who are supposed to ultimately work

with the technology. In the context of transfer of Geographical Information Systems (GIS) to India, Sahay and Walsham (1996) write how these decisions are taken at the national level by officials of the international agency (USAID in their case) and the Ministry of Environment and Forests. The district forests officers, who are the supposed end-users of the system, are not consulted at all in the decision to transfer the technology. Such exclusions of users often lead to the selection of “inappropriate” technology.

- Transferring an application focused technology (such as HIS) and related knowledge becomes problematic, since it involves contextual and cultural elements such as language and meanings, which can not be transferred, but rather need to be built locally. This requires, in addition to the transfer of artefacts, technological learning to take place (Braa and Monteiro, 1995).
- It ignores various important internal and external factors, such as the organizational structures and infrastructure, awareness of the value of [ICT] in the organization or nation, and the indigenous organizational capacity to use ICT. For example, Puri and Sahay (2003), in their study of the transfer of GIS for land management in India, describe that indigenous knowledge (context-specific knowledge embedded in the practice of community members) has historically been excluded and made invisible through the use of westernized scientific models developed by remote sensing scientists on land and water management on the assumption that it was inferior, unscientific, and static (Howard and Widdowson, 1996, 1997). As a result, such projects did typically not reach a stage wherein the systems were actually being used by the district officials. Their study suggests that technology transfer is not about the artefact only, but also of the different kinds of knowledge systems that are required to make it work in practice.

1.4.3. Technology transfer understood as conceived within a life-cycle

Another perspective on technology transfer is given by Baark and Heeks (1999), called the model of donor funded [ICT] transfer from industrialized to developing countries. This model conceptualizes technology transfer as a life-cycle comprised of five steps: choice of technology; purchase and installation; assimilation and use; adaptation; and, diffusion. In developing this model, the authors consider two types of technologies to be transferred: those related to the development of general projects and [ICT]-specific projects. In the general development projects, [ICT] is used as a means to achieve goals other than the implementation of the ICT itself. A typical example is the establishment of telecenters in different countries such as Mozambique. Telecenters are seen in this case as means for addressing the unequal development of rural areas, and ICTs provide the mechanisms to enhance universal access to knowledge and thus contribute to the larger problem of rural development (Macome, 2003).

ICT specific projects aim at, for example, raising the technological level of the recipient community. For example, the establishment of a Wireless fidelity (WiFi) local network represents an initiative aimed at raising the technological level of the receiver to communicate. The start-up costs of WiFi are lower and its installation more flexible than other broadband options, which makes it potentially appropriate and cost-effective for developing countries (Dutton et al., 2003).

While this life cycle model provides a useful structure also for analyzing donor funded transfer to developing countries, at least two limitations can be identified:

- While transfer of machinery related technological infrastructure can take place without much adaptation, most information systems transfers require significant modifications to be made to the software, including training,

- maintenance, bug fixing, and software customization according to the current organizational needs.
- The sequential nature of the model may hardly reflect the sequence of events in practice. For example, adaptation [of software] might happen partly before and also in close contact with the assimilation. Often, the adaptation is carried out as a trial and learning process similar to designing a new system by means of prototyping (Bødker et al, 1987).

In summary, I have in this section discussed three perspectives on technology transfer conceptualization. While representing different approaches, the three conceptualizations have a common ground in the sense that they view technology transfer primarily as a one way and sequential process. This, however, deemphasizes the processes involved in institutionalizing the transfer, problems of a social nature, such as politics, power, education, and culture of the potential adopters of the technology.

1.5. The need to re-think “technology transfer”

The above approaches to ICT transfer and adoption conceptually and also empirically can be seen to have been influenced by a diffusion kind of approach to innovation. The following limitations can be identified to characterize these approaches:

- Technology is treated as a ‘black box’. Once developed, technology is seen to be invariant and context free, and can thus be seamlessly transferred. The characteristics¹⁴ of the technology are seen on a rather superficial level,

¹⁴ The characteristics of the [technology] include relative advantage – the degree to which it appears superior to existing products, compatibility – the degree to which it matches values and experiences of individuals in the community, complexity- the degree to which it is relatively difficult to understand or

deemphasizing the technical specificities. Researchers, especially in the domain of science and technology studies (for example Williams and Edge, 1996, Star, 1991, Law and Callon, 1992, Lyytinen and Damsgaard, 2001), have argued against treating technology as a black box, and for being more specific about technology (Monteiro and Hanseth, 1995, Orlikowski and Iacono, 2001).

- Technology transfer is seen as a sequential and one way process, treated in a binary manner in terms of the transfer of artefact from the North to the South (Madon et al., 2004). The technology is created in the North and spread to the South for use, to help regions to “catch up” by implementing innovation and with it bringing about social change. This rather macro-level perspective on the spread of technology tends to disregard the negotiations required to make things work in practice at the micro level of an organization. This view also tends to ignore the potential for unintended effects and drift, like political elections (Silva, 2002), which may exert a significant influence on actual technology transfer processes (Avgerou, 2000; Pradhan, 2002).
- The technology transfer process is seen in a rather de-contextualized manner. The inherent intra-organizational (Prescott and Conger, 1995) conditions, such as the bureaucracy, politico-economic motivation and infrastructure, are largely ignored. Puri and Sahay (2003) for example, found that despite a variety of governmental initiatives¹⁵ to mitigate land degradation and water scarcity in India (in rural areas), related projects failed to realize the potential of GIS technology. Reasons for this included how the centralized, scientific and technical-focused design approach failed to align with the local social priorities.
- The degree of adoption, use and diffusion of technology is measured in terms of the rate of adoption and potential adopters are seen as individuals de-linked from the socio-technical system. Such a static and limited approach ignores

use, triability - the degree to which an innovation may be experimented with on a limited basis and observability - the degree to which the results of an innovation are visible to others.

¹⁵ These include 10 pilot projects launched by the local Ministry of Environment and Forests, and implemented by leading scientific institutions (Hutchinson and Toledano, 1993) in selected districts.

technological learning (Braa and Monteiro, 1995) which may result from such transfer processes, and also influence them.

- The technology transfer process is seen in one frame and as one giant step of movement from the North to the South rather than as a series of incremental and interconnected steps. Such a conceptualization ignores critical issues of how these projects are scaled up and sustained over time. This rather rational economic logic is for example explicitly expressed in the Development Discourse of Harry Truman, former US President, in 1949. He suggests that poor countries can become “developed” by “replicating” the economic models of “advanced” societies, based in the application of capital, science and technology (Escobar 1995). Arguments have been made about the incompatibility of western [management] methods and techniques that inscribe assumptions of rationality that are different from those in the context of the South (Powell, 2001). Walsham (2003) similarly argues that development is not something which can be reduced to ‘best practice’ transferred from the “developed” to the ‘developing’ countries.

Existing technology transfer perspectives, especially as exemplified by diffusion theory, have been seen to inscribe a number of limitations which suggest that developing countries need to identify alternative and more appropriate models or mechanisms to enable more effective transfer processes. One alternative conceptualization is provided by Actor Network Theory (ANT), for example, (Akrich, 1992, Law and Callon, 1988), in which the inherent separation of people/society and technology/things is avoided. This perspective, based on the key notion of translation, is drawn upon in this thesis to describe and analyze the technology transfer of the District Health Information Software (DHIS) to Mozambique, within the framework of the Health Information Systems Programme (HISP) action research initiative.

1.6. Research aims and contributions

My research aims can be formulated as follows:

- To develop a theoretical conceptualization of technology transfer based on a “translation perspective”. I will seek to formulate an alternative conceptual framework to understand the dynamics of HIS technology transfer drawing upon concepts from ANT, especially the notions of translation and network.
- To understand and address the challenges shaping the translating process of a HIS software in South-North-South networks.

1.7. Empirical basis

To address the above research aims, an empirical study was carried out to understand the involved tensions, challenges and dynamics, procedures and methodologies in the process of transferring a HIS (including its adaptation and localization) from South Africa to Mozambique. The main focus is to follow and facilitate the process of adaptation and customization of the DHIS software to fit and address the context of the health system in Mozambique. The empirical basis for addressing the research questions (more details are provided in Chapter three) is provided by an ongoing action research project called HISP which was initiated in South Africa in 1994 and “transferred” to Mozambique in 1998. My thesis examines the various challenges and opportunities that were involved in this process, based on empirical work carried out during the period from 2000 to 2003 in selected districts, provinces, and also at the national level. Further details of the empirical strategy adopted will be provided in Chapter four.

1.8. Structure of the thesis

The structure of the thesis comprises of the following five chapters:

In chapter one, I have presented the problem domain and research motivation. The chapter was built around five themes (1) the challenges of healthcare in the developing world; (2) the potential of ICTs to support healthcare management; (3) a critical view on the reasons underlying this unrealized potential; (4) traditional approaches to technology transfer; (5) the need to re-think technology transfer.

Based on a survey and critical analysis of traditional approaches to technology transfer, chapter two presents the theoretical framework, also informed by the relevant literature from the IS field. Here, the diffusion perspective is presented as the historically existing dominant IS paradigm on technology transfer. This chapter presents and extends an alternative to the diffusion perspective based on the concept of translation.

Organized in three sections, chapter three provides background information about Mozambique and with it the empirical research setting analyzed in this thesis. The socio-economic overview and health profile of Mozambique are provided in section 3.1. The section 3.2 is devoted to the organizational structure, infrastructure, human resources and financial capacity, while the last section 3.3 is dedicated to experiences of technology transfer to Mozambique.

Chapter four is devoted to describe research strategy and methods, and is organized in five sections (1) research genesis and motivation; (2) research design; (3) research approach (4) data collection methods; and (5) data analysis. The chapter provides both the philosophical and ontological assumptions of the research, and empirical details of

the research design characterized by Action Research (AR), longitudinal case study, multiple level analysis and interpretative approach.

Chapter five provides an overview of the research findings as summarized from the publications included in the thesis as appendixes. It starts by presenting the individual summary of each article and ends with an integrating synthesis of all articles. Here, the research questions addressed in each articles are highlighted and the respective findings described.

The contributions and conclusions of the study are provided in chapter six organized in three sections. In the first, the key theoretical contribution concerning the conceptualization of the technology translation process is presented. The practical challenges and approaches to develop such translations are described in section 2. Finally, in section 3, some concluding remarks are presented.

2. CHAPTER TWO: THEORETICAL FRAMEWORK

In this chapter, I develop a theoretical lens to study technology transfer based on a translation perspective. In the introduction chapter, I had outlined three perspectives to the study of technology transfer. These perspectives, I argue, do not address adequately the issue of acceptance of the technology by the users and the sustainability of the processes. This issue is the focus of this chapter, in which I elaborate on the diffusion perspective, exemplified by its application through the Technology Acceptance Model (TAM) in the domain of IS. I then present its critique arguing for the need for an alternative perspective based on translation defined in terms of sustainability of networks. As a conclusion to this chapter, I propose a conceptual framework which identifies the various influences to this translation process: legacy systems and installed base; changing code – how software is adapted to the local context; the role of participation – how users are enrolled; and the balance between localization and internationalization. This leads to the formulation of an integrated theoretical framework.

2.1. The diffusion perspective: A dominant paradigm in IS

The application of the diffusion perspective in IS finds substance through the Technology Acceptance Model (TAM). The TAM, which was formulated and introduced in the IS domain by Davis et al. (1989), has been applied in various IS settings, including the transfer of ICT to developing countries. Before describing these applications, I outline the basic assumptions and principles underlying the TAM.

The TAM is based on two key theoretical concepts relating to the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975)¹⁶ and Innovation Diffusion Theory (IDT) (Rogers 1983, 1995)¹⁷. Despite differences in the conceptualization of TAM, TRA and IDT with respect to their specific constructs, there is a relative convergence in the concepts used, especially in their focus on how individual's beliefs or perceptions of ICT have a significant influence on usage behaviour. The constructs used in TAM, and their relation to those used in TRA and IDT are summarized in Table 3 below, and then discussed.

Table 3: Models and Theories of [ICT] Acceptance.

Core constructs and definitions		
Innovation Diffusion Theory (IDT)		
Relative Advantage		“The degree to which an innovation is perceived as being better than its precursor” (Moore and Benbasat 1991, p.195).
Ease of Use		“The degree to which an innovation is perceived as being difficult to use” (Moore and Benbasat 1991, p. 195).
Image		The degree to which use of an innovation is perceived to enhance one's image or status in one's social system (Moore and Benbasat 1991, p. 195).
Visibility		The degree to which one can see others using the system in the organization (adapted from Moore and Benbasat 1991).
Compatibility		The degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters (Moore and Benbasat 1991, p. 195).
Results Demonstrability		The tangibility of the results of using the innovation, including their observability and communicability” (Moore and Benbasat 1991, p. 203).
Voluntariness of Use		The degree to which use of the innovation is perceived as being voluntary, or of free will (Moore and Benbasat 1991, p. 195).
Theory of Reasoned Action (TRA)		
Attitude	Toward	An individual's positive or negative feelings (evaluative affect) about performing the target behaviour (Fishbein and Ajzen 1975, p. 216).
Behaviour		
Subjective Norm		The person's perception that most people who are important to him think

¹⁶ Drawn from social psychology, TRA is an influential theory of human behaviour. It has been used to predict a wide range of behaviors (see Sheppard et al. 1988 for a review). Davis et al. (1989) have applied TRA to individual acceptance of technology and found that the variance explained was largely consistent with studies that had employed TRA in the context of other behaviours.

¹⁷ Grounded in sociology, IDT (Rogers, 1983, 1995) has been used since the 1960s to study a variety of innovations, ranging from agricultural tools to organizational innovation (Tornatzky and Klein 1982). Within IS, Moore and Benbasat (1991) adapted the characteristics of innovations presented by Rogers and refined a set of constructs that could be used to study individual technology acceptance. Moore and Benbasat (1996) found support for the predictive validity of these innovation characteristics (see also Agarwal and Prasad 1997, 1998; Karahanna et al. 1999; Plouffe et al. 2001).

	he should or should not perform the behaviour in question (Fishbein and Ajzen 1975, p. 302).
Technology Acceptance Model (TAM)	
Perceived Usefulness	The degree to which a person believes that using a particular system would enhance his or her job performance (Davis 1989, p. 320).
Perceived Ease of Use	The degree to which a person believes that using a particular system would be free of effort (Davis 1989, p. 320).
Subjective Norm	Adapted from TRA/Theory of Planned Behaviour (TPB). Included in TAM2 only.

TAM is tailored to the context of IS, and was designed to predict information technology acceptance and usage in the workplace. Unlike TRA, the final conceptualization of TAM excludes the attitude construct in order to explain intention relatively parsimoniously. A further enhancement of TAM (called TAM2) has extended TAM by including subjective norms as an additional predictor of intention in the case of mandatory settings (Venkatesh and Davis 2000).

The TAM is based on the assumption that two particular beliefs, perceived usefulness and perceived ease of use, are of major relevance for [ICT] acceptance behaviours (Davis et al., 1989), and its diffusion over a larger population. Davis describes the goal of TAM as to provide an explanation of the determinants of computer acceptance that is general, and capable of explaining user behaviour across a broad range of end-user computing technologies and user populations (Davis et al., 1989:985). Schematically, TAM is depicted in Figure 3 below.

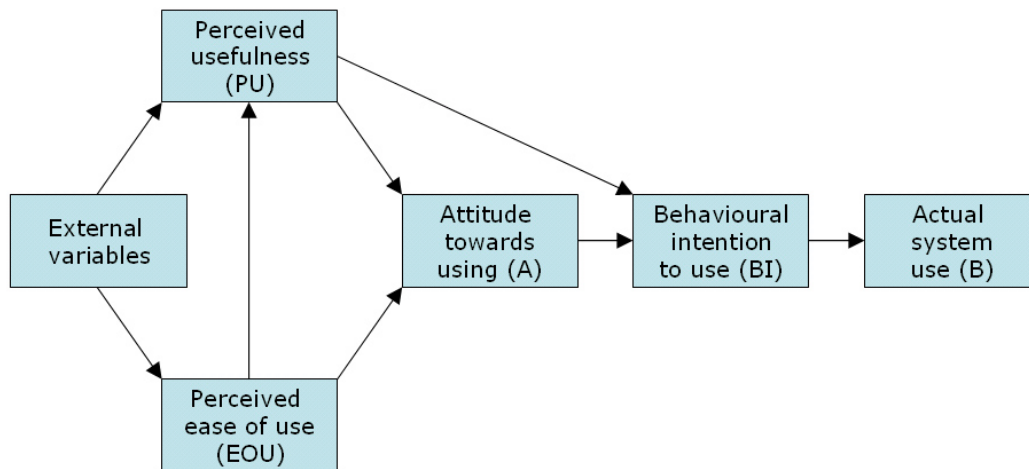


Figure 3: Technology Acceptance Model (Davis et al., 1989).

Perceived usefulness is defined as the degree to which a person believes that using a particular system would enhance his or her job performance (Davis et al., 1989). This means that people are more likely to use ICT that they believe will help them perform their job better. Perceived usefulness is argued to have a significant influence upon system utilization because of a user’s belief in the existence of a user-performance relationship. Further, Davis adds that the theoretical foundations for perceived usefulness as a predictor of usage behaviour are derived from a number of other research streams, such as, self-efficacy theory, cost-benefit paradigms, and the adoption of innovation research.

Davis (1989:320) defines perceived ease of use as “the degree to which a person believes that using a particular system would be free of effort.” Therefore, even if a system is believed to be useful by an individual, if the system is too difficult to use, the potentially enhanced performance benefits to be derived from the system are outweighed by the effort required of having to use it. Perceived ease of use is an individual’s assessment that technology interaction will be relatively free of cognitive burden, i.e., ease of use reflects the facility with which the individual is able to interact with a particular software. It has been shown that individuals are more likely to

interact with new technology if they perceive that relatively little cognitive effort will be expended during the interaction (Adams et al., 1992).

Over the years, the TAM has been drawn upon by IS researchers to study acceptance of various ICTs including the internet, mobile phones, E-Commerce, etc. both in the context of developed and developing countries. In the next section, I discuss some examples of these applications, and then analyze some of their limitations.

2.2. Application of the Technology Acceptance Model in IS

ICT prediction models including TAM have been applied to study usage behaviour of a range of technologies including the internet (Rai et al., 1998), Text Processors, Spreadsheets, Electronic and Voice Mail (Adams et al., 1992; Gahtani and King, 1999), Face-to-Screen interfaces in electronic commerce (Aladwani, 2002), expert systems application (Agarwal and Prasad, 1998), telemedicine and mobile technology.

For example, Rai et al., (1998) applied TAM to study the global diffusion of the internet. Understanding internet growth patterns is an important task, particularly for policy formulation, capacity planning, and for the introduction of new networks and software. For example, planning for the number of hosts that can be supported has to account for the network's potential future use. Rai et al. (1998) applied the model based on the assumption that non-adopters of an innovation are increasingly likely to imitate adopters over time. Their study concluded that policy planners and ISPs should carefully reassess their assumptions about the simplistic factors driving internet diffusion because of their inability to recognize the diversity of the social systems into which the internet is diffusing, including variations in government policies, commercial sponsorship, related technological developments, and also user behaviour.

In other studies related to usage behaviour towards Text Processors, Spreadsheets, Electronic and Voice Mail (Adams et al., 1992; Gahtani and King, 1999), attempts were made to establish a better understanding of the relationship between ease of use, usefulness, and actual usage of the technologies. These different authors acknowledged the difficulties in studying this relationship, including finding systems where usage is truly voluntary, a basic assumption of TAM. Therefore factors such as usefulness and ease of use may have little (or no) influence on overall levels of use, although they may influence measures such as user satisfaction. The studies concluded that the relationship of the two constructs to usage is more complex than is typically postulated in the literature. Adams et al. (1992) recommended linking compatibility issues to three further belief variables: user needs, values, and experience (Gahtani and King, 1999), as a means to address this complexity.

In another study conducted by Aladwani (2002), the TAM was applied to analyze the challenges in the diffusion of electronic commerce, including the exchange relationship from face-to-face to face-screen, and to examine the ease and usefulness of transactional Web sites. The findings from the study, while useful for the development of two tools for measuring perceived ease of use and usefulness in a Web based context, acknowledged that each organization is particular based on its operations, management practices, customers, etc. These differences need to be identified and measured explicitly in Web site planning, analysis, development, and implementation.

These studies thus demonstrate how variations in the context influence technology adoption and use. While prediction models such as TAM have been largely generated and confined to North American empirical settings (Mathieson et al., 2001; Straub, 1994; Gallivan, 2001), there have been some, although limited, attempts to apply these models in non western contexts (for example, de Vreede et al. 1999; Musa et al. 2005, and Gefen and Straub 1997).

For example, de Vreede et al. (1999) explored the application and acceptance of Group Decision Support Systems (GDSS) in Africa, in which the TAM model was extended to include a number of relevant external factors. The findings from this study suggested that although there is a potential for applying GDSS in Africa to support capacity building efforts, there is a need to consider other constructs in TAM such as the endorsement of top management, computer literacy, oral communication, preferences, power issues, and satisfaction with use. The empirical analysis of this study suggested to avoid unconditional generalizations related to the use of TAM across countries.

Musa et al. (2005) attempted to extend TAM to account for the realities in developing countries, in particular Sub-Saharan Africa. They argued that most technology adoption research presumes that technology is readily available, and the onus of accepting or rejecting it resides with the end user. However, for the majority of potential users in developing countries, adoption is not about choice, since universal access to technology is not possible for various reasons such as a weak IT infrastructure. Musa and colleagues thus suggested extending TAM to include constructs such as technological cultururation, accessibility and exposure to ICT, and perceived socio economic prospects.

The above examples of the application of TAM to study the usage behaviour of different technologies in various settings, both in developed and developing countries, highlight some important points of critique. Four main critiques are identified:

- Considering the characteristics of the technology itself
- Socio-technical mismatch
- A focus on voluntary use situations
- Snapshot instead of a process perspective (Retrospective timing of measurement)

These are now discussed.

Considering the characteristics of the technology itself

Hanseth and Monteiro (1995) argue the need to consider the material characteristics of the technology more seriously, and that IS must be analyzed with respect to varying degrees of granularity. Since IS consists of a large number of modules, functions and inter-connections, it is not prudent, for example, to discuss it only at the granularity of an artefact (Pfaffenberger, 1988), the programming language (Orlikowski, 1992), the overall architecture (Applegate 1994) or a media for communication (Feldman, 1987). Hanseth and Monteiro's critique is reflected in the following quote:

[..] We can not indiscriminately refer to as IS, IT or computer systems [ignoring their specificities] [...] Unintended consequence of not being fine-grained enough is removing social responsibility from the designers (ibid., p. 343). It removes social responsibility in the sense that a given designer in a given organization obliged to use, say, a CASE tool, may hold that it is irrelevant how he or she uses the tool, it is still a tool embodying a certain rationale beyond her control (Hanseth and Monteiro, 1995: 329).

The argument that IT has the potential to enable or constrain organizational changes (Applegate 1994; Orlikowski 1991) has been well established by IS researchers. This suggests therefore that there is a need to be more concrete about which aspect, module or function of an IS enables or constrains what kind of organizational changes. However, what is found in a majority of TAM applications is that technology is treated as a "black box", with its material characteristics not elaborated upon. A black box implying that, no matter how complex it is or how contested its history, it is now so stable and certain that it can be treated as a fact where only the input and output counts. Aanestad's (2002) study on the implementation of surgical telemedicine in

Norway contradicts the aforementioned assumption. Her thesis argues for a better understanding of how the technical and the organizational issues are related and interwoven. She found, for example, that telemedicine technology is not merely a tool to be introduced and deployed in an organizational context. It must rather be cultivated in the sense that its use must be achieved or performed through an ongoing adaptation and development process.

The technologies that have been studied in many of the TAM applications have focused on relatively simple (individual or one department-oriented) technologies as opposed to the complex and interconnected infrastructures such as computer-based HIS, which involve many actors each with different interests and agendas (e.g. Ministry of Health, donors, program managers, community, etc.). In this case, for a technology to be successfully implemented, there has to be alignment both between its data structures and the use domain, and between its functionality and the processes and practices of the organization. To the extent that the technology prescribes specific action to be carried out, the technologies impose structures, which may be in conflict with the organizational culture.

In summary, it can be argued that TAM applications have tended to treat technology rather unproblematically and have been generally limited to study single user applications. As a result, their applicability to large, complex and interconnected systems like systems for healthcare support in developing countries, remains questionable.

Socio-technical mismatch

In applications of the TAM model, the link between the model's mathematical formulas and the social realities is somewhat obscure. The model allows for an observation of the effects of altering the weighting values against the attributes under assessment through the utilization of in-built sensitivity analysis tools. Such models

can be criticized for their highly technical (essentially mathematical) character which can make them technocratic and inappropriate for conducting deeper socio-organizational examination.

Repeated studies of TAM have emphasized how the model is inadequate to apply universally to different social contexts, and have gone on to suggest additional variables to be included to account for these variations. For example, in the context of TAM applications in developed countries, additional variables such as subjective norms (Venkatesh and Davis 2000), extrinsic¹⁸, and intrinsic¹⁹ motivation (Davis et al. 1992) have been suggested. In the context of developing countries, where there are greater variations in conditions from developed settings, additional variables such as technological curation, accessibility and exposure to ICT, and perceived socio economic prospects (Musa et al., 2005) have been further incorporated into the TAM equation.

However, in line with recent research in IS which has made significant critiques of treating culture as a “static” variable, which can be measured using standardized instruments across social contexts, I argue that such incorporation of additional variables is inadequate, and cultural differences between countries should be considered seriously (Walsham, 2001). Walsham argues:

I do think that Western-origin methodologies such as Logframe are often inappropriate for [...] different cultural environments. I have had many years experience of failed Western-driven technology projects in Third World countries. Whilst these cannot be put down simply to a particular

¹⁸ The perception that users will want to perform an activity “because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions” (Davis et al. 1992, p. 1112).

¹⁹ The perception that users will want to perform an activity “for no apparent reinforcement other than the process of performing the activity per se” (Davis et al. 1992, p. 1112).

methodology, they often reflect unwillingness on the part of Western aid agencies and others to take due account of different attitudes to fundamental issues such as conceptualization of knowledge, politics, information sharing etc. Training is often the mantra, but training does not touch more fundamental cultural attitudes ...My argument in a nutshell is the need to take culture seriously (Walsham, 2000:227).

Westrup et al. (2002), in supporting Walsham's argument, has advocated based on empirical analysis in China, Jordan and Egypt, that to take culture seriously implies investigating cultures, analyzing how cultures are expressed, and by describing cultures. Further, technical aspects are embedded within deliberative decision-support processes and cultural preoccupations within organizational and socio-economic contexts, conditions which are historically shaped. Madon (2000) also argues that diffusion models such as those applied by international agencies (e.g. the World Bank), need to take into consideration cultural aspects such as beliefs, values and language, [which can not be reduced to a formula or statistical generalizations].

In summary, the TAM approach tends to reduce complex cultural contexts to a limited set of variables and assumes that they can be measured using standardized scales. Such an approach is contrary to current conceptualizations of culture and social context in IS research, which argues for a more interpretative, situated and processional understanding.

A focus on voluntary use situations

While there have been some tests of the TAM in organizational settings for example (Plouffe et al., 2001), in many cases the actors/participants have been students or managers/users/employees with or without control of the tasks, and experience with the technology in question. Further, most of the tests of the models were conducted in voluntary usage contexts rather than in organizational settings where use is mandatory

(Braa, 1997). Therefore, one must use caution when generalizing those results to mandatory settings that impose more challenges including the socio-cultural and political influences, which represent the daily life of managers. This suggests the need to extend our understanding of user behaviour as studied by TAM to go beyond situations of voluntary adoption or use, if we are to consider using TAM for mandatory settings.

Researchers using mathematical models like TAM tend to make statistical generalizations from the sample studied to the larger population. However, an interpretive approach, as is the case in this thesis, does not rely on statistical generalizations but rather on understanding the [socio-technical phenomena] in question and its associated practices (Walsham, 1995; Walsham 1999).

Generalizations, Walsham (1995) argues, come in the form of rich insights, theories and concepts, which reflect a level of abstraction not provided by statistical generalizations.

In summary, the argued applicability of TAM is based in its successful tests in voluntary use situations, where the users have limited control over the tasks or experience with the technology. Such use situations tend to ignore the socio-political realities of organizations and their influences on use. The value of statistical generalizations arising from TAM are thus of limited value to interpretive analysis of technology use in organizational settings.

Snapshot instead of a process perspective (Retrospective timing of measurement)

In general, most of the tests of TAM have been conducted subsequent to the participants' acceptance or rejection decision rather than during the active adoption decision-making process. With some exceptions (for examples, Davis et al. 1989), the technologies examined were also already familiar to the individuals at the time of measurement. The problem with this is that by the time the studies have been carried

out, behaviour has become routinized such that individual reactions reported in these studies are retrospective (see Fiske and Taylor 1991; Venkatesh et al. 2000). Rather than studying the users' *post-hoc* rationalizations of decisions, there is a need to explicitly focus on the processes the user goes through in making these decisions.

Being discontinuous, technology transfer, adoption or implementation is not a definitive phenomena which can be understood in 'snapshots' in time or predicted from levels of precursor variables, but is also influenced by chance and random events (der Blonk, 2002).

Contemporary thinking in IS research emphasizes the need for a process (Markus and Robey, 1988; Orlikowski and Baroudi 1991; Walsham, 1995) perspective to study issues like "transfer" or "implementation". The process perspective helps to follow and explicate how outcomes develop over time, focusing on the dynamics of social change and explaining how and why the results of development (or adaptation) efforts are achieved.

In summary, the limitation of TAM is associated with the fact that its usability or applicability was mostly evaluated subsequent to the participants' acceptance (or rejection) of the technology is question. Such an approach tends to overlook the inherent discontinuous adoption process, which includes the user-technology interaction and mutual influence, chance or unanticipated events, the context and the process of technology, which can not be predicted as cause/effect variables, but can be understood rather overtime as a socio-technical process of change.

The primary objective of this review was to investigate the strengths and weaknesses of the diffusion approach, as emphasized by the application of the TAM to different IS domains. The TAM model can be seen to have particular strengths, which is reflected in its large scale use amongst IS researchers, especially those trained in and based in North American universities. Being a model that is quantitative in nature and leading

to statistical generalizations, makes it attractive to researchers favouring a positivist orientation. The model is simple and parsimonious in nature, (for example the manner in which it reduces culture to a few variables) thus making it very accessible. Researchers can apply the model in classroom settings, for example, without having to do extensive and extended empirical fieldwork.

However, it is hard to defend the model against the critiques presented, especially when applied to complex social settings like the healthcare sector in developing countries. In this thesis, I argue that the limitations of this model can not be addressed in a piecemeal manner by adding a few additional variables, but instead the conceptual approach towards technology transfer needs to be radically re-conceptualized. In the next section, I argue that the translation perspective provides one potential avenue for such a re-conceptualization.

2.3. Re-conceptualizing technology transfer using the translation perspective

I will here first describe how the translation perspective offers an alternative conceptualization of the processes of technology transfer and the spread of innovations, more generally, and to this particular study of HIS. With a focus on the transfer of software, in the context of the health care sector of a developing country within a global network of software exchange, a particular set of relevant concepts are identified in order to analyze the dynamics of translation. These concepts are drawn from the domain of Actor Network Theory (ANT), particularly from the “sociology of translation” (Callon, 1980, 1986) and are useful to analyze how actors are identified, how their roles are defined, and how their interests are aligned in such a way that certain entities control others (Callon, 1986; Callon and Law, 1989; Latour, 1987, 1993).

An illustrative example of the application of sociology of a translation perspective is Michel Callon's description of the process of domestication of the scallops and the fishermen of St. Brieuc Bay in France (Callon, 1986). The study examines the progressive development of new social relationships through the constitution of a "scientific knowledge" to understand the causes for the decline in the population of scallops and to develop specific conservation strategies. In such an endeavour, a problem is formulated, actors are identified, and the actors' interests are determined to lie in admitting the proposed (by the initiator or *primum movens*) program of action. The basic argument is: If the scallops want to survive, if the scientific colleagues hope to advance knowledge about the subject, if the fishermen hope to preserve their long-term economic interests, then [all the actors together including the *primum movens*] must agree in answering these critical questions and thus align their interests through the obligatory passage point, which refers to the node in the network through which all the actors who have a stake in the problem have to pass.

In this classic paper, Callon (1986) proposes to understand translation as comprising of four moments. **Problematization** is the first, and is concerned with how to become indispensable to other actors in an issue defined as a drama. This includes defining the nature and the problems of the others in such a way that actors establish themselves as indispensable to the solution, and suggest that the problem would be resolved if the actors negotiated the 'obligatory passage point'. **Interessement** is a series of processes by which the *primum movens* of the story seek to lock the other actors into the roles that were proposed for them. This includes the deployment of special devices aimed at imposing the roles and identities defined during the problematization moments. If successful, **interessement** leads to the establishment of a stable network of alliances and to the next moment, the **enrolment** (of actors). **Enrolment** represents a set of strategies by which the *primum movens* of the story seeks to define and interrelate the various roles they had allocated to others. The fourth moment is of **mobilization** which is a set of methods used by the *primum movens* to ensure that supposed

spokesmen will represent the various relevant collectivities and not be betrayed by the latter.

An important study using this translation perspective in the context of technology transfer is presented by Madeleine Akrich (1992). Akrich describes the negotiations that take place when a machine for compacting forest waste is transferred from a developed country (Sweden) to a developing country (Nicaragua). In this case, the author visualizes how the machine starts to change (it starts to play different roles) as it moves between the two contexts and at the same time how the social and technical relations surrounding it also are reshaped as new actors come onto the scene such as deforestation, the civil war, etc. In this study, it is argued that there is no such thing as technology transfer. Technology is rather passed from “hand to hand” and with this process, it becomes less and less recognizable [over time]. There is thus a translation in the sense that new relations are created not only in the process of change, to Nicaragua in this case, but also in what is transferred.

The translation perspective has been used in the domain of IS by various authors such as Madon et al. (2004) and McMaster et al. (1997). For example, Madon and colleagues applied this perspective to study the implementation of a property tax reform process in India. The translation perspective, they argue, helped them to go beyond the lens of technology diffusion while studying innovation processes. A concluding remark from their work is that the translation perspective was instrumental to realize that despite the weak institutional capacities, organizations are capable of introducing even complex reform initiatives through their ability to create enabling networks of actors with different interests, capacities and responsibilities.

The concept of translation as an alternative to diffusion theory is also drawn upon by McMaster et al. (1997) to analyze the failure of a UK City Council to adopt a structured method, the SSADM, as its systems development methodology. SSADM

adopts a prescriptive approach to IS development in that it specifies in advance the modules, stages and tasks which have to be carried out, the deliverables to be produced and furthermore the techniques to be used to produce the deliverables. SSADM adopts the Waterfall model (Royce, 1970) of systems development, where each phase has to be completed and signed off before subsequent phases can begin. Their analysis builds upon the basic assumption that the key to technology transfer is the creation of a powerful enough consortium of actant's interests to create the required "black box". The study concludes that the SSADM fiasco was due to the inability or failure of the [primum movens] to build such a strong and stable network of alliances. It is maintained in this study that there is a need to abandon the naïve belief in cause and effect (i.e. factors), suggested by the diffusion perspective, and focus on understanding how actor-networks are created, strengthened and weakened.

The translation perspective in its four moments (problematization, intersement, enrolment and mobilization) was used by Macome (2003) to describe, highlight and address the contextual factors hindering the adoption of a technological innovation in Mozambique. The study builds on an empirical case of the purchase of a computer based invoice information system from the Ivory Coast by a local electricity company in Mozambique. The translation perspective helped to identify the skills that the human actors needed to develop in order to improve the interaction with the non-human actors. These included communication skills (for example by managers and IT professionals) to persuade other agencies to traverse the obligatory passage point, and negotiation skills of the [primum movens] to increase the likelihood of enrolling other actors. A major lesson from the study is that local stakeholders should be involved in the entire implementation process, so that their interests are gradually translated and strengthened over time.

Overall, these studies help to develop the argument that, technology transfer should not be seen as a process of "diffusion" from some central controlling point but as an

outcome of how [interested/involved] actors translate the interests of others so that they become aligned in the complex heterogeneous network of human and non-human actors. The notion of translation is an important tool to describe how this actor-network grows, changes and stabilizes during the process of [ICT] spread. Within such a conceptualization, the effectiveness of the technology transfer process is thus dependent on how the actor-network (people and things) is created and strengthened over time (Callon, 1986; Callon and Law, 1989; Latour, 1999).

In summary, I discuss how the translation perspective addresses some of the points of criticism that I have identified to be associated with the diffusion approach as exemplified in the application of TAM.

- A. *Technology treated as a “black box”*: The translation perspective suggests taking the characteristics of technology (e.g. relative advantage, compatibility with the values/skills of the adopter, degree of difficulty to understand and use) more closely and in detail. Moreover, these characteristics are not seen in isolation, but in relation to how they shape and are shaped by socio-technical networks, which include the level of education, social status, degree of centralization/decentralization, technical competence, and level of conformity with the norms of the social system (McMaster et al., 1997).
- B. *Technology transfer is one giant step of movement from the North to the South*: According to the translation view, technology transfer is seen as a set of rather small incremental steps of co-adaptation between users and technology, where in each step something is lost and something is gained (Latour, 1999)²⁰. Technology transfer is not

²⁰ Latour (1999) raised the question about *what is gained, what is lost, and what remains invariant* in the process of translation, in his discussion around the notion of a *circulating reference*, and how the idea of standardization is tied up with the concept of *invariant*. He wrote: A reference is not simply the act of pointing or a way of keeping. Rather it is our way of keeping something constant through a series of transformations. What a beautiful move, apparently sacrificing resemblance at each stage only to settle again on the same meaning, which remains intact through sets of transformations. The rupture at each stage of the ‘thing’ part and its ‘sign’ part. The details are often lost, and what remains is the horizon, the tendency. Reduction, compression, marking, continuity, reversibility, standardization, compatibility with text and numbers – all these count infinitely more than adequatio (does this mean resemblance)

seen as a binary movement but as a series of incremental steps, and with each step, different heterogeneous networks are created, which redefine both the social relationships in the process of change, but also the technology that is being moved from hand to hand.

- C. *Socio-technical mismatch*: The translation approach emphasizes a focus on the open heterogeneous socio-technical networks including the technology. Since the focus is on negotiations around the creation of networks, politics is inherent in the consideration. By providing symmetry to technology and people, the histories, politics and social settings of people, institutions and technologies are equally considered. Translation does not treat culture as a set of externally defined variables, but instead, sees culture and the technology translation process to be mutually constituted. Culture is thus seen as constructed and emergent rather than as something static that can be measured by variables.
- D. *The degree of adoption and diffusion of technology is measured in terms of the rate of adoption*: In line with the translation perspective, the degree of adoption is seen with respect to the stability of the network, and to what extent the interests of the actors have been aligned. Further, potential adopters are seen not in isolation but rather as belonging to a socio-technical network of allies with shared interests which are continuously being renegotiated.
- E. *The diffusion perspective ignores the inherent challenges of scaling up and sustaining the [ICT] initiatives over time*: According to the translation perspective, the core focus is the activities that go into building and maintaining strong and stable networks. Within this perspective, scaling (Sahay and Walsham, 2005) and sustainability (Braa et al., 2004) are central concerns, with a focus on how networks can be cultivated while considering the complex interdependencies that constitute them.

alone. No step – except one – resembles the one that precedes it, yet in the end when I read the field report, I am indeed holding in my hands the forest of Boa Vista (page 56).

2.4. Theoretical framework around “technology translation”

Actor network theory, in particular the translation perspective, emphasizes the need to analyze technology transfer as occurring in socio-technical networks. Studies drawing upon this perspective analyze how these actor-networks, including the technology, get transformed through the incremental steps of the translation process. This involves analyzing several networks and relations of variable geographic extension, and following them from where the technology was initially developed to where it is being “transferred”. The success (or not) of the technology translation process is dependent on the capacity to create and support a stable network in which actors translate the interests of others including that of the technology.

In the context of this thesis, the translation perspective is seen in relation to the notion of sustainability; *as the process of cultivating sustainable networks*. Sustainability represents an important concept for this thesis, since it suggests the capacity of the technology and the surrounding network to endure over time and space. In the context of donor-funded development programs and projects, sustainability is conceptualized as the continuation of benefits after major assistance from a donor has been completed (Young and Hampshire, 2000) and sustaining the flow of benefits into the future rather than on sustainable programs or (ICT) projects. Projects are by definition not sustainable as they are defined and limited in scope of time and funds/resources.

For example, an [health] sector project may assist in the re-structuring of in-service [...] training, sustainability does not necessarily mean that the activities required to develop new structures be sustained but rather that the new structures are appropriate, owned by the stakeholders and supported on an ongoing basis with locally available resources (Young and Hampshire, 2000).

(Korpela et al., 1998a) define the sustainability of HIS as the ability to identify and manage risks threatening its long-term viability. Misund and Høiberg (2003) define sustainable IT as technology that is capable of being maintained over a long span of time independent of shifts in both hardware and software. Braa et al. (2004) provide another perspective on defining sustainability. They suggest that sustainability concerns the longevity of processes of inception, design, development, support and implementation of the system, especially once external support is withdrawn.

A study by (Heeks, 2002) within a developing country context, provides a checklist of five risks contributing to unsustainability of HIS including:

1. Organizations in developing country environments are more hierarchical and centralized;
2. Formal, quantitative [and qualitative] information stored outside the human mind is regarded as of less value in developing countries;
3. The physical infrastructure, such as roads, power, networks, telecommunication is more limited and older in developing countries;
4. Linked to computer illiteracy, systems analysis, design or implementation skills are limited in the context of developing countries; and
5. Because of the more unstable political environment, work processes are more contingent in the context of developing countries.

Technologies or systems become sustainable if they are institutionalized in the sense of being integrated into the everyday routine of the user organization. However, sustainable technology or systems need not only be institutionalized, but also need to be flexible in order to allow for changes as the user needs them. Seen from this perspective, I define technology translation as a process characterized by the following:

- The initiative should be designed as an incremental and context sensitive process, carried out in rather small steps.
- Translation represents an iterative and evolving long term process, having implications for both sustenance and scale issues.
- Technology translation includes building and supporting heterogeneous socio-technical networks and ensuring indigenous capacity building.

In summary, technology translation can be defined in the context of this thesis as a process of incremental change involving a socio-technical heterogeneous network, which leads to the development of sustainable networks, implying that they are both institutionalized and are flexible enough to change according to evolving needs.

A key characteristic of this definition of translation is the need for a balance between flexibility and stability. This corresponds to ideas of fluidity and immutable mobile (Latour, 1987). Sustainable systems must become institutionalized and ‘rooted’, while at the same time they must remain flexible enough to accommodate emerging changes. While a stable network of aligned interests may imply a degree of rigidity, empirical studies have shown that in fact flexibility in the network can contribute to the stability of the overall network. For example, this role of flexibility is emphasized in the work conducted by de Laet and Mol (2000) to argue that the Zimbabwe hand water pump is an appropriate technology for the context. Their study is not about an information system, but rather on a solid and mechanical technology – the water pump. However, the emphasis of the study on the technology’s flexibility, as well as the context and the process of its design, implementation, integration, use and further development, makes it relevant for the present thesis.

De Laet and Mol writes:

[...] the Bush Pump does all kinds of things [...] it acts as an actor. Thus subsuming the pump under the category of ‘actor’ broadens the category, allowing it to include nonhuman, non-rational entities. [...] the Bush Pump, is not well-bounded but entangled, in terms of both its performance and its nature, in a variety of worlds. These begin to change more or less dramatically as soon as the Bush Pump stops acting. Yet it is not clear when exactly the Pump stops acting, when it achieves its aims, and at which point it fails and falters. [...] if the Bush Pump may be called an ‘actor’ despite its fluidity, then ‘actors’ no longer (or not always) need the clear-cut boundaries that come with a stable identity. [...] the Bush Pump [therefore] is not a solid character. Not only can actors be non-rational and non-human; they can also be fluid without losing their agency (de Laet and Mol 2000: 226-227).

Flexibility is of particular importance if the technology is moved from place-to-place. In each location, it encounters specific challenges which must be addressed for its integrated adoption, adaptation, use, and further development. However, in each location the technology needs to also be stable to enable the adopters to experiment or evaluate it for their advantage and to learn with this process. Most previous uses of the translation perspectives within the IS field have focused on the establishment of stable and strong actor-networks, building on ‘classical’ ANT concepts such as alignment, enrolment, and closure. However, in this thesis I argue that instead of emphasizing only stability, the focus should be on the balance between “flexibility and stability”.

This study suggests that technology that is not too rigorously bounded, that does not impose itself but rather tries to serve, that is adaptable, flexible and responsive, may well prove to be stronger than one which is firm and stable. From this extended understanding of translation, it can therefore be argued that the reason for failures may not be because the network was not strong enough, but rather because the technology was not flexible enough. Accordingly, what makes a technology appropriate is its

balance between its flexibility or fluidity and rigidity; fluidity in the sense that it is able to move, flow and change shape without separating even when it is under pressure.

Such a conceptualization of “translation” calls attention to the need for a new understanding of networks and actors, that of fluid networks and “mutable mobiles” (Law, 2000). This perspective becomes even more valuable when talking about technology transfer involving heterogeneous contexts (e.g. developed and developing countries), in which, as argued earlier, the diffusion model is inadequate. The object of study in this thesis is of a HIS that has to be locally adapted and appropriated, making flexibility crucial. Moreover, this software is not an isolated artefact, it is not a self-standing piece of technology, but a HIS, which is passed through many “hands” including donors, researchers, Ministry of Health officials and users.

Complex socio-technical networks are defined and redefined with different activities within a global software exchange network, where open source code is exchanged. Continuous feedback, adaptations and new releases creates ongoing processes of exchange. Consequently, this transfer is not merely a process of passing along technology, but rather one in which the technology takes part in and also shapes and is shaped in existing networked relations.

Within this conceptual perspective of translation as the process of cultivating sustainable networks, the focus of this thesis has been on understanding the various conditions and activities that influence and are influenced in this process of translation.

Four key influences identified are:

- The influence of history: Legacy systems and installed base;
- The role of adaptation: How software is adapted to the local context;
- The role of participation: How users exercise control over HIS; and

- The process of customization: The balance between localization and internationalization.

These are now discussed.

2.4.1. The influence of history: Legacy systems & installed base

Contemporary trends in computer based applications is towards bigger/integrated, more powerful and complex systems. This is partly associated with technical advancements, leading organizations or managers to expect more from them, and to satisfy more complex and sophisticated needs. In the healthcare sector, similarly there are higher expectations from HIS from supporting electronic transactions of patient records, to remote consultations through telemedicine. However, attempts to introduce these new technologies are constantly challenged by history, including the existing installed base comprised of legacy ISs.

The problems of non-evolving and technically outdated information systems have been recognized by the IS community for some time (Sommerville, 2001). Old systems may be expensive to maintain, as they use obsolete hardware and exist in non-supported representation formats, e.g. programming languages that few people know (making hiring of skilled staff a challenge). Fault tracking may be tedious if documentation is missing or when system understanding is limited. For the same reasons, the old ISs may also be difficult to extend or change in other ways. Different programming paradigms (not object-oriented) make clean interfaces rare, i.e. more difficult to make the systems interoperable with other systems. Legacy systems inscribe important business rules that are crucial to the organizations' processes, and are thus a major part of the company's knowledge base. The legacy systems' inertia/resistance to change is not only costly, but may also hinder organizational development (Kelly et al., 1999), as they show a surprisingly high degree of survival.

The year 2000-problem made legacy systems capture the attention of IS managers to a larger degree than before, and today e-commerce and back-end integration have made it a current issue.

Most of the research and IS literature addresses strategies for handling or coping with legacy systems with a key focus on the challenges of developing methodologies and associated tools, including tools for migration, system analysis or reengineering. In general, the LIS handling strategies fall into three categories with varying degrees of radicalism in the change attempts: wrapping, migrating or redevelopment (Bisbal's, 1999).

Wrapping the old software components into new more accessible components. This means to create new interfaces to programs, applications and interfaces. This is seen as a partial and short-term solution, which may even make maintenance even more complicated. The technique of 'screen scraping' is one well known approach of wrapping. Providing web interfaces to access legacy data would be another.

Migrating the system, i.e. moving it to a more flexible environment, e.g. to an object-oriented or component-based platform, while maintaining the data and the functionality. Migration is thus a middle ground approach, aimed at causing as little as possible disruption to the existing operational and business environment. There are several actual transition strategies: a) cut-and-run; b) phased interoperability; and; c) parallel operations.

Redevelopment (and reengineering) means to rewrite the system from scratch, to make a new system. This often involves substantial amount of analysis of the old system to make sure it is correctly understood. This is often more resource-intensive than other strategies.

In summary, being part of the existing practices, LIS are difficult to cope with, because in general they are business critical and of high business value (and often low quality) for the organization. Therefore, they can not be ignored when designing and implementing changes or new systems, regardless of the high price required for their maintenance. Bisbal (1999) argues that LIS represent a massive, long term investment and are thus difficult (if not impossible) to extend or change. LIS can not just be scrapped and forgotten, since they are deeply embedded in the life of the organization. Traditional IS design strategies, assume that systems can be developed from scratch, as isolated and stand-alone applications with defined goals, start and ending times; as events rather than as ongoing processes (Orlikowski 1996). Such a perspective is limited in the present context where technological solutions seek to integrate multiple systems across organizational and geographical borders, for example Enterprise Resource Planning systems (Hanseth, 2002).

Research extending upon ANT concepts has argued for an *Information Infrastructure* (II) perspective to study complex IS like that represented by HIS. This thinking suggests analyzing design and change not of isolated IS but rather of IIs (Hanseth et al., 1996). The II perspective which seeks to analyze systems as inter-connected socio-technical networks is more appropriate to understand the challenges of introducing change when there are multiple LIS already in place, requiring integration with new initiatives for change.

Hanseth (2002) outlines some key concepts that help to understand II: increasing returns and positive feedback, network externalities, path dependency, and lock-in, installed base and cultivation. On installed base, he writes:

[...] All elements are connected. As time passes, new requirements appear which the infrastructure has to adapt to. The whole infrastructure cannot be change instantly - the new has to be connected to the old. The new version must be

designed in a way making the old and the new linked together and "interoperable" in one way or another. In this way the old - the installed base - heavily influence how the new can be designed. Infrastructures develop through extending and improving the *installed base*.

We need to look at LIS not just in a technical sense, but as an installed base which reflects the nature of the institutional and technological legacies. The concept of installed base emphasizes that the technical system is interconnected with the institutional legacies which influence the translation and change of systems.

In this thesis, it is argued that the concept of cultivation as suggested by Hanseth (2002) within the II perspective is as an appropriate lens to both respect existing history and to develop strategies to address it. This notion of cultivation emphasizes that [changes or systems] cannot be designed using top down "construction" kinds of methodologies like the Waterfall approach but rather need to be nurtured gradually, bottom up and incrementally. A classic example of such an approach is seen in the evolution of the internet (Abbate, 1999), by changing a small part of the infrastructure and making sure the newly added parts work in consonance with the existing network. Cultivating a [system] implies building a new one such that the new features also obtain their value from the size of their installed base.

In summary, legacy systems conceptualized as installed base, can be seen to influence the technology translation as defined in terms of sustainability. LIS can be seen as institutionalized, thus rigid, inscribing technical and institutional conditions that restrict its change. This lack of balance between rigidity and change makes it thus not sustainable, requiring negotiations and strategies to create a better balance. From the point of view of my definition of translation, cultivation of this installed base thus involves the process of identifying which elements should/can be changed, as well as

those that should/can not be changed, and the strategies through which this change process can be enabled.

2.4.2. Changing code: How software is adapted to the local context

Technology transfer is the commonly used mechanism for adoption of ICT or ICT-based systems for most developing countries. However, an important aspect that historically has been neglected is the need to adapt hardware or software to the specific context as an integral aspect of its implementation, rather than focusing on a physical transfer of the artefact from the North to the South (Lind, 1991). Contextual differences, determined by both the material realities (e.g. power supply, temperature, humidity), as well as the economy, culture, and beliefs make it problematic to make a technology developed in one context work seamlessly in another.

In this thesis, the term “translation” has been used more broadly than just referring to language translation but to also include adapting the software to the different contexts of use, for example, the varying structures of the health organizations in the different countries involved. For the purpose of this thesis, I have chosen to categorize software application into two types: General Business Domain Applications (GBDA) and Special Business Domain Applications (SBDA).

GBDA refers to general purpose software like spreadsheets and text processors. In this, the functionality, content and the interface is largely decided by the software vendor, and it is relatively easily moved across organizations, countries, contexts and cultures. Improvements, changes and evolution of the software are driven by the vendor in terms of new releases with the view to maximize the time efficiencies for testing and debugging whilst expanding the market scope. SBDA software is more application focused, and thus the translation process requires a greater understanding of the

business domain and the context of use. Specific meanings of terms and concepts are important to understand as they are linked to particular business rules. To enable this understanding, it is important for end-users and systems developers to work collaboratively with each other. The HIS studied in this thesis is a SBDA.

In a SBDA, the development process is facilitated in such an environment where the systems developers need to be pulled from the context of design into the context of use, and are therefore confronted with incompleteness in understandings of complex cultural settings (Gregory, 1995). The translation processes of SBDAs are more complex and require greater time and investment of end users as compared to GBDA. It can be argued that while GBDA (like Microsoft office) can be “transferred” from one context to another, SBDAs (like HIS) need a greater degree of “translation” in order to make them work effectively.

This study focuses on the translation process of a SBDA application related specifically to the domain of primary health care (PHC) in developing countries. This translation process is different from most examples described in the literature for at least two reasons: the software is open source and not for profit; and the software is designed within the context of the public sector. While these differences create challenges related to the availability of resources and skilled personnel, they also help to open up new opportunities since profit maximization is not the sole and driving motive. This study thus has potentially important contributions to make to both the understanding of open source software development, and to the design and development of HIS in developing countries.

However, there are certain elements in a HIS which are indeed common to more than one setting, and can be taken from one context to another as a starting point. So, while there is no need to “reinvent the wheel”, sensitiveness to contextual differences must be taken into account when designing, developing and implementing the systems. The

theoretical notion of translation, as defined in this thesis, emphasizes the need for balance between the flexible and stable elements: Some elements of a software application are generic, while others must be flexible enough to be changed as the software is moved. The important research issue is therefore to understand the elements of the HIS that need to be “transferred” and those which need “translation”, and the mechanisms by which this can be done.

In summary, while there is no need to “reinvent the wheel” while moving software from one context to another, sensitiveness to the local context of use must be seriously taken into account. Therefore the technology translation perspective, as defined in this thesis, will imply identifying the context free and dependent features of the technology as an ongoing process of cultivation.

2.4.3. The role of participation: How users are enrolled

It is widely supported that the organization-driven issues are more important than the technical ones in IS development and use (Lucas, 1975, Long, 1987, Hornby et al., 1992, Ewusi-Mensah and Przanyski, 1994). However, the IS design and development processes have been preoccupied with technical issues at the expense of organizational issues (Doherty and King, 2001, Eason, 1998, Clegg et al., 1997). This situation, as argued in IS literature, has historically contributed to what Doherty and King (2001) call failure of a universal problem. These points suggest examining the development, implementation and use of ISs from two perspectives: computer science and information systems logic. The computer science perspective focuses on the technology itself and the systems development techniques and procedures, while the information systems logic also focuses on the role of the actors (people and organization) involved. It is argued in this thesis that both aspects (organizational and

technical) need equal emphasis in adapting the HIS to the local context, and that participation of the potential users is of crucial concern.

User participation in IS design has historically been considered to be an important determinant of the eventual success or failure of the system (Franz and Robey, 1986; Mumford and Weir, 1979). Participation is justified through the recognition of the failure of traditional technical approaches, where participation is not considered seriously enough (Fitzgerald, 2002: 52). For example, the users' sense of ownership is significant for the sustainability of the system. (Lorenzi and Riley, 1995) suggest that technically competent [ICT-based] systems may be woefully inadequate if their implementation is resisted by people who have low psychological ownership of that system. On the other hand, people with high ownership can make a technically mediocre system function fairly well (ibid: 10).

However, there is considerable diversity in the participatory approaches to IS development depending on the countries where the traditions are developed. Three key sources of participatory traditions are: North America, United Kingdom and Scandinavia. The variations across these sources are now discussed.

North America

In the North American context, in particular, participatory approaches to system design were adopted by a way of engineering co-development (Asaro, 2000: 276) with a major focus on customer-centeredness. Here, participatory approaches were adopted on a relatively limited scale, as compared to Scandinavia (details provided later), given the different socio-political conditions. While in Scandinavia participation is regulated by legislation, in the North American context this type of enabling institution is not provided. In the case of North America, the basic methodology adopted was to place working prototype systems at customer sites for obtaining their feedback to "tune" the

artefacts as per the needs of the users. The features of participation, in the US, can be summarized as: the right to participate in design by users is limited; most design decisions are driven by the managerial domain; in most cases the user participation takes place mainly for instrumental reasons; and there is a limited concept of the workplace.

The Joint Application Design (JAD) methodology developed by IBM in 1977 (Davidson, 1999; Asaro, 2000) and business process reengineering (BPR) (Asaro, 2000) are two other strands of user participation in North America. In BPR the various organizational tasks and business processes around them are analyzed to eliminate redundancies and to establish a tighter, functionally related process flow (Asaro, 2000:273). This approach is claimed to enable a closer and direct relationship between the employees and the reengineered processes. While seeking to involve users in design, the basic aim of approaches such as JAD and BPR is primarily to reduce the overall development time and costs, increasing quality of the systems, and improving the skills of designers by exposing them to novel work situations in which traditional design methodologies, such as the Waterfall approach, could not be applied (Asaro, 2000:263; Greenbaum, 1993:29).

Summarizing, in North America the role of user participation is mostly confined to testing/evaluating the prototypes/work of external designers.

The European participation approach in IS, as described by Asaro (2000: 260, 265), includes two methods: socio-technical (with its roots in UK) and collective resource (with its roots in Scandinavia).

United Kingdom

The socio-technical approach (Floyd et al., 1989) developed in Britain includes approaches such as ETHICS (Mumford, 1995). The major focus of this approach is on

achieving autonomy in workgroup organizations through power sharing, joint responsibility and multiple leadership (Reeve & Petch, 1999: 99). Here, the focus is on development of local communities, who are often not technically-oriented.

In contrast to North America, participatory research in the UK includes user involvement and user control in the process of design and development. This conceptual foundation of its production paradigm is based on “organization choice and on the need to consider interaction between the social and technical parts of any work system” (Mumford, 1987, p. 70). Underlying assumptions of the socio-technical approach were to emphasize what humans consider important in their work, and seek consensus amongst management and workers over a specific project’s aims and implementation. Floyd et al. (1989) termed the socio-technical approach as being premised on a harmony perspective (ibid:267, original emphasis). The project-based orientation of the socio-technical approach is confined to individual organizations, “rather than building up a general strategy for democratization,” (ibid: 268) and therefore has attracted criticism from trade unions.

Scandinavia

The collective resource approach to participation is that adopted in Scandinavia, with an emphasis on union empowerment. While in US the role of users is limited to usually just testing the work of external designers, in Scandinavia, participation is used to involve users into the design process as co-designers with decision-making roles in planning technological change (Spinuzzi, 2002). As emphasized by the Scandinavian tradition, a major argument for participation may be that it is ethically and morally right for workers to be involved in the development of systems which are to affect their working lives.

In Scandinavia, participatory approaches evolved since the 1970s (Aarhus, 1975; Bjercknes et al, 1987) based on the fundamental premise that every human should have

the right to participate equally in decisions concerning his or her life, including the process of design and use of computer-based IS (Bjørn-Andersen and Hedberg, 1977; Ehn, 1993). The Scandinavian approach is politically significant, interdisciplinary, and action-oriented focusing on the resources and their control in the process of design and use of computer-based information systems. It raises questions of democracy, power, and control in the workplace and assumes that the participation of skilled users in the design process can contribute importantly to successful design and a high quality product (Ehn and Sandberg, 1979). Therefore users are designated co-designers and systems development is conceptualized as an organizational, technical and human change process.

There are a number of reasons as to why items learned from Scandinavia and other Western countries are not immediately transferable to the context of developing countries, thereby requiring a process of translation both in content and in the mechanisms for enabling participation. The Scandinavian approach emerged in a context where there is a positive attitude to new technology, strong national trade unions and as a result, a legally regulated right for workers to participate in workplace issues. Even if IS research has been extended to the third world domains [for example, (Sahay and Avgerou, 2002; Walsham, 2000)], the issue of participatory design has received little attention, and more so on community focused systems.

Byrne and Sahay (2003) note that the issue of community participation has been dealt with more comprehensively by international agencies like the World Bank and UNICEF in development projects, through techniques such as Participatory Rural Appraisal and Rapid Rural Appraisal (Chambers, 1994). Given the present context where there are increasing attempts to develop e-government applications aimed at the community in developing countries, and rising concerns about the digital divide, the need to develop approaches to facilitate participatory design involving community-

based IS is important (Puri, 2003), especially in a social developmental contexts like that of healthcare (Byrne and Sahay, 2003).

In the context of socio-economic development, Adnan et al. (1992) outline the following characteristics of participation:

- Participation is a process in which information on a planned project is made available to the public. This type of participation often involves only community leaders. These people are listened to but the decision-making power rests with outside planners and project implementers.
- Participation includes project-related activities rather than mere information flow. This might involve labour from a community or a longer-term commitment by local groups to maintain services or facilities or even to plan for their future use. However, people are involved but not in control.
- Participation means that a project is a direct outcome of people's own initiatives. A famous example of this is the Chipko movement, which began in the Himalayas in the 1970s when women mobilised themselves to protect the trees that were vital to their economy (Shiva 1988).

In the healthcare setting in the developing world, participation processes need to be organized very differently, with respect to both the process and the result.

Adopting a human rights perspective and based in their empirical experiences in South Africa, Byrne and Sahay (2003) point to four points of departure for the conventional participatory design approach to work in contexts other than the Western context:

- The obligatory nature of community involvement;
- The need for a multi-level and multi-sectoral approach;
- The politics of participation and “non-participation”; and
- The need to develop capacity for participation and for developing a climate for learning.

Viewed from the perspective of translation with the objective of building sustainable networks, user participation is crucial both for exercising control of the system and its institutionalization, and also to develop user capacity so that they are capable to evolve the systems in the future, thus enabling the required flexibility. The extent and quality of user participation thus fundamentally influences the process of technology translation. However, it is emphasized that user participation is a context sensitive process requiring both the mechanism of participation and its content to reflect the local conditions, rather than being unproblematically “transferred” from the West.

2.4.4. The balance between localization and internationalization

While there are increasing pressures on developers to create software that can be used in different settings (O’Donnell 1994; Howard 1993), the adaptation of software or computer-based HIS for other cultures (or settings, locations) is not a technical/trivial matter. It raises the question/dilemma of the need to find the balance between the processes of internationalization and localization. Internationalization refers to the process of isolating the culturally specific elements from the software and building a system for use in different countries (Russo, 1993; (O’Donnell, 1994)). Normally this process occurs in the country where the software is originally developed and is typically limited to translating text and date, time, and number formats, following specific guidelines (Russo, 1993). Localization, in contrast, refers to the process of infusing a specific cultural and business context into a previously internationalized product (Taylor, 1992; (O’Donnell, 1994)). This raises the need to both identify the common elements between the global and local, while also being sensitive to the diversity of particular cultures, as Griffiths argues:

The wide range of cultures in the world should be preserved, not only because they may be rich cultures but also because it is important to maintain cultural

diversity. A wider variety of cultures carries with it a wider variety of perspectives, potential insights and solutions to the world's problems (Griffiths et al., 1994).

The techniques for software internationalization and localization fall into two major categories: One, software is developed from the outset to be used in varying international settings, and internationalization is incorporated as one element of the software development cycle. Two, software is developed for local settings and internationalization is not considered as a pre-defined aim, but subsequent attempts are made to adapt and customize it to different national situations (Braa and Hedberg 2002). In the first approach, the development process is very resource intensive as the application needs to incorporate functionalities for different languages and cultural contexts of use. Also, since the context of use is always changing, there is continued pressure for the development agency to acquire new knowledge and incorporate it in the newer versions of their application. In the second approach, while the development process is initially not that resource intensive, there are similar needs in individual customization efforts in each context, raising the potential danger of "reinventing the wheel".

Context-sensitive features (dialog messages, error messages, and menu names) can be localized and stored in a message file, while the context-free components contain the bulk of the software that is limited with respect to culture-sensitive features. There is thus a different message file for each context, and if the software is required in a new context, only the localization process is conducted; there is limited modification in the generic core of the software. Such an approach, it is argued, is easier for maintenance since modifications are implemented only on the generic core component. However, the focus on the content of the software and not on the process of how to build the dialog or error messages, of the above approach, emphasizes a technical orientation to software development. While such a conceptualization of software internationalization

may be effective for the development of GBDA's such as spreadsheets or text processors, applying it uniformly for development of SBDA's may become problematic if the application area is very context specific and continuously changing, as is the case of the healthcare sector.

A middle ground to these approaches is what Rolland and Monteiro (2002) describe as the "pragmatic balance". In this case, the focus is to try and distinguish between context-free or generic core and context dependent components (Yeo, 2001, Russo and Boor, 1993), and to try to globalize the independent parts and focus on the dependent parts for local customization. However, this pragmatic balance is very complex to attain in practice as it is influenced by many aspects including the process itself by which the software customization takes place; which I term as the *social construction of the customization process*.

Social construction refers to the process by which social meaning becomes embedded into an object under study, be it science, technology, or other forms of knowledge (Berger and Luckmann 1967). The common-sense methods which go into the development of this meaning, and social interests which account for this process, become the units of study for the constructivist. Technology is not viewed as objective truth which is independent of the social world, but is seen to be shaped by social processes related to their design, implementation and use (Pinch and Bijker 1987). Social construction of technology studies have described the importance of social alliances and control (for example, Noble 1984), social groups and their frames of meaning (Bijker 1987), the use of heuristics (Van den Belt and Rip 1987) and various organizational issues (Mackenzie 1987).

The social construction of the software customization process is empirically interesting to examine when the same software is customized in different national settings, for the same application domain (primary health care in our case) by different local groups of

developers. The World Health Organization (WHO) model for HIS, mandated for all developing countries, implies that some elements are common, for example how the lowest level collects data routinely and sends it up the levels of the health administrative hierarchy. There is an implicit assumption made that the same application model can be unproblematically applied to different country situations (Braa et al. 2004). Such an assumption, I argue through the empirical analysis of this thesis, is incomplete as it does not take into consideration the context dependent aspects of the software, which are shaped significantly also by the very process of software customization/adaptation.

Indeed, processes of software customization are organized differently in varying contexts such as the skills and configuration of the software development team. This social construction of the process thus shapes how the context dependent parts and the content are translated. In this thesis, I analyze how this process is constructed differently in Mozambique and India, and infer elements that influence translation.

In summary, the emphasis of the translation perspective, as defined in this thesis, is on the balance between flexibility and stability, and emphasizes the need to analyze the challenges related to internationalization and localization. This involves deciding what should be generic or core functionality/features, and what should be context-dependent and changeable functionality/features. The social construction of the software customization process influences how these decisions are made and the very content of the software itself.

2.4.5. Summing up my theoretical framework

A fundamental point of the theoretical framework embedded in the technology translation perspective is the need to cultivate sustainable networks. This involves a process of incremental change involving a socio-technical heterogeneous network,

which leads to the development of sustainable II, implying that they are both institutionalized and are flexible enough to change according to evolving needs.

The four conditions identified to influence this translation process are summarized below.

The influence of history - Legacy systems & installed base: Legacy systems conceptualized as installed base, can be seen to influence technology translation in terms of sustainability. Technology translation includes then the challenge of handling and cultivating the installed base, which is related to negotiating rigidity (stability) and change (flexibility). The process of identifying which elements should/can be changed, as well as those which should/can not, is a crucial activity underlying this translation attempt, and requires a cultivation strategy.

Changing code - How software is adapted to the local context: While there is no need to “reinvent the wheel”, the context of use must be taken into account. The technology translation process involves identifying the context free and context dependent features of the technology as an ongoing process of cultivation.

The role of participation - How users are enrolled: User participation involves taking control of the system, and with it contributing to its institutionalization. However, along with this, it is important to also develop user capacity to evolve the system effectively in line with their changing needs. Technology translation thus involves enabling user participation in ways that this balance between stability and change is maintained.

The balance between localization and internationalization: This involves the cultivation of the balance between flexibility and stability. This requires the analysis of what should be generic or core functionality/features, and what should be context-

dependent and changeable functionality/features. The greater the context-dependent component of the application, the higher the translation effort required.

The object of study in this thesis is the adaptation and appropriation of HIS/software which is exchanged within a global open source software network. Consequently, I conceptualize technology transfer not just as a process of passing along technology, but rather as a process in which the technology takes part in existing networked relations and also in creating new ones. Sustainability of the transferred information systems as well as of these relations is the goal. However, sustainability does not equate with stability and institutionalization only. The extended translation perspective emphasizes the need for ‘fluid networks’ and ‘mutable mobiles’. The dilemma between “flexible and stable” is crucial to the phenomena addressed in this thesis. Thus, rather than conceptualizing translation just as the establishment and strengthening of actor-networks around the new technology, I employ the notions of ‘fluidity’ and ‘mutable mobiles’ to emphasize the focus on the need for finding an effective balance.

My theoretical framework identifies four significant conditions that influence and are influenced by the process of technology translation. These conditions represent the practical realities involved with HIS/software transfer to developing countries. The set of concepts that make up my framework is presented schematically in figure 4 below, and conceptually represent my proposed integrated theoretical framework.

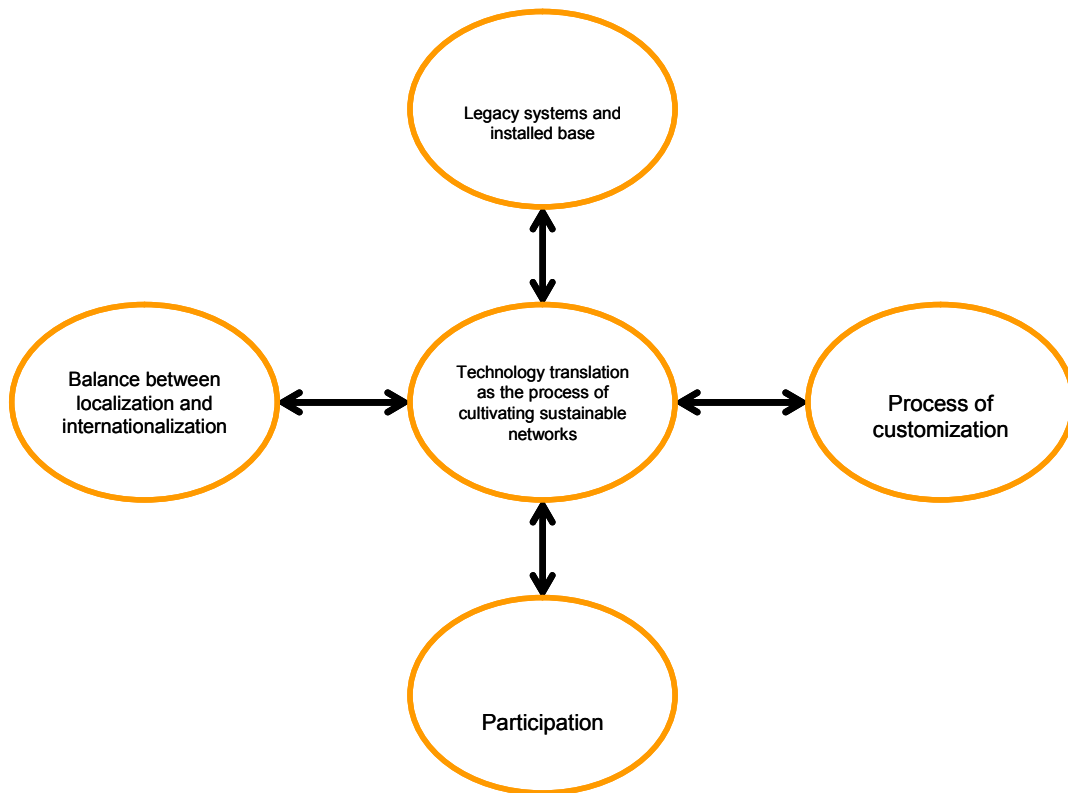


Figure 4: Influencing factors of the translation process.

Through the analysis of the DHIS transfer process presented in this thesis, I seek to identify the micro-level dynamics of each of these four conditions, and how they shape and are shaped by the technology translation process. These relationships are further discussed in Chapter six of the thesis.

3. CHAPTER THREE: RESEARCH SETTING

The primary focus of this chapter is to provide background information about Mozambique and with it the empirical research setting analyzed in this thesis. It is subdivided in three sections. In the first, an overview of the socio-economic and health profile of Mozambique is provided. While the section 3.2 provides an overview of the organizational structure, infrastructure, human resources and financial capacity of the local Ministry of Health (MoH), the last section 3.3, is dedicated to experiences of technology transfer to Mozambique.

3.1. The Socio-economic and health profile of Mozambique

Mozambique is located in the south-eastern cost of Africa with a population of about 18 million inhabitants (INE, 1999), with over 70% living in rural areas. Administratively, the country is divided in eleven provinces including the country's capital city Maputo. The provinces are further divided into districts and these into administrative posts. Nationally, there are 144 districts, 33 municipalities, 68 towns and 387 administrative posts. Mozambique represents a country of varied cultures with over 20 different tribal and ethnic groups speaking a variety of languages and dialects.

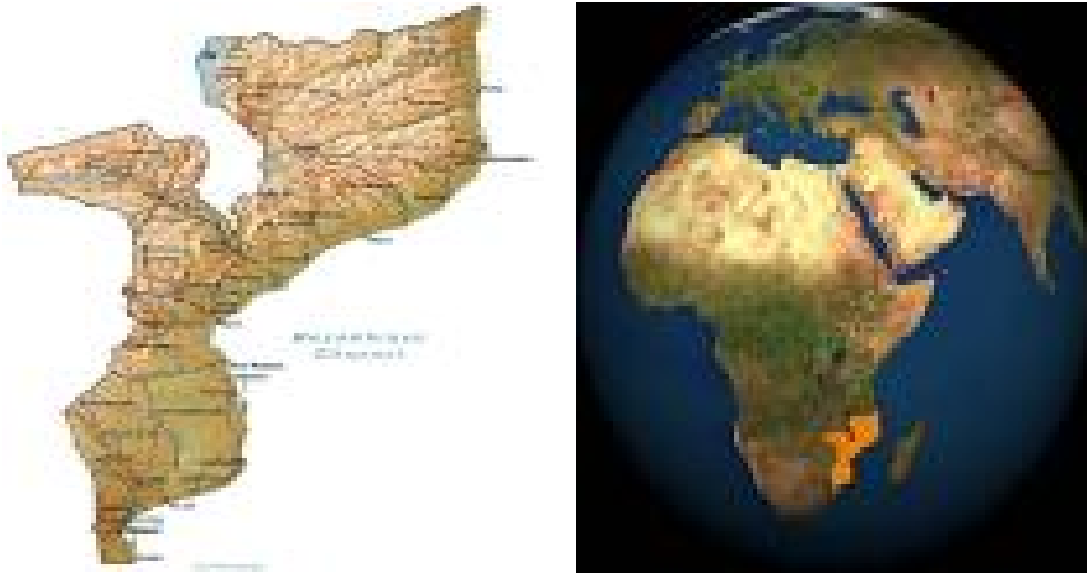


Figure 5: Map of Mozambique and its location in the African and world map.

Mozambique, a country with a developing country profile, has historically experienced multiple developmental problems, including an acute scarcity of resources, poverty, and weak infrastructure. These problems are translated into poor living conditions, inefficient healthcare system, and a majority of the population living in absolute poverty²¹, reflected in the country's social indicators. For example, the poor and ultra-poor tend to miss more days of work from illness than the non-poor, and are less likely to seek treatment due to lack of access to health care facilities. Lack of health care, hygiene, and access to safe water and sanitation breeds disease that could potentially be avoided. While food insecurity that was rampant during the war period has improved, however, susceptibility to floods and irregular rain patterns creates fluctuations and vulnerability in food production. Chronic malnutrition is still common among children less than five years of age. The illiteracy rate is above 60% amongst the population.

²¹ About 70 percent of the population are living in grinding absolute poverty and have limited access to safe drinking water and sanitation (Governo de Moçambique 2000). Processes of social development are largely inequitable, especially in the health sector, and the relatively promising changes can be observed in Capital cities, such as Maputo.

The government's adoption of the Plan for the Reduction of Absolute Poverty (PARPA) for the period 2000-2004 then 2001-2005 shows the country's determination to fight poverty, with particular emphasis on education, health and rural development.

The PARPA aimed to reduce the rate of poverty from 70 per cent in 1997 to 60 per cent in 2005 and 50 per cent in 2010, setting a series of social objectives including: enhancing primary school enrolment, expanding primary health care, improving mother/child health, and combating major economic problems. In the field of education, the government is concentrating its efforts on the principle of the universal primary school and access to school for all. In 2002, overall literacy stood at only 46.5 per cent, and only reached 31.4 amongst females. Thanks to rapid growth and increased spending in the social sector and on infrastructure, poverty levels show a declining trend over the past five years. For example, preliminary results of a 2002/03 household survey indicate that the national rate of poverty has decreased to 54 per cent in 2002/03, compared to 69 per cent in 1997.

Today, Mozambique is cited as an example of success in economic reforms undertaken since the end of the civil war in 1992 (Hanlon, 2002). These reform efforts have contributed in significant growth rates which averaged around 8 per cent annually between 1995 and 1999. In 2000, the floods reduced the growth rate by 1.5 per cent. Then, thanks to the reconstruction carried out by the local government of the infrastructure destroyed by the floods the economy is reported to have made up the lost ground with a 13 per cent increase in gross domestic product in 2001²² (AfDB-OECD, 2004).

Despite the innumerable efforts by the national government and international community to counter the negative impacts of civil war, through various development activities, Mozambique remains one of the poorest countries in the world. According

²² It should be noted, however, that progress was mainly concentrated in urban areas.

to the United Nations Development Programme's (UNDP) 2004 Human development Report, Mozambique's human development index ranks 171 out of 177 countries and is well below the Sub-Saharan Africa and Least Developed Countries averages, despite improvements over the last half-decade (UNDP,2004). Such a status quo of Mozambique as compared to other countries, regions or groups, is illustrated by the comparative social indicators provided in Table 4 below.

Table 4: Socio-economic indicators of Mozambique compared to other regions of the World.

	Mozambique	Sub-Saharan Africa	Low Income Countries	Developing Countries	World
GDP ²³ per capita 2002 (ppp ²⁴ US\$)	1,050	1,790	2,149	4,054	7,376
Adult literacy rate 2002 (% age 15 and above)	46.5	63.2	63.6	76.7	Non Available
Population with sustainable access to an improved water source 2000 (%)	57	57	76	78	82
Population with access to improved sanitation 2000 (%)	43	53	43	51	61
Undernourished people 1999/2001 (%)	53	32	27	21	Non Available
Life expectancy at birth 2001 (years)	38.5	46.3	59.1	64.6	56
Under-five mortality rate 2002 (per 1,000 live births)	197	178	120	89	81
Maternal mortality ratio 1985-2002 (per 100,000 live births)	1,100	1,098	671	463	411
Infant mortality rate 2002	125	108	80	61	56

²³ GDP – Gross Domestic Product.

²⁴ PPP – purchasing power parity – a rate of exchange that accounts for price differences across countries, allowing international comparisons of real output and incomes.

(per 1,000 live births)					
Personal computers in use 2001	0.4	1.1	0.6	2.5	8.7
Internet users 2002 (per 100 people)	2.7	9.6	13	40.9	99.4
Telephone main lines 2002 (per 100 people)	5	15	28	96	175

Source: UNDP (2004); # - UNDP (2003);

The relatively positive economic achievements described earlier are however masked by a deficient healthcare provision to citizens. The infant mortality rate was 125.5 per 1 000 live births in 2002 but 198.9 children in every 1 000 did not reach the age of five even though almost all (92 per cent) had been given the principal vaccines. The number of births in maternity facilities was 41 per cent in 2001 but, in the rural areas in particular, the majority of woman give birth without appropriate assistance in non government institutions, contributing to high infant and mother mortality rates. Nationally, it is reported that about 22 women die every day from pregnancy and childbirth related causes. Mozambique's maternal mortality rate stands at an estimated 1,500 out of 100,000 live births, one of the highest in the world (AfDB-OECD, 2004).

In this southern African country, reliance on traditional systems, lack of awareness and education, inadequately trained medical staff, poorly equipped health facilities with no maternity wards, unreliable and poor communication facilities and transport, makes giving birth a high risk event. Complications in pregnancy, such as sepsis (infections), haemorrhage and uterine rupture, are in some areas traditionally believed to be the woman's fault, and medical care often is not sought (Medilinks, 2002).

3.2. The health sector structure

After independence from the Portuguese colonial rule in 1975, major health reforms were attempted to be introduced by the national government (Mwaluko et al. 1996), following a centralized socialist model of planning. Such reforms resulted in the development and implementation of the nation-wide Mozambican National Health System (NHS) (MISAU, 1979). MISAU²⁵ is the governmental institution responsible for planning; organizing, coordinating and controlling all activities relating to the delivery of health services, including the supporting HIS.

Mozambique inherited from the colonial past a health system which was designed to provide essentially urban curative services, marginalizing the rural and remote areas. Aiming to improve this situation, the national government undertook several initiatives including setting up a health policy, whereby principles of equity (such as the PHC approach) were applied to enhance and expand the health services across the country. Health programs such as mother and child health, immunization and communicable disease control were formulated and implemented as a strategy to provide preventive and curative care to people. MISAU was created as the institution responsible for formulating the health policy, defining the health priorities, planning and executing various health system related activities, including the HIS.

MISAU comprises of four directorates, as illustrated in Figure 6 below: National Health; Human Resources; Administrative and Management; and, Planning and Cooperation. The Planning and Cooperation Directorate (Figure 7 bellow) is of particular interest for this study, since it hosts the Department of Health Information together with two others, Cooperation and Planning. The Department of Health Information was established in 1982 with technical support from the WHO and is currently responsible for the HIS, across the four levels: Health units; district; province; and, national. Health data are on a daily basis collected at the health units,

²⁵ Ministério da Saúde, in Portuguese, for Ministry of Health.

processed at the district level and on a monthly basis communicated to provincial level and then to the national levels through pre-defined report formats.

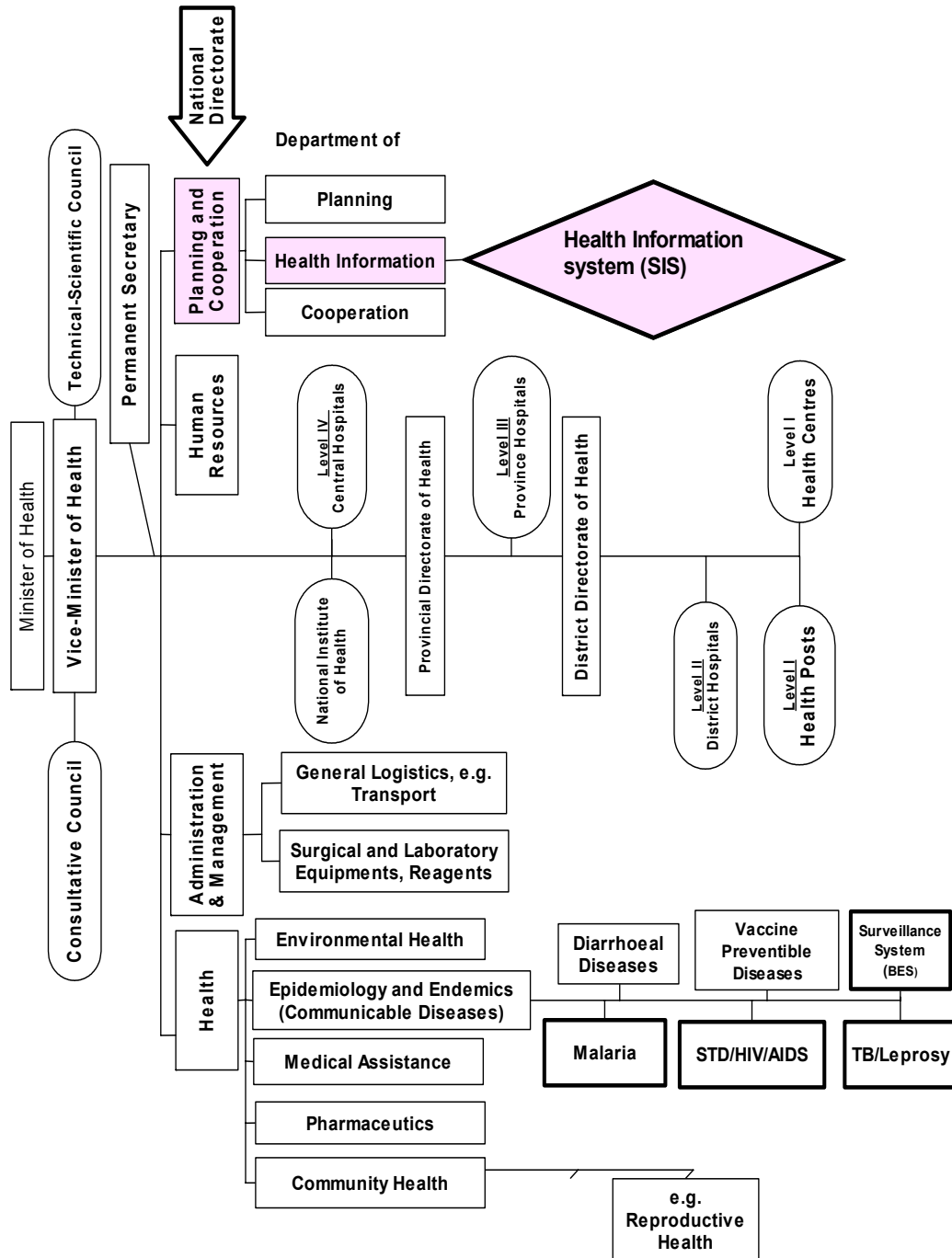


Figure 6: Organizational structure of the Ministry of Health

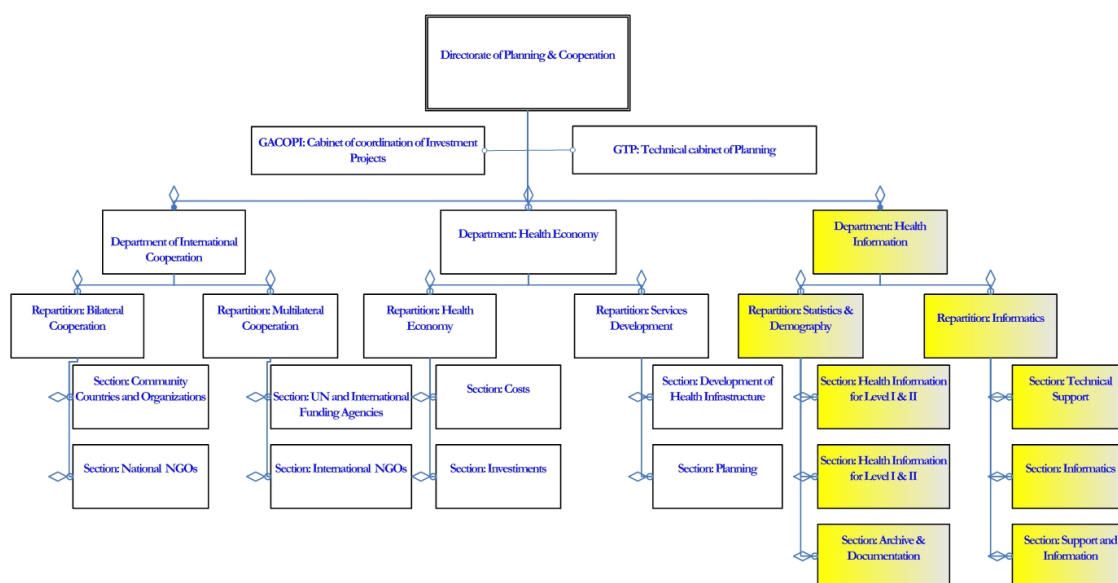


Figure 7: Organizational structure of the Planning and Cooperation Directorate.

Organizational structure of health sector and human resources capacity

The provision of healthcare is organized in four levels (1) primary (health posts and health centres); (2) secondary (rural or general hospitals)²⁶; (3) tertiary (provincial hospitals)²⁷; and (4) quaternary (central or specialized hospitals²⁸, including the National Reference Hospital in the capital city Maputo).

The Mozambican health system comprises of four sectors (1) the National Health System - NHS; (2) private for-profit; (3) private non-profit; and (4) community sector. Of these, NHS is the only sector which is part of the NHIS. Community health workers are recruited and trained locally, and are not formally part of NHS but receive basic supplies from the district directorate of health.

While there has been numerous calls for increased attention to the decentralization of health services as means to improve health for all (Chitah and Bossert, 2001; Mills, 1990; Mills 1994), the current structure remains primarily top-down. Within such a hierarchical organizational structure, planning and management of the health services

²⁶ Found in the boundaries of the District Directorate of Health.

²⁷ Found within the boundaries of the Provincial Directorate of Health.

²⁸ Found in some Provinces (such as Sofala and Nampula).

activities are undertaken at the top level at MISAU, while data collection and reporting are the primary responsibility of the personnel working at the health units and district levels. As an outcome of the top-down structure, the data transaction activities at the lower levels do not include local analysis and use of the available or collected data, and feedback from the higher level (MoH) is seldom provided. HIS activities can thus be inferred to take place primarily for reporting purposes rather than to support local action (Braa et al., 2001).

In addition to the top-down structure, the Mozambican health system is characterized by a number of vertical autonomous health programs (Malaria, TB, HIV/AIDS) each with their respective HIS. This multiplicity imposes pressure on the field level health workers to support parallel and not integrated channels of information flows through data collection and reporting. Such information flows adversely influence both the top management who don't get a holistic overview of the situation due to this fragmentation, and the lower level staff who have to deal with a high number of (often redundant and overlapping) data elements, primarily to satisfy bureaucratic reporting needs rather than their care related work (Braa, et al., 2001; Mukama, 2003).

In the NHS, everyday work is a combination of PHC services and administrative activities, which presupposes the existence of human capacity with specific skills in clinical and HIS related work (e.g. data collection, processing, analysis, reporting, indicators definition and calculation, etc.). Such skills are often lacking, especially in the district and sub-district levels, and are relatively more concentrated in cities which have more developed socio-economic infrastructure like roads, schools, sanitation, employment opportunities and availability of everyday necessities.

These inadequate skills, both in numbers and quality, is magnified by the absence of continuous training and education of health workers, with respect to both clinical care and HIS, as emphasized in the quote:

Nationally, the health system [...] employ about 16,248 people - 10,141 health technicians (all levels) of which about 435 are physicians (Jamisse et al. 2004) (being most located in Maputo) and about 6,200 administrative staff (non-medical personnel) (MPF and MISAU 2004). While the NHS employs a higher proportion of elementary and basic trained personnel, the percentage of university trained personnel is very low, especially in the district and general hospitals. At the district level, there is a lack of personnel trained in management and administration. In general, the NHS has been struggling today to fill the gaps caused by the departure of qualified technicians, a problem magnified by the relatively fast growth of health facilities, especially in the rural areas (Mosse, 2004: 23).

Organizational (ICT and physical) infrastructure

Both the ICT and physical infrastructure in Mozambique is extremely weak. Where electric power is available, frequent power cuts are typical, not favouring the installation and use of computers and related equipment. Power backup systems or generators are used as an alternative, but do not present an economical solution because of the fuel costs. In addition, both the hardware and software in the provinces are outdated and slow, making it extremely burdensome to undertake tasks such as data entry, analysis and reporting. The transport, (tele) communication and roads facilities are very poor making the reporting of information across and within the various levels a very demanding exercise.

Regardless of the weak ICT-infrastructure in terms of both human and technical capacity, recent studies (Commission for Informatics Policy in 2000, Braa et al. 2001) indicate an increasing spread of ICTs national wide. However, such ICT proliferation is characterized by an uneven distribution between rural and urban areas; with 50% of the ICTs and technically competent work force being concentrated in the capital cities

and major districts (Braa et al., 2001; Comissão Nacional de Política de Informática, 2001; Macome, 2003).

While the PHC strategy was selected to extend health services to the most peripheral areas in the country, the ICT related capacity, both people and technology, is focused to the centre with limited spread to the districts. The centralization of healthcare services, the asymmetric distribution of infrastructure and access to ICTs and information makes it extremely difficult for the PHC strategy to work effectively in practice.

Organizational financial capacity and health reforms

The country is highly dependent on international aid support, currently constituting about 17% of the overall GDP. Nearly 50% of government spending and 75% of public investment including in health is being financed by external aid (Falck et al., 2003). In particular, the external financial contribution to the health sector has increased from 9% in 1983 to about 60% in the early 90's. The provision of health services to the population is therefore largely dependent on funding agencies such as the World Health Organization, World Bank, African Development Bank, European Union, NGOs like the Bill and Melinda Gates Foundation, and many other charity based international organizations.

The development of the health sector in general and of the HIS more specifically, has been guided by specific policy documents, which were meant to provide the health framework, such as, the (2001-2004) government program, the (2001-2004) action plan for reduction of absolute poverty (PARPA), the health sector strategic plan, and the information and communication technology policy.

Currently various reform processes are taking place in Mozambique including efforts to implement further decentralization, enhance community participation,

strengthening human resource capacity and public expenditure management systems and the introduction of ICT-based HIS. The guiding document, i.e., the National ICT policy, introduces two important changes in the public administration towards e-Government, namely improving the current Public Servants Information System (SIP) and the State Financing Information System (SISTAFE), placing increased demands on integration, accuracy and timely information for various stakeholders. Constraints and problems in the NHIS have been identified through various assessments of the NHS. For example, a joint evaluation conducted by MISAU/WHO in 1999 pointed out the following constraints to the NHS:

- Absence of a comprehensive MISAU ICT strategy.
- Inadequate training of health staff in health information and utilization.
- Inadequate software application packages and existing Legacy Information Systems (LIS) were outdated and incomplete.
- Absence of an integrated/unified HIS that could provide management with essential indicators for decision making and cross-link resources with activities, management and accounting systems.

With this overview about Mozambique in general and the empirical setting (the healthcare domain) in particular, I further discuss prior experiences of Mozambique in the “transfer of technology” which will help to better contextualize the subject of this thesis – the transfer of HIS, and the historical tendencies or paths of the technology transfer process in Mozambique.

3.3. Experiences of technology transfer to Mozambique

The history of diffusion of computers in Mozambique is linked to both private and public institutions. Activities of private and public firms included selling office and business machines and computers, and providing services such as training in hardware

and software use. In these terms, they contributed to the transfer of technology process since 1964-65 when the first computer was installed in a tobacco company in Mozambique (Kluzer, 1993).

A relatively recent study by CPD²⁹ conducted between 1989 and 1990 concluded that out of 350 computers belonging to approximately 30 institutions based in Mozambique:

- Only 20% were acquired from local companies;
- 50% were acquired from South Africa, United Kingdom, Italy, and United States; and,
- 30% were imported from 11 different countries including Norway, Sweden, Portugal and Taiwan (Matusse, 2003:128).

The above numbers show a clear tendency of a North-South movement of hardware/software. This can be attributed to the following reasons: (1) Donors' rigidity in including equipment originated from their countries as a precondition for the aid package; (2) Limitations of the local vendors to provide after-sales services (e.g. support in spare parts, maintenance); (3) Relatively lower prices to acquire equipment from the "North" compared to local sources; and (4) Generalized suspicion of the integrity of local companies with respect to their sales ethics. These reasons indicate the continued dependence of Mozambique on external funding for the acquisition and support of ICTs.

A recent example of technology transfer to Mozambique of an invoice information system, called Galatee, is reported by Macome (2003). According to Macome, this system was developed by an international team and had been previously implemented in different countries, including Brazil, Poland, Ivory Cost, and France. A major lesson

²⁹ CPD: Centro de Processamento de Dados. One of the pioneers public institution of informatics for data processing.

from the study is that local stakeholders should be involved in the entire implementation process, in order to make the technology transfer successful.

MISAU has experienced at least two significant initiatives of “technology transfer”. In 1992, MISAU introduced SisProg at province and national levels, as the first attempt to establish a computer-based reporting system (Brown, Sioi, Iras, 1997). The aim of this system was to automate most of the information transaction activities linked to the different health programs. SisProg was developed in-house by a foreign expert (who is long gone) who tried to develop an application that could integrate data from more than ten different health programs such as immunization, mother and child health, drugs and infrastructure. However, in practice the SisProg only managed to integrate data of two health programs, Immunization and Mother and Child Health. As a result, the remaining health programs set up individual projects supported by different donors to develop and use their own software and computer technology for handling their data. In the absence of overall coordination and control by the MISAU, the systems developed were not capable of sharing information among themselves or with the SisProg.

In order to address this lack of integration, another foreign expert with a background in epidemiology, employed at MISAU, developed an integrating spreadsheet system called SIMP³⁰ that was subsequently implemented at all provinces and at the national levels in 2002 (MISAU, 2003). SIMP integrates data from finance, public servants information system (SIP), office of cooperation and international projects (GACOPI), infrastructure, epidemiological surveillance data, and also SisProg through a series of standardized reports that enable cross correlation of major indicators. Different technical evaluation teams criticized the integration of SIMP and SisProg because it

³⁰ Sistema Integrado de Monitorização e Planificação, Portuguese for Integrated System of Monitoring and Planning. SIMP deals with government budget and funds from donors and is currently meant to administer data from all health units on the services provided, patients attended and drugs.

does not handle the validation of data generated from SisProg. SisProg is reported to have many bugs, however, SIMP tends to automate these existing inefficiencies.

4. CHAPTER FOUR: RESEARCH STRATEGY AND METHODS

This chapter describes the research strategy and methods carried out as a part of my empirical research in Mozambique from 2000 to 2003. I first describe the research genesis and motivation in section 4.1. In the following section 4.2, I provide details of the research design, organized in four subsections: Action Research (AR); longitudinal case study; multiple level analysis; and interpretive approach. The section 4.3 provides information on research approach, while the details on data collection and data analysis are presented in sections 4.4, 4.5 respectively.

4.1. Research genesis and motivation

An action research program called HISP (Health Information Systems Program) was established in Mozambique aiming to strengthen and further develop local Health Information Systems (HIS) through training, capacity building, and the design, development and implementation of a Free Open Source Software (FOSS), called District Health Information Software (DHIS). The stated aim of HISP is “to design, implement, and sustain HIS, following a participatory approach to support local management of health care delivery and information flows in selected health facilities, districts, and provinces, and its further spread within and across developing countries” (Braa, Monteiro and Sahay 2004; 343). HISP³¹ started in South Africa in 1994 (Braa and Hedberg, 2002; (Braa et al., 2004) which provided the starting point for the establishment of HISP³² in Mozambique in 1999 through a process of “technology transfer”, which is the empirical focus of this study.

³¹ . See www.hisp.org.

³² The overall goal of HISP was defined as to support the development of the information and communication infrastructure and human capacity at district and provincial levels in Mozambique. The program would use the development of good practices of usage of information for management within the health sector as a means to subsequently spread the approach and model to other sectors of the local national economy, (such as education, agriculture, etc.) and the community in a more comprehensive approach.

The partners of HISP in Mozambique (the University of Oslo, Eduardo Mondlane University - UEM and the MoH or MISAU) signed in 1998 a MOU³³ for a pilot implementation of HISP in three selected districts, namely Chókwe, Maxixe and Cuamba. During 2000, funds from Norway contributed to initiate work in these three districts and provide the basis for the development of a strategy for the National Health Information System (NHIS).

The present study is part of the HISP program which was initiated in Mozambique through a survey in 1999 of ICT infrastructure, in which the author was a member of the survey team. The main focus of the survey was to study how ICTs were spread and adopted at the province and district levels more broadly and within the health sector in particular. The specific aims of the survey were to analyze the following:

- Information use, analysis and pattern of feedback amongst health workers and management staff;
- Assessing the skills, training, quality of computer use, and the level of ICT infrastructure overall in the district, not just restricted to the health sector; and,
- To identify formal and informal networks of support of ICT and provision of training at the district and provincial levels.

A number of districts of Niassa, Inhambane and Gaza provinces in Mozambique were visited as part of this survey, and the results from it were used as a basis to start planning for the HIS based at district level. Results from the survey (published in appendix A) emphasized that in Mozambique, the ICT capacity and use at district and province levels is weak but at the same time the existing ICT users draw upon technical support through informal networks, including people dealing with computers in other sectors, such as education, administration etc. (Braa et al., 2001).

³³ Memorandum of understanding.

My personal motivation to embrace this topic for the thesis stemmed from the following reasons:

- It is common to hear health workers complaining about the hassle of filling in a multitude of forms instead of rendering assistance to the patients. Filling in forms is the only way to show senior people that they are working. There is thus the challenge of how computers can be introduced in such a complex setting and still provide benefits to the staff.
- While strengthening HIS is a stated priority for the MoH, the results on the ground still leave much to be desired.
- Personal interest to learn about the design, development and implementation of HIS/ICTs; and investigate how ICTs can contribute to the better provision of public health services.
- Interest in improving my knowledge about processes of “technology transfer” to developing countries, and the inherited challenges of their integration within the existing HIS.
- Mozambique remains underdeveloped regardless of the immense potential of natural and human resources as well as great cultural, ecological and economic diversity. One reason for the status quo is the failure to provide basic health and education needs to the citizens. How can ICTs help to address the health care problems hindering the development of Mozambique?
- At the University of Oslo (where I am currently a research fellow), there is an information systems research group with a strong emphasis and tradition on development of ICT-based information systems as part of social and cultural change processes. The focus of the research group lies in the study of the interplay between technical and non-technical aspects of IS development. I wished to apply and extend some of the theoretical ideas developed in this

research group, such as Actor Network Theory and Information Infrastructure, to the context of developing countries.

- My prior education has been in computer science in the Soviet Union which emphasizes a strong engineering approach. Through my doctoral studies, I wished to complement my prior education with a social science perspective to IS.

Summarizing, in trying to integrate research and practice around HIS within the umbrella of the HISP initiative, five academics, including myself, with background in computer engineering and medicine from UEM Mozambique, took up doctoral studies at University of Oslo (UiO). My research strategy and methods are presented in the next sections, given this background about HISP and also of myself.

4.2. Research design

The research design is characterized by four key features:

- Action Research;
- Longitudinal case study;
- Multiple level analysis; and,
- Interpretative approach.

These are each now discussed.

4.2.1. Action Research

This is an action research study (Elden and Chisholm, 1993) within an interpretive case study framework (Walsham, 1993). Action research is defined by Greenwood and Levin (1998) as follows:

”Social research carried out by a team encompassing a professional action researcher and members of an organization or community seeking to improve their situation. Action research promotes broad participation in the research process and supports action leading to a more satisfying situation for the stakeholders” (Greenwood and Levin 1998: 4).

Action research is a strategy for the use of scientific methods to solve practical problems in a way that also contributes to general social science theory and knowledge. The starting point of this approach is that research should lead to change (Smith et al., 1991), by establishing collaboration between the researcher and researched. Action research approaches seek to address open-ended problems, rather than those with identifiable solutions, and the focus on change is mandatory. Because of collaborative characteristics of action research, the participants (researcher and researched) should learn from each other. Working with and for the people involved in the problem domain, in the process of identifying and generating solutions, is a basic strategy applied in action research.

Participation and developing simultaneous contributions to social change and knowledge are key characteristics of action research. The element of participation is important to ensure that everyone who takes part have the opportunity to put the results to work and iteratively learn from this process. The diversity of experience and capacities of the local group is considered a source of enrichment of the research-action process. Action research seeks to change something, not just study it, and this has to lead to action which should improve the situation of the stakeholders. The approach of action research is especially relevant in the health domain of developing countries, for a variety of reasons including (1) large and increasing amount of health problems and an urgent need to improve; (2) poorly performing HISs; (3) majority of the citizens (lower socio-economic groups) depend on public provision of health services; (4) provision of public services is highly dependent on aid, providing opportunities for

strengthening the local HIS capacity but also making them vulnerable; (5) the public sector faces ever increasing demands for improving health services provision in a context of decreasing resources; (7) a key focus of ongoing health reforms is the strengthening of existing HIS.

Action research processes and its research outcomes are often described through case studies. A case study approach allows the researcher to describe the dynamics of a process over a long time span. Action research initiatives include interventions in practice for both problem-solving and theory development. Intervention (theory-informed) is a necessary attribute of action research (Avison et al., 1999), and action research projects such as HISP can be labelled as case studies with an intervention component. In this thesis, the case study is related to the analysis and shaping of the process of technology transfer and the surrounding dynamics in the context of MISAU. Specifically, this study reports on the process of transfer and adaptation of the DHIS, at three levels of the Mozambique health structure of the District, Province and National.

4.2.2. *Longitudinal case study*

A case study aims at investigating a contemporary phenomenon within its natural settings (Benbasat et al. 1987), especially when the boundaries between the phenomenon and its context are not clearly evident (Yin 1994). This study started as a pilot project in 2000, and over time has focused on the processes surrounding the processes of design, development and implementation of a HIS at various levels of the NHIS. The case study focus was on MISAU. The analytical focus was on the process of “technology transfer” of the HISP developed software (DHIS), including the supporting know-how (e.g. training approaches) and associated artefacts (the training manuals) developed in and for the South African context to Mozambique. Key to this

analysis was to understand how contextual differences (between South Africa and Mozambique) shape this translation process, and how can they be addressed in an action research framework.

The features and design assumptions adopted in South Africa expressed the intention and achievement of building a software that was flexible to change, and to adapt and localize to Mozambique. These features provided the starting context, within which the DHIS from South Africa had to be translated, changed, adapted and implemented in Mozambique. While in South Africa the focus of the health reform was on the integration of the pre-apartheid health services, in Mozambique, the focus was on improving or changing the current LIS and the surrounding work practices. While there was a well entrenched paper-based HIS in MISAU, the same was not the case when the process started in South Africa. In South Africa, the HIS had to be built primarily from “scratch” following the “breakdown” of apartheid. These contextual differences shaped the processes of translation as has been elaborated through this thesis.

The translation process took place over time, emphasizing the need for a longitudinal design, which helps to understand how organizational change emerges, develops, grows, or dies over time. The translation process studied and influenced through this research consisted of various events, interventions and effects. As these changes take place over extended periods of time, the focus was on the study of the translation process as it unfolded over time. Van De Ven and Huber (1995) emphasize the importance of a longitudinal design to study such change processes as follows:

Change processes are composed of events with antecedents and consequences, and when these are understood and connected in the form of a story or historical narrative, an understanding of the process is often the result (Van De Ven and Huber 1995: Xii).

Since the focus was not only on understanding the actual lived experience of actors in a social setting as is the case of ethnography (Suchman, 1987; Orr, 1996), but also on introducing change over time, the longitudinal case study was seen an appropriate tool to guide this research.

4.2.3. Multiple level analysis

The field work was carried out at multiple levels of the international, national, provincial, district and sub-districts. The reason for this multiple level design was to trace how technology “changed hands” from where it was originally developed in South Africa (international level), through to the national and other levels till it reached the user primarily located at the district level. The aim was to analyse the process of translation as the technology was changing hands, the mechanisms by which it took place, and the conditions that influenced this movement. This movement was not a linear process and a multiplicity of networks were seen to be simultaneously in play, both influencing the translation process and being influenced by it.

At the international level, the focus was on understanding how the DHIS was designed and developed in South Africa. At the national level, the focus was on MISAU and their policies and strategies, at an intermediate level, the field sites were represented by the three provinces of Gaza, Inhambane and Niassa and finally, and the micro level was represented by the three HISP pilot districts within the mentioned provinces, i.e., Chokwe (Gaza Province), Maxixe (Inhambane Province) and Cuamba (Niassa Province).

In particular, the pilot HISP districts were selected by the MISAU authorities and the UEM because they were training centres of the Faculty of Medicine for the rural apprenticeship of medical students. Within the action research framework, these sites helped to focus the research analysis and also to contribute to the broader objectives of

MISAU and UEM. The challenge was to compare and contrast the findings vertically across levels, horizontally across programs or activities at the same level, while also examining their linkages. Such an analytical focus was important since the same technology or system (DHIS) was expected to support all levels and programs of the NHIS.

In addition to the vertical across levels (sub-districts to national) there was also the need to study linkages horizontally across different health programs (mother and child health, expanded program of vaccination, in-patients, diseases of mandatory notification, stock, etc.), and across facilities at the same levels, say of the districts. This multi-level approach was important to assess the specific data elements and information flows, and how they flow across levels, and how the data is interpreted and used differently. This allowed for a comparison of similar phenomenon (e.g. adaptation of computer-based HIS, report generation) across and between the levels, representing different conditions and challenges. For example, in one province where the commitment was greater, the uptake of the system was greater as compared to one in which there was limited interest.

The adoption of the multi level approach helped to assess and understand data related issues at various levels of the NHIS hierarchy. For example, when the HISP programme was launched in Mozambique, one of the major concerns was to test the DHIS tool in the context of Mozambique. This implied developing the local database (backend) and translating the user interface (front-end). For testing purposes, DHIS was installed in the pilot districts³⁴ and training sessions were subsequently organized at the province level mainly on how to enter data into DHIS. A plan was defined in each pilot site for entering the available data on a per-unit basis. However, there was a request from MISAU to extend the scope from one pilot district to the whole province in order to establish the necessary linkages of support between the province and the

³⁴ HISP pilot districts were Chokwe, Maxixe and Cuamba in Gaza, Inhambane and Niassa provinces, respectively.

districts. This request raised various practical and implementation challenges. In order to scale up the pilot to include more instances of use, based on learning and findings from testing activities, organizational interventions needed to be made, which were not easily forthcoming because of institutional and political reasons.

The DHIS was installed in all three province directorates including the districts with the potential for using a computer system (e.g. the existence of electricity). Similarly a plan was set for entering data, using the clustering³⁵ strategy. A cluster involved ideally a “hub” district which had relatively good infrastructure, and surrounding districts were expected to come to this hub to enter their data and receive training. The cluster districts were assigned coordination and supervision responsibilities, but were not provided additional resources for implementing their responsibilities. This strategy for data entry was initially reported to function in all provinces, but with time was abandoned due to constraints of resources, and the fact that a district preferred to “give” its data to the province and not a district since the latter was considered to be at the same level of hierarchy. Understanding such dynamics would not have been possible without the adoption of a multiple level approach which allowed the analysis of interlinkages, such as related to the hierarchical relationships.

4.2.4. Interpretive approach

Interpretive studies attempt to understand a phenomena through the meanings that people assign to them, their understandings of the context, and how the processes around the IS influence and are influenced by the context (Walsham 1993). Interpretive research does not predefine dependent and independent variables, but focuses on understanding the complexity of human sense making in situated contexts (Kaplan and Maxwell, 1994). In contrast, a positivist approach focuses on establishing formal hypothesis, quantifiable measures of variables, hypotheses testing, and making

35 Cluster district: having proper infrastructure (Electricity, Communication) so that the neighbouring can refer to, in a regular basis to enter their own data.

statistical generalizations from a sample where the phenomenon is studied to a larger population (Orlikowski and Baroudi 1991). A positivist approach assumes the relationship between human and social reality as “independent,” and not influenced by the “bias” of the researcher (Orlikowski and Baroudi 1991; Levin 1994). Positivist studies seek to test theory in an attempt to increase the predictive rather than developing descriptive understanding of the phenomena under investigation (Walsham 1995b).

Interpretive research makes the epistemological assumption that reality is subject to multiple interpretations, and cannot be studied objectively to establish a truth. Interpretive research aims at understanding and analyzing subjective interpretations and their consequences; thus it seeks a relativistic, rather than shared, understanding of phenomena (Orlikowski and Baroudi, 1991: 5). This understanding and analysis is mediated by the researcher. (Walsham 1993; Myers and Avison, 2002).

The interpretive approach adopted helped to understand the socio-technical processes involved in adapting, using and scaling the DHIS software and associated processes. The interpretive perspective helped to focus on various formal and informal practices that surround, and are constituted in, the flow of health information. We tried to understand the social world of the health staff as they emerged in their everyday tasks and as they interacted with each other and ourselves within the context of HIS. Given the complex and busy nature of health work, we tried to also organize training workshops outside the workplace, in the Province Directorates. However, due to various operational limitations (like time and money), workshops organized were few and sporadic, inadequate for the participants to feel confident and comfortable with computers. At the end of the provincial level workshops, when the participants went back to their districts they did not get the opportunity to practice or apply what they learned, since computers were not available in their workplace. This reduced the efficacy of the training workshops.

Action Research is normally seen as a cyclical process with multiple phases (Susman and Evered, 1978), suggesting a rather rigid model in which one cycle is expected to build upon the earlier one. The present study was conducted following the general and core principles of Action Research, but not the rigidity of following predetermined cyclical stages. In the next section, I describe the specifics of the action research approach as was adapted in this research.

4.3. Research approach: adapted action research

In the process of studying and enabling the process of technology transfer, I conducted a set of iterative processes of action research cycles of prototyping (Budde et al 1992). Budde et al. describe prototyping as an approach based on an evolutionary view of software development, producing early working versions (prototypes) of the future system, based on experiment and experience. A prototype implements limited aspects of the future system; which is then used for problem clarification and future definition. The aim of prototyping is to gather user and management requirements if the problem situation is unclear. “Exploratory” prototyping is used to develop or clarify the initial ideas about the systems requirements. Further specification of the user’s needs through “experimental” prototyping involves improving the communication between users and developers. Evolutionary prototyping refers to a continuous process of adaptation of a system to meet the constantly changing organizational needs.

The research approach followed is fundamentally based on the principles of prototyping, which I describe below in detail. This prototyping approach represents my adaptation of Susman and Evered (1978) five iterative cycles (diagnosing, action planning, action taking, evaluating and specifying learning) approach to action

research. My action research approach is described to include the following iterative cycles:

- The first AR cycle: Situation analysis (2000).
- The second AR cycle: Selecting the minimum functionality (2001).
- The third AR cycle: Matching the prototype with the context (2002).
- The fourth AR cycle: Scaling up the DHIS (2003).

These cycles are now described.

4.3.1. The first AR cycle: Situation analysis (2000).

A starting point was to conduct a situation analysis in various health facilities at the district and province levels and their interlinkages. This activity was initiated through a survey with the aim of identifying the main problems regarding the ICT status with a focus on the health status. We then drew an organizational map of the districts (including all the organizational units) and their estimated catchment areas and target populations based on the 1997 census. We tried to understand what were the various data items, data collection instruments, and what were the various channels through which the data flowed, and the associated challenges (MoU, 1998; Braa et al., 2001).

Within the framework of the HISP team, a action plan was elaborated which had the following components: to develop a district based database application which stores data on a per health unit basis and which enabled the calculation of relevant health indicators at the district and sub-district levels; to integrate the application with the current provincial information system (SisProg); and, to develop and conduct training programs and associated manuals and protocols for the health staff on the analysis and use of health information.

Operationalizing the action plans involved identifying key actors and champions at the UEM and MISAU, to undertake various DHIS adaptation activities, including the

language translation of the monthly data module user interface of DHIS for initial demonstration purposes. While the action plan wish list was much longer, a limited amount was achieved in the field due to the 2000 cyclone across Southern Africa leading to three weeks of severe floods which devastated Mozambique, including destroying many health facilities. Publishing the survey findings in an international conference in South Africa was a key output of this phase of the action research process. The conference provided opportunities for networking with similar initiatives being carried out in other African countries, such as the INDEHELA-Methods in Nigeria³⁶.

The focus of this AR cycle was not primarily on the development of the application but rather on understanding the HIS needs and the formulation of plans and approaches to pilot the DHIS in the districts. These plans were discussed in meetings and in informal talks involving HISP team members and authorities from the Ministry of Health. A feedback document which reported on the various activities undertaken till date, including recommendations on implementation, was presented by HISP members and analyzed by the MISAU staff in several meetings.

The implementation of the planned actions was expected to be carried out by the HISP team members. Five of the team members subsequently enrolled for the PhD program at UiO on the assumption that the project work would provide the empirical basis of the action research, for example, related to questions concerning technology transfer of HIS to developing countries. However, it was not possible to always find a one-one correspondence between the project and research, for example, one of the team members was working on practices related to laboratories where DHIS was not involved. This mismatch, magnified by scheduling issues of people being in Norway for their studies during different time periods, meant that the team was not always well equipped to provide field level support.

³⁶ <http://www.uku.fi/tike/indehela/>

4.3.2. The second AR cycle: Selecting the minimum functionality (2001).

From the situation analysis, we learnt that the current software application in use, SisProg, was rigid and locked on an outdated platform which had not evolved since 1992. The HISP team felt that DHIS could better support the constantly changing needs of the NHIS than SisProg. The DHIS software developed in South Africa had varied and extensive functionality, reflecting their 6 year experience and maturity relating to HIS design, implementation and development. As Mozambique was at a much earlier phase in this process, we had to make conscious choices of different (minimum) functionalities that should be adapted to reflect the different context, and be in phase with the local requirements. The HISP team decided and agreed to extract the minimum functionality and build the initial prototype of DHIS, which would form the starting point of the adaptation process. This process was the focus of the second action research cycle of prototyping. In the following five boxes, I describe the different functionalities included in DHIS South Africa, the choices we made, and the underlying reasons for them.

Box one: Outline of DHIS.

DHIS was historically conceptualized to support the Expanding data warehouse logic: Include routine (e.g. immunization data, mother and child data), semi-permanent (e.g. infrastructure – organizational units, human resources, data elements or variables – in Mozambique) and survey data (population data and its projections). This is a set of MS-Access database modules (Access Back-End) (Ex:DHIS_#MZ.mdb). The database files can be classified according to the administrative organizational structure of the health system of a specific context of use. For the case of Mozambique where the structure is of three levels, the database files will correspondently have three instances: National, Provincial and District. The community data feature provides the definitions for the different semi-permanent data elements, specifically population groups. Population data is entered for each district catchment according to the different population age cohorts.

Box two: Three functionalities embedded in DHIS.

Initially, three functionalities were included in the DHIS from South Africa: Indicator engine; Evaluation and data quality control tool; and Data dictionary.

The indicator engine: This feature allows the user to define and calculate Indicators according to numerator, denominator and indicator type. These form different indicator groups (for example, district and province indicators) that are the source for the pivot tables in Excel. The population data (denominator) in relation to the people served by the health facility (numerator) allows calculating the health indicators for any combination of data elements or variables, using the numerator/ denominator framework. For example: number of infants (under 1 year) vaccinated against (e.g.) measles (numerator) divided by the population under one year in the area (denominator).

Evaluation and data quality control features: These allow checking the quality of data entered by setting the minimum and maximum ranges for all the data elements. A validation check should be done once a facility's data has been entered for the month.

This functionality allows the user to define rules using logical operators (e.g. Less or equal) between combination of data elements, to filter or validate data accordingly.

Data dictionary: The Data Dictionary is a web based application storing the nationally approved names and definitions for all the data elements that are in common use throughout the country.

Box three: Rationale for the choices done.

While at this stage, Data dictionary was not a priority, both the indicator engine and the evaluation and data quality control functionality was chosen for inclusion in the DHIS prototype. While the entry of data to the backend/database implies essentially hiding it, the generation of indicators, based on validated data, is a form of output, visible to users or managers. This formed the underlying reason for the choice and inclusion of the two functionalities in the DHIS prototype.

Box four: Four modules included in DHIS.

The current DHIS had 4 modules used for different purposes: These modules represented the different user interface environments of the DHIS tool for data entry, analysis and reporting.

Routine monthly data module (DHIS_MD.mdb). This module contains all the business processes of the system. Here the user enters data in monthly routine basis for each health facility. For validation purposes, each value has a specific range (min/max). These data is then used for reporting to higher levels, using the reports module of DHIS. For each database module there is a corresponding MS-Excel module-pivot table (Ex:DHIS_\$MZ.xls): The different databases are for reasons of data analysis linked to MS-Excel Spreadsheet. Here data can be visualized in pivot tables and used to build standard or customized graphs for different analytical and cross-checking purposes.

Most of the adaptation and prototyping work in Mozambique were centred in this module, given its role as compared to other modules of DHIS.

Report generator module (DHIS_RG.mbd): The data stored and hidden in the database can be visualized using the “report generator module of DHIS”. In “Ad-hoc” or “user defined” reports, the user can visualize in screen or in the printed format data elements with data aggregated by facility, month and of specific year.

Client satisfaction survey module: This module is meant to capture and analyze client satisfaction survey data.

Quarterly TB module (DHIS_TB.mdb): This module was conceptualized for routine TB data entry, verification and analysis.

Box five: Rationale of the choices done.

The Report Generator, Client satisfaction survey, and Quarterly TB modules were not used, partially because were incomplete and suggested different from the Mozambican report formats and structure. In particular, we used the embedded in the Routine monthly module functionality for report generation.

The first steps to start using the DHIS included defining the hierarchical structure and details of the organizational units, compile the list of health facilities associated with specific organizational units and data elements depending of the health services provided. Accordingly, in this AR cycle, the various actions included:

- Diagnosing activities for further familiarization with DHIS software;
- Studying the health related concepts and terminology;
- Attendance by three HISP members of courses on DHIS, HIS management and epidemiology related topics in the Summer School, organized in South Africa;
- Full language translation of the DHIS software;
- Full translation of the user manual from English to Portuguese;
- Development of the backend to include all available data elements and health services;

- Feeding the backend with historical data of Gaza, Inhambane and Niassa provinces;
- Definition and calculation of relevant health indicators; and,
- Testing and evaluation of the DHIS prototype in the districts with real data;
- Conducting training for health staff.

In practice, most of the aforementioned actions were only fulfilled partially. This meant, for example, that:

- The translation focused on the most visible and likely to be used functions/buttons, such as related to data entry, standard reports, and back up features. The language translation in particular, was undertaken in 'lab' conditions (not in the district offices). This work served not as the final but rather the starting point for discussion and further translation of the DHIS (for more details see Nhampossa, 2004a).

The planned training (on the job) was conducted for only one district (Cuamba, in Niassa) and not confined to DHIS, but also included general computer use, statistical calculations, drawing graphs manually, and HIS procedures conceptualized through the Information Cycle, as visualized in the Figure 8 below



Figure 8: Facilitating a on job training session in Cuamba District.

- The installation, configuration and testing of the DHIS prototype in the districts implied acquiring a desktop computer and a printer, and bringing it along to Niassa (the furthest province in the North of Mozambique). However, in the field, we were faced with constant power cuts, forcing us to improvise; to use laptops instead, for training.
- The evaluation of the DHIS accompanied training activities. This evaluation was conducted through specific meetings, and also through informal conversations with the potential users and also amongst the HISP team members. With the specific aim of evaluating the impact of the HISP activities, in 2001, a seminar was organized by HISP, in which participants came from Niassa, Inhambane and Gaza provinces and from the MoH. In this seminar, various issues were raised and discussed, around DHIS performance. We tried to incorporate these suggestions into making further improvements. For example, while the participants felt motivated to use DHIS because it could help them to generate graphs and reports easily, they requested for more training on how to interpret the generated graphs. Space was also provided in

the evaluation seminar for discussing other aspects, such as how to deal with infrastructure problems, such as not functioning telephones.

In the efforts to build a working prototype, various lessons were learned from the interaction with the participants of the evaluation seminar, we realized the importance of being more sensitive to the contextual differences both across and within provinces, districts and health units. In the next section, some of these issues are elaborated.

4.3.3. The third AR cycle: Matching the prototype with the context (2002)

In this cycle, a key focus was to match the prototype with the use context. This involved the identification of the critical aspects likely to hamper the use of DHIS including language incompatibility, different hierarchical structures, and inconsistent naming conventions (see Kaasboll and Nhampossa, 2002). An important intervention involved completing the translation of the remaining forms and addressing the existing errors; also, we had to complete the mapping of the organizational units, data elements and indicators related to all health services; translating the DHIS user manual provided in the original installation CD from South Africa.

In this phase, we realized that DHIS was hard coded where all the displayed strings were part of the code. This implied that all the adaptation processes needed to start from scratch, to comply with the new DHIS version releases from South Africa. As a result, the implementation of the planned actions took quite different paths and required more time and efforts than anticipated. In this phase, activities included the re-editing of all the forms with English strings, re-building the backend, and translating the DHIS user manual. In addition, work was done to adjust the Portuguese text (which was longer than English) in the different screens/buttons of the directly visible users' forms and screens.

The approach was to install the (new) prototype in the personal computers of each of the HISP members and also of the MoH authorities involved, for testing and evaluation purposes. In parallel, the HISP team organized weekly meetings and workshops to discuss the meanings of each string or phrase displayed in every visible screens/forms. The result of this evaluation was the development of a checklist with a set of DHIS bugs and a proposal for improvement, which was subsequently submitted to the South African DHIS development team. This included a proposal for shifting from mono to Multilanguage DHIS.

The learning resulting from this action research cycle of prototyping suggested the need to shift from hardcoded to Multilanguage system. Both the new prototype and the translated DHIS user manual were tested in the field sites and during the specially organized workshops. We found that the translated user manual was of no use for the participants, since it was designed for the South African context which was relatively advanced as compared to the Mozambican, in terms of computer literacy and HIS practices. As a result, we turned to a strategy where a tutorial kind of user manual was developed interactively with the participants in the workshops.

4.3.4. The fourth AR cycle: Scaling up the DHIS (2003)

A number of positive experiences were recorded from the previous attempts or cycles of prototyping: Building awareness about the role of ICT, calling attention to the importance of decentralization and focus on district based HIS, capacity/skills building and emphasis on local analysis and use of information for decision making, and, building the team and collaborative spirit within the HISP team. Based on the various learning gained through reflecting on the implementation experiences, formal and informal feedback from the potential users of DHIS, participation in training seminars, workshops, reports³⁷ and meetings held at the MoH level, we started to better understand the challenges to scaling our implementation efforts.

³⁷ Ad-hoc and MSc student thesis and field work activities

After addressing some of the contextual challenges, the focus now was on expanding the scope and rolling out DHIS to include the remaining districts within Niassa, Inhambane and Gaza provinces, as suggested by the MoH. Therefore an action plan was suggested with the following key points:

- Developing a scaling strategy to extend the scope from the pilot districts to the whole province (s) in order to establish the necessary links of support between the provinces and the districts. As a consequence, a shift in focus from the three pilot districts to three pilot provinces took place. This included establishing a clustering strategy, so as to support the use of DHIS in those districts without proper electricity and communication facilities.
- Further refining the earlier cycles and activities by testing it in other province/district sites.
- Evaluation of previously implemented prototypes and implementing the required revisions.
- Developing the “hierarchy of standards” and minimum data sets.
- Developing a strategy to further develop the software technically, such as incorporating new data entry screens.
- Shifting from aggregated to a per health unity reporting system, which in turn implied changes in the data collections standards.
- Report generation.

Since during the earlier cycles data was entered into DHIS, some new data handling features were added in this cycle, such as “Data quality control features”, “Indicators handling features”, “Community data features” and “Institutional infrastructure features”. So we tried to shift the focus from data entry to reports generation, data presentation, and use.

At the end of this AR cycle, we had a working prototype in eight district sites of Niassa province (Cuamba), Maputo province (Magude), Gaza province (Manjacaze and Chicumbane) and Inhambane province (Massinga, Homoine, Maxixe and Vilanculos). Processes were further undertaken to assess the information needs relevant to the visited provinces, districts and local rural hospitals, in order to develop their minimum datasets. This was done through one-two weeks of systematic meetings, discussions and interactions between the HISP team members, authorities from the MoH and the district health staff.

However, the process of expanding the scope and rolling out the DHIS was impeded by the presence of a number of LIS supported by various MISAU managers and donors. The weak human resource capacity, technical, power and communication infrastructure also contributed negatively to the scaling up processes. As result, the suggested clustering strategy to support the use of DHIS in the sites without proper infrastructure failed to succeed. Also contributing to the complexity was the centralized administrative system, in which all decisions were taken at the national level. For example, the use of the DHIS by the district authorities was very weak, because a formal sanction was not given by Maputo.

In summary, the adaptation of DHIS through the AR cycles helped to gradually understand the domain of health and the inherent contextual and emergent challenges. The sensitiveness to the context of HIS suggested the need to further identify different needs within and across the different levels; for example, related to developing the “hierarchy of standards”, or further refining the “Front End” and “Back-End” modules.

I employed different but complementary techniques for data collection at national, province and district levels. Various relevant groups of people were met including managers, information officers, doctors, HISP team members, statisticians, HIS/DHIS users and DHIS developers in South Africa. Qualitative methods were used including

questionnaires, observations, analysis of documents, and interviews and group discussions. In the following section, I provide the description of these various data collection methods.

4.4. Data collection methods:

The exploratory study started in 1999 by mean of administering two questionnaires on the potential usage of ICTs for supporting the management and provision of health services at provincial and district levels (see APPENDIX M and N). The administration of the questionnaires provided information about the current situation in terms of the existing infrastructure (people, hardware, software, transport, communication), content and quality of the health data collection tools and procedures, and MISAU's HIS vision and plans. Details about this phase are published in the thesis background paper, i.e. appendix A by (Braa et al., 2001). The questionnaire administration and its analysis and documentation constituted the first phase of the study.

Based on the information from this phase and aiming to acquire better understanding of the HIS domain, work practice and LIS, I collected and analyzed a wide array of documents including the strategic and policy documents and reports issued by the MoH/MISAU, technical teams, donor agencies, and nongovernmental bodies. While the majority of these documents were in hard copy format, there were also some electronic documents, such as previous HIS evaluation reports, routine reports from the province levels, and HIS training and procedure manuals. Some of these documents were paper forms (e.g. A01, A02, A03, B01, B02, B03, B04) for data collection, aggregation and reporting (see Table 5 below). These forms were used to collect various types of data related to in-patients, community health, maternity, vaccination, diseases of mandatory notification and stock handling.

Table 5: Summary of data collection and aggregation forms.

Form name	Category	Purpose	Level of use
A01	Expanded Immunization Program	Daily registration of data for BCG, Polio, DTP and measles.	Health unit level
A02	Expanded Immunization Program	Daily registration of data for Tetanus.	Health unit level
A03	Expanded Immunization Program		Health unit level
A11	Expanded Immunization Program	Monthly stock control of vaccines.	Health unit level
A12	Expanded Immunization Program	Daily control of temperature variations	Health unit level
B01	Mother and child health	Registry book for maternal	Health unit level
B02	Mother and child health	Registration of consultancies for Ante-Natal and Post-Partum care	Health unit level
B03	Mother and child health	Registration of consultancies for 0-4 years and 0-35 months children and nutritional control	Health unit level
B04	Mother and child health		Health unit level
C01	Outpatient services	Registry book for outpatients	Health unit level
C04	Outpatient services		Health unit level
C05	Outpatient services		Health unit level
C02	Weekly notification of cases		Health unit level
C03	Weekly notification of cases		Health unit level

A04	Immunization		District level
A11	Immunization		District level
A05	Immunization		District level
B06	Mother and child health		District level
B07	Mother and child health		District level
B08	Mother and child health		District level
B05	Mother and child health	Monthly stock control of	District level
C07			District level
C05			District level
C04			District level
C03			District level
A11			Province level
A05			Province level

These documents (available at MISAU) were accessed and analyzed in detail, with respect to questions of HIS **design** (e.g. who was involved), **development** (e.g. which approach was used), implementation (e.g. how the appropriateness of the current HIS was tested and by whom), **training** (e.g. who was involved and what was the purpose of the training), **use** (e.g. how the current HIS is used, and **support** (e.g. how often the support is provided and who provides it). More details are included in the APPENDIX O. Accessing the library of the MoH and the various reports laying in the offices of some of the top managers at the MoH was a relatively easy task because of our good personal relationships. In these documents, I found in most cases, the description of what people and systems were supposed to do in formal terms, but did not focus on the performance of the systems on the ground such as SisProg. For example, I read a document which stated that 10 paper forms (see Table 5) were computerized and included in SisProg, which did not correspond to the reality which we observed in the field where we only saw 4 forms to be computerized.

To get answers to questions such as how training was organized, how people were selected for training, what were people's opinions about the current LISs and also the DHIS, I used the techniques of interviewing, discussions with HIS users, and participant observations in the field settings and also in specially organized workshops.

Data collection involved registering more than 100 individual/group interviews throughout the timeline of the fieldwork (2000-2003), with MoH officials, information officers, system users, managers, statisticians and software developers. Out of the 100, 8 were video recorded semi-structured interviews spanning an average duration of one and a half hours. These interviews were directed to the head of DHIS development team in South Africa, head of the Department of Health Information at MoH, consultants employed at the Directorate of Planning and Cooperation, and other HISP team members in Mozambique.

I also organized about 6 focus group meetings of six-to-ten province/district managers and information officers to discuss the integration of DHIS in their work routine. The interviews and focus groups were organized in the work setting to discuss issues related to the performance of the currently used computer based HIS (SisProg) and other LISs, including issues of work routines, procedures and systems. The focus group meetings were not taped, as some of the topics of the discussion were sensitive to the respondents. Instead, I took notes³⁸ during these meetings and later typed them in personal reports.

³⁸ For conducting the interviews and discussions with the informants, the working language was Portuguese. For the purpose of the thesis, I translated the text in the reports from Portuguese to English. However, doing reporting from interpretative research in a multi-lingual context has implications on the meaning attached to what is said or recorded.

Observations took place in workshops, training seminars, discussion meetings and in the workplace. Two workshops were organized in Maputo involving the South African development team and members of the HISP Mozambique team. The focus of these workshops was on software development (design and use), bugs fixing, building the backend and populating it with health, semi-permanent and population data. These activities were done with technical guidance of the head of DHIS development team in South Africa. In addition to these national workshops, a number of other workshops were held in the provinces. The focus of these workshops was on (1) accessing the LISs and understanding the current HIS's functionality and procedures; (2) matching the information and data gathered at national level against the reality at the provincial level: information flows, infrastructure, naming conventions, legacy and ad-hoc systems in place towards building the BACKEND for DHIS; (3) studying the data collection and reporting tools: Identifying the data elements (variables) of the current HIS, the business logic and mapping them in the DHIS; (4) language translation: translating the user interfaces from English to Portuguese. In order to gather information about the local experiences from the different levels (national, province and district), workshops were organized including representatives from the MISAU, province and district levels. Managers, doctors, statisticians, HIS and potential DHIS users participated in these workshops.

In general, with the workshops we tried to provide for an enabling environment for the sharing of experiences and mutual learning between the developers (HISP team members) and the users (from the three levels of the health administration) and among the users themselves. These were basically interactive workshops drawing upon both participants' domain knowledge and skills, and also the facilitator's expertise and ideas relating to HIS, computers and public health. These sessions included solving technical problems, DHIS use, data entry, removing viruses from the computers, and answering questions from the users such as how to use other computer programs, for example

word processors and spreadsheets. In my role as both a facilitator and developer, I tried to answer these questions both orally and through practical demonstrations.

The focus of these workshops was normally on practical aspects (data entry, indicator's definition and calculations, DHIS installation and configuration, drawing graphs, etc.). An important focus was on the use of information, as we wanted to emphasize that computers are tools for addressing a larger problem and not an end in itself. These interactive workshops helped to a certain extent to facilitate dialogue and conversation amongst health staff from different hierarchical levels, something which does not happen regularly in the hierarchical context of Mozambique.

In office conditions (such as at the provincial or the district directorates), participant observations were conducted. In this case, I managed to organize/participate in several workshops and training seminars in Gaza, Inhambane and Niassa provinces. However, most of the observations I did were in the Southern part of Mozambique, given the relatively shorter distance from where I live. For the case of Niassa (which is the farthest location) I participated and collected empirical data in only 2 workshops. The distance implied longer and more extended workshops in which hardware, software, organizational and training configuration, data entry, and follow up issues were covered. The Table 6 below summarizes the workshops held.

Table 6: Summary of the workshops held at district, province, national and international levels.

	2000	2001	2002	2003
HISP-MZ-RSA		1	1	
MISAU/UEM	5	11	5	2
Directorate of Gaza	1	1	5	
Directorate of Inhambane	1	1	5	
Directorate of Niassa	1	1	2	

Niassa				
Cuamba	1	1	1	
Lichinga			1	
Maxixe			1	
Murrombene			1	
Massinga			1	
Zavala			1	
Homoíne			1	
Chókwé	1	1	1	
Xai-Xai		1	1	
Bilene		1	1	
Xai-Xai Cidade			2	
Chibuto		1	1	
Manjacaze		1	1	

In summary, these workshops helped to:

- Understand the information flows that characterized the HIS.
- Assess the basic requirements needed to implement DHIS at the three levels, as a starting point for the major overhaul of the NHIS in the Mozambican Ministry of health (MISAU).
- Discuss the strategic approach to follow for the DHIS implementation, and gain feedback.
- Discuss and refine new data sets and reporting tools to be implemented in DHIS.
- Identify and address specific technical DHIS related issues, such as translation, meanings, customization of data entry screens and reporting tools.
- Discuss issues concerning the integration of DHIS with other existing LIS like SisProg, SIMP.
- Conduct training.

In conclusion, I provide below the summary of the different data collection techniques (Table 7) and the fieldwork events at the four levels, international, national, province and district (Table 8).

Table 7: Summary of the different data collection techniques employed.

Data gathering technique	Objective	Description
Questionnaires	Contextualization	This was survey based on two questionnaires, quantitatively accessing the use of ICT and information at province and district levels.
Acquiring documents	Accessing the design assumptions and business processes of the current health information systems and the information flows.	A number of legacy information and ad-hoc systems were identified at national and province levels. Documentation on data collection, processing and reporting forms was instrumental for my first familiarization with the NHIS.
(Participant) observations	<ul style="list-style-type: none"> • What the users do rather than what they say they do; • Experiences sharing among users, middle and top managers and developers. • Skill enhancement. Improve the communication channel between the users and the developers. 	<ul style="list-style-type: none"> • Working in the user's office rather than in developers. • Province or national wide workshops, joining representatives from the district, province or ministry levels. • Installation and configuration of the DHIS prototype in the local computers. • Most of the information was captured from the video recorded workshops and observations. • Training at work place vs. out, aiming to reduce the gap between the users and developers. • Training focusing on DHIS use, data entry, data analysis and generating outputs in tables, graphs, etc.
Interviews and group discussions	<ul style="list-style-type: none"> • Understanding user needs, developing "user participation" in the action research process. 	<ul style="list-style-type: none"> • Accessing information from key informants (from different levels) on meanings and his related gaps to be addresses in the subsequent DHIS prototype and action research cycle. • Facilitating communication between people working in different hierarchical levels

Table 8: Summary of the field work events (locations and number of interviews) at the international, national, provincial and district levels from 2000 to 2003.

Location	Head of the	Managers at	Information	Trainers and	Total
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	HISP/DHIS team in South Africa	MoH	officers and system users	HISP team members	
International level					
HISP team in South Africa	2				2
National level					
MoH		3	3		6
HISP team in Mozambique				7	7
Gaza Province					
DPS-Gaza	2	6			8
Chókwé	1	4			5
Xai-Xai	1	4			5
Bilene	1	4			5
Xai-Xai Cidade	1	3			4
Chibuto	1	4			5
Guijá	1	1			2
Massingir	1	3			4
Mabalane	1	2			3
Manjacaze	1	4			5
Inhambane Province					
DPS-Inhambane	2	6			8
Maxixe	1	3			4
Murrombene	1	3			4
Massinga	1	4			5
Zavala	1	2			3
Homoine	1	2			3
Niassa Province					
Provincial Directorate of Health	2	5			7
Cuamba	1	4			5
Total	23	67	3	7	100

The different strategies for data collection described above contributed substantially to both understand issues and try to undertake action for improving the HIS. Data collected through the various sources were subjected to analysis through a process which is now described.

4.5. Data analysis

Data analysis refers to the techniques employed to analyse the empirical data collected during the course of the fieldwork (2000-2003). Data analysis helps to develop an interpretation or understanding to answer the basic question of *what is going on here*, in my case concerning the challenges and approaches to technology transfer. In the present thesis, data was collected through qualitative methods, and its analysis was guided by an interpretive approach that accords primacy to the subjective understandings of the actors in question, and the processes through which intersubjectivity is obtained.

As suggested by (Agar, 1980: 9), the data collection and analysis processes did not follow a linear but rather a dialectic process in which you learn something (“collect some data”), then you try to make sense out of it (“analysis”), then you go back and see if the interpretation makes sense in light of new experience (“collect more data”), then you refine your interpretation (“more analysis”), and so on. The starting point, or the aims of the analysis, was to develop deeper insights into the process of technology transfer, how it could be conceptualized, what are the conditions that influence it and how can these challenges be addressed. I did not start with any predefined theoretical model, but instead took my action research efforts as the point of departure to collect and analyze the data that was being collected.

In analysing the data I paid attention to the reasons given by particular interviewees when explaining their perceptions, decisions and actions concerning:

- The design and development of the current and new computer-based systems;
- Account of the political environment/circumstances of their decisions on how issues such scalability and sustainability of computer-based systems were addressed.
- The understanding of the design assumptions and business processes of the current LISs, visions, procedures and information flows.
- The existing history of the HIS in the Mozambique context and how this influences current actions.

Through this analysis process, I was able to identify particular contextual conditions and events that contribute to the historical development of disintegrated and unsustainable computer systems. Since the starting point of the analysis was to understand why are HIS in general unsustainable, thus needed to conceptualize my efforts at translation to be stated in terms of the challenge of sustainability. This led to the following definition of technology translation with its focus on sustainability: technology translation can be defined in the context of this thesis as a process of incremental change involving a socio-technical heterogeneous network, which leads to the development of sustainable network, implying that they are both institutionalized and are flexible enough to change as per evolving needs.

As I worked on various aspects of system development and adaptation, I tried to interpret the challenges that I experienced in the various action research tasks, with respect to my conceptualization of technology translation in terms of sustainability. For example, while working on the task of translating the software, I encountered various problems such as the meaning of words, the length of strings, the interaction with the South African development team, that helped me to interpret how the language translation problem influences and is influenced by the larger process of technology translation. This analytical process led to the following definition of software adaptation and customization:

While there is no need to “reinvent the wheel” while moving software from one context to another, sensitiveness to the local context of use must be taken into account seriously. Therefore the technology translation perspective, as defined in this thesis, will imply identifying the context free and dependent features of the technology as an ongoing process of cultivation. Similarly, during the process of conducting training and workshops, I experienced the challenges to enable participatory processes and also to make the contents of what people see as more relevant and meaningful.

The above process led to the identification of 4 key conditions that shape the translation process. The individual action research interventions and their analysis contributed to the development of various papers that deal with the specifics of each of these conditions. In the stage of writing the kappa of this thesis, the data analysis process was taken to a higher level of abstraction where the attempt was to see how these different components taken together help to develop a broader and more holistic understanding of the technology translation process. This process of analysis and further reading of the data in relation to other themes led to the development of the theoretical model that I have articulated in Figure 4.

The analysis process proceeded iteratively involving various and simultaneous activities including conducting literature review, discussion with my supervisors and colleagues, writing research papers, making presentations at international conferences and also in departmental seminars. The written and oral feedback received in terms of review reports, questions in seminars etc, helped me to reflect on my analysis, read new literature, and refine my approach so as to respond to the feedback. This iterative and ongoing process of dialogue between my data, analysis, discussion with a larger research community, and the reading of literature helped me to both deepen my focus and expand the scope of my data analysis.

In conclusion, I have presented in this chapter the details of my research strategy and methods including the research genesis and personal motivation, the research design, research approach, data collection and analysis methods. In the next chapter, I present the findings of the articles included in the appendix of the thesis.

5. CHAPTER FIVE: RESEARCH FINDINGS

This chapter is an attempt to briefly summarize the conference and journal articles included in the appendixes of the dissertation. For each article, I reproduce the full reference and present a summary of the article. The chapter ends with an integrating summary and synthesis of all articles, in which the research questions addressed in each article are highlighted and the respective findings described.

- A. BRAA, J., MACOME, E., MAVIMBE, J. C., NHAMPOSSA, J. L., COSTA, J. L. D., JOSE, B., MANAVE, A. & SITÓI, A. (2001). A study of the actual and potential usage of information and communication technology at district and provincial levels in Mozambique with a focus on the health sector. *Electronic journal of information systems in developing countries*, 5 (2), 1-29.

This article presents the results from a study on the use and appropriation of ICTs in Mozambique with a focus on the health sector. The three provinces of Gaza, Inhambane and Niassa were surveyed and two questionnaires were deployed addressing the following issues: 1) computer users and their ability to manage ICT, and 2) health workers and their handling of health information. Based on this study, appropriate strategies for developing an ICT- infrastructure with the needs of the health sector as points of departure were discussed. The study is born out of a program to strengthen and further develop the health information and management systems at district and provincial levels as part of a process to support decentralization of the health system in Mozambique. The study shows that computers and Internet are rapidly being spread to the provincial capitals and major districts in Mozambique. A main problem identified was the lack of ICT-skills and education and poorly developed infrastructure and networks of support. There were very few formal ICT companies providing hardware, and even less, software support. Maintenance and learning about ICT are to a large extent going on within informal networks of computer users in the provinces. A main finding in this study was that the

development of ICT capacity and information systems at the district and provincial levels in Mozambique needs to be an integrated effort across sectors. A district health information system cannot be developed in a void. A general recommendation is to develop educational programmes ranging from training of ICT entrepreneurs and health workers and managers, to Masters and PhD programmes in ICT and health information systems. A specific recommendation related to health information systems development is to focus on the district level and to develop a strategy which encompasses and integrates all districts, both the advanced districts with computers and the majority of others where there are no computers.

- B. NHAMPOSSA, J. L. (2004). Strategies to deal with legacy information systems: a case study from the Mozambican health sector. IN IRMA (Ed.) *Innovations through information technology*. New Orleans, Louisiana, USA, Idea Group Inc. 475-479.

This paper discusses and presents the challenges imposed by the context when trying to introduce an HIS designed and developed elsewhere into the Mozambique setting. When implementing reforms in the public sector in general, and in the health sector in particular, special attention needs to be taken of the role of existing legacy information systems (LIS). Traditional strategies for system change were developed within a frame of one (or few) isolated systems, and moved from an old to new architecture. The existing infrastructure – installed base of LIS – is typically not seriously considered when implementing changes. A theoretical perspective is developed drawing upon concepts from LIS and Information Infrastructure (II) related literature. This theoretical perspective is drawn upon to analyze experiences from an ongoing attempt to introduce new HIS in the context of Mozambique. The paper concludes by proposing some strategies to deal with existing LIS.

- C. AANESTAD, M., MONTEIRO, E., KIMARO, H., MACOMBE, E., MACUEVE, G., MUKAMA, F., MUQUINGUE, H., NHAMPOSSA, J. L. & LUNGO, J. (2005). Strategies for development and integration of health information systems: coping with historicity and heterogeneity. *Working papers in Information Systems*, 5. 1-51.

The starting point of this paper is that health is crucial for development, and well-working HIS are required for sound decision making and effective use of resources. However, establishing working HIS in developing countries is truly a challenge. Moreover, strategies for the development and integration of large and growing collections of IS escapes simplistic recipes. This is a pressing practical problem globally, as well as being an under-researched area within the IS field. The paper aims to contribute to the understanding and development of such strategies by underscoring two core dilemmas: (i) the conservative influence of historically accumulated and institutionalized practices, technologies and perceptions (dubbed as the ‘historicity’ of information systems) and (ii) the poor integration and increasing fragmentation across the collection of information systems (dubbed as the ‘heterogeneity’ of information systems).

The empirical underpinning for our analysis is an action research project, the Health Information Systems Program (HISP), which aims at improving existing sub-optimal health information systems in developing countries. HISP provides a particularly poignant illustration of the challenges related to historicity and heterogeneity of information systems as these are implied in the politico-historical context. Our empirical material is a cross-national comparative analysis of the current reporting systems for administrative health data in Mozambique, Tanzania and in the state of Andhra Pradesh in India. Several problems are associated with the existing systems and the need to change or replace them is recognized. For example, due to the donor- and aid-dependent economies of most developing countries, there are often other specialized health care programs e.g. targeted towards specific diseases like malaria, tuberculosis and HIV/AIDS. These programs usually have their own reporting systems, and the result emerging over time is a disintegrated and heterogeneous collection of systems. The challenges associated with attempting to change such large-scale, heterogeneous and fragmented systems involve complex dilemmas. As the current information systems are embedded and institutionalized nationwide, a realistic

strategy needs to take a phased approach whereby present systems are gradually integrated into the environment. In the case of donor-supported and -managed program, the national health authorities may not even have the required power to intervene. Thus the existing reality cannot be ignored or done away with, whether it be the information systems, the institutions or the work practices; they constitute the point of departure. Analytically, we draw on recent socio-technical conceptualizations of large, integrated systems - so-called information infrastructures - especially through recent elaborations in the theoretical foundation in actor-network theory (ANT). The development strategy we suggest emphasizes an evolutionary, 'cultivating' approach while at the same time accepting that there will be a certain level of non-integration (often perceived of as 'mess') as chronic.

- D. LUNGO, J. H. & NHAMPOSSA, J. L. (2004). The Impacts of Legacy Information Systems in Reporting Routine Health Delivery Services: Case Studies from Mozambique and Tanzania. International ICT Workshop 2004. Dar es Salaam Tanzania. 91-113.

The understanding of the value of an effective HIS has increased substantially and is reflected by many ongoing efforts of HISs reform in many developing countries such as Mozambique and Tanzania. Among the challenges hampering the effectiveness of the HISs, Legacy Information systems (LIS) are mentioned as one of the major obstacles. The issue of LISs is also addressed in this paper. The paper draws upon two comparative empirical studies of extraction of health data locked on LIS and loading it to a modern computer system, the district health information software; It elaborates on the impacts of LIS in the performance of HIS, specifically on the reporting of routine data, and describes the process of securing the historical health data using a specially developed extraction transformation and loading software. The study found that the data reported are often not helpful to inform management or decision-making because they are incomplete, inaccurate, untimely, obsolete, and unrelated to priority tasks and functions of the health personnel. The analysis of the findings suggests that the poor performance of the HIS is contributed by the poor and hard coded design of

the LISs, which has a negative impact on the process of introducing health reforms, including the HIS, and on the everyday functioning of the HIS. As this study was performed under the HISP programme, its main goal was to shed light on problems of the old legacy systems (SisProg and MTUHA in Mozambique and Tanzania respectively) and to pilot the new one, the DHIS.

The study, focused on the progress of the HISP programme in order to identify learning lessons that could be sensitively applied in other developing countries when dealing with LIS. Some of these learnings included: (1) the new computer systems need to be extensively demonstrated to users. In this study, we populated the new computer systems with real health data and conducted on site and workshop trainings for health workers; and, (2) deliberate political negotiations between the collaborating programme (HISP in this case) and the local organization (MoH in this case) need to be in place. This is because technical solutions are not convincing enough for the Ministries of Health officials, and requires additional political brokering and negotiations.

- E. KAASBØLL, J. J. & NHAMPOSSA (2002). Transfer of public sector information systems between developing countries: south-south cooperation. IN KRISHNA, S. & MADON, S. (Eds.) *Social Implications of Computers in Developing Countries*. Bangalore, India, IFIP. 507-517.

This paper was inspired by the model of technology transfer suggested by Bark and Heeks (1999). It explores the applicability of this model for the case of transfer of an HIS between two neighbouring countries, Mozambique and South Africa. Technology transfer from north to south has been studied through several research projects. This paper describes a case of transfer of technology from one developing country to another, including 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 such transfer between two neighbouring countries in the south also entails problems of assimilation and adaptation. A model of donor funded transfer is adapted to fit the observed case.

- F. NHAMPOSSA, J. L. & SAHAY, S. (2005). Social construction of software customization: the case of health information systems from Mozambique and India. IN BADA, A. & ADELAKUN, O. (Eds.) *Enhancing human resource development through ICT*. Abuja, Nigeria, IFIP. 339-347.

This paper discusses two comparable case studies drawn from software customization initiatives conducted in Mozambique (by the author) and a senior IS researcher in India. Debates around the internationalization and localization of software are widespread in the current context of globalization. This paper argues the need to include in these debates, the question of the process of software customization itself, which is extremely context dependent, and can influence the content of the software itself. A social construction perspective is drawn upon to make this argument, drawing upon an empirical analysis of the customization process of the same application software within the primary health care domain set in two different countries – India and Mozambique. The analysis identified four conditions that contribute to the very different outcomes in these two settings: the health sector context; the organization of the development team; the nature of the customization process; the nature of the installed base; and the question of language.

- G. PURI, S. K., BYRNE, E., NHAMPOSSA, J. L. & QURAIISHI, Z. B. (2004). Contextuality of participation in design. A developing country perspective. IN CLEMENT, A., OOSTVEEN, A.-M., SCHULER, D. & BESSELAAR, P. V. D. (Eds.) *Artful integration: Interweaving media, materials and practices*. Toronto, Canada, Association for Computing Machinery, Inc. (ACM). 42-52.

This paper explores the role of end-user participation in ICT initiatives, especially in non Western contexts. Participatory approaches to information systems design have

evolved over approximately the last three decades, mainly in Scandinavia, UK, and subsequently in the US. However there has been limited and peripheral research and debates over participatory design approaches and techniques as applied in developing country settings. This paper explores three case studies in developing countries where participatory approaches have been used in the design and implementation of HIS. The investigation reveals the politics of design, the nature of participation, and the methods, tools and techniques for carrying out design projects are shaped with respect to the diversity of the socio-economic, cultural and political situations faced in each of these settings. Though common strategies, such as capacity development, could be found that cut across the three case studies it is the importance of the contextual nature of participatory design that emerges most strongly. There is no single algorithmic best practice regarding participatory design in information systems which can be made applicable to all situations.

- H. NHAMPOSSA, J. L., KAASBOLL, J. J. & BRA, J. (2004). Participation in the information system adaptation process in the public sector in Mozambique. IN CLEMENT, A., OOSTVEEN, A.-M., SCHULER, D. & BESSELAAR, P. V. D. (Eds.) *Artful integration: Interweaving media, materials and practices*. Toronto, Canada, Association for Computing Machinery, Inc. (ACM). 84-88.

While the previous paper is a comparative study focusing on the discussions around participatory design approaches and techniques and the role of end-user participation in ICT initiatives in developing country settings, this paper is an in-depth exploration of the applicability of participative and prototyping approaches in the specific case of Mozambique. In the attempt to employ participative and prototyping approaches in Mozambique, a number of challenges were encountered. They were related to the organization (the MoH), the action research program (HISP) and the individuals (who were expected to use the system). The organization specific challenges of participation relate to the time required for adaptation of DHIS, the availability of financial resources, involvement and commitment of top management authorities. There are also individual specific challenges of participation such as the willingness to participate,

ability to participate and user behaviour. The study and the specificities of the context (such as the strong bureaucracy) help to develop specific strategies to enable participatory approaches in the context of Mozambique and they include: First, the communication between the top level managers and health workers normally takes place in a one way, top down manner. The interaction was enhanced by involving academics who were seen as being relatively neutral but sensitive to the MoH management problems. Second, participation between system developers and users at the lower level required extensive skills training, due to the users' low level of education. Third, interaction between system developers and users at the top level took place as an alternating process of negotiation and participatory design. Similar transitions can be expected in cooperation with the upper level managers of the bureaucracy due to the loyalty squeeze they may experience between the possibly shifting policies of the top leaders and their commitment to the ICT initiative.

- I. NHAMPOSSA, J. L. (2004). The challenge of "translating" health information systems from one developing country context to another: case study from Mozambique. IN LEINO, T., SAARINEN, T. & KLEIN, S. (Eds.) *Proceedings of the 12th European Conference on Information Systems*. Turku, Finland, ECIS - The European IS Profession in the Global Networking Environment.

This paper is an outcome of the ongoing effort to translate a software to meet the needs of the Mozambican context. What does it take for an open source and not-for-profit software developed in one context to be internationalized and localized so as to be used in another that is different from its origin. This question is addressed in the frame of a HIS application developed in and for South Africa and subsequently transferred to be used in Mozambique. Through an action research effort, five sets of key challenges to cross-country translation process were identified: (i) language rules and the lack of Portuguese equivalent terms from English, (ii) length of strings, (iii) different naming conventions, (iv) different organizational structures, and, (v) inadequate knowledge. The understanding of these challenges helps us to identify the different features of translation associated with "general purpose" and "special

purpose” applications. The analysis helps to address the question of how a “pragmatic balance” can be obtained between the needs for creating internationalized products on one hand, and that for providing flexibility for local adaptation on the other hand.

- J. NIELSEN, P. & NHAMPOSSA, J. L. (2005). Internationalization of Information Infrastructures and control: Cases from Mozambique and Norway. IN BADA, A. & ADELAKUN, O. (Eds.) *Enhancing human resource development through ICT*. Abuja, Nigeria. 220-230.

Based on the growing interest in internationalization in the IS domain, this paper examines two attempts of internationalization. The first relates to a health information system for developing countries and the second concerns a telecommunication platform for premium rated SMS services. Discussing the experiences from these cases, we use concepts from information infrastructure (II) as our theoretical and analytical lens. This analysis leads us to the articulation of an extended framework for theorizing and understanding the processes of internationalization. Our discussion engages with the inherent challenges of internationalizing IS, in particular the tensions related to control. Throughout the paper, we argue that internationalization processes are highly contingent upon the IIs it is growing out from and into. The discussion, in particular, is concerned with the nature of standards and the relations between the global and the local as well as the choice of a process or a product approach towards internationalization.

- K. KIMARO, H. C. & NHAMPOSSA, J. L. (2004). The challenges of sustainability of health information systems in developing countries: comparative case studies of Mozambique and Tanzania. IN LEINO, T., SAARINEN, T. & KLEIN, S. (Eds.) *Proceedings of the 12th European Conference on Information Systems*. Turku, Finland, ECIS - The European IS Profession in the Global Networking Environment.

This paper builds on two comparative case studies from Mozambique and Tanzania. The introduction of Information Technology (IT) typically comes with the promise of helping to manage scarce resources, increase efficiencies, reduce workload, and increase work productivity. In the context of developing countries, the lure of these promises is

magnified given the existing conditions and inefficiencies. International donors, for example the World Bank or the World Health Organization, play an important role in shaping this promise because developing countries are dependent on them for both technical and financial aspects. Given that IT projects may take a long time to be fully institutionalized, sufficient resources are required to build the local capacity to support and sustain the project after the withdrawal of donors. Inadequate donor support often contributes to weakening rather than strengthening human resource capacity and effective system design, since it emphasizes the technology itself, at the expense of the needs of the users. These factors contribute to the design and implementation of unsustainable HIS in developing countries. Through comparative case design, we identified three sets of relationships as crucial in shaping the sustainability of HIS: between the Ministry of Health (MoH) and the software development agency; between the MoH and the donors; and, between the donors and the software development agency. The reasons for the lack of alignment between the relationships, although different in the two cases, are identified and some specific recommendations are made to support their alignment, and with it, we argue, the sustainability of the system.

- L. KIMARO, H. C. & NHAMPOSSA, J. L. (2005). Analyzing the problem of unsustainable health information systems in less-developed economies: Case studies from Tanzania and Mozambique. *Information Technology for Development*, 11, 273-298.

This paper drew its empirical data from two case studies conducted by the author of this work in Mozambique and his colleague in Tanzania. Most of donor supported information technology (IT) based projects developed or implemented in Less Developed Economies (LDEs) end up as a complete or partial failures and are largely unsustainable. Notably, a number of intra-organizational and external factors are associated with this problem including inadequate infrastructure and human resource capacity, fragmented donor policy and lack of policies to manage the sustainability problem. Accordingly, IT initiatives are often donor driven, top down and hijacked by top managers who (normally) do not have adequate skills but have enormous power to enforce such initiatives across organizational hierarchies.

In analysing the cases through the concepts of sustainability and institutionalization, the article develops key insights towards a better understanding of the problem of unsustainability. It is argued that HIS become sustainable if they are institutionalized in the sense of being integrated into the everyday routine of the user organization. However, sustainable HIS need not only to be institutionalized, but also be flexible to allow changes as the user needs change. Moreover, the introduction of new HIS is not only a technical change, but requires the cultivation and institutionalization of a new kind of culture. Through a comparative case analysis of the HIS development and implementation processes in Tanzania and Mozambique, we identified two sets of relationships, between the Ministry of Health (MoH) and donor agencies and between the MoH and software development agencies as critical and contributing factors to the unsustainability of HIS. Given this setting, we highlight three key strategies for dealing with the problem of unsustainability in LDEs: (1) Integration of HIS, (2) local shaping of new cultures, and (3) cultivation approach to systems development.

Next, I present the integrated summary and synthesis of these articles.

5.1. Summary and synthesis of the findings

The research findings presented in the various papers, drew upon relevant theoretical concepts and the analysis of empirical data. The research findings are grouped around five key themes:

- The influence of history: legacy systems and installed base.
- The role of adaptation: how software is adapted to the local context.
- The role of participation: how users exercise control over HIS.
- The process of customization: the balance between localization and internationalization.
- Technology translation as the process of cultivating sustainable networks.

Next I present the key research findings of each article, within the frame of the above mentioned themes. These themes are further developed as contributions in the following chapter six. The research process started with the cross-organizational assessment of the ICT capacity and the performance of the national HIS in Mozambique. The results of the assessment were initially shared in the international conference, organized by IFIP 9.4 and subsequently published in the Electronic Journal of Information Systems in Developing countries. The findings and the results of this particular study served as the background for the further conduct of the present work.

5.1.1. *The influence of history: Legacy systems and installed base*

What already exists and what is the current status of ICTs and HIS?

Four articles were published focusing on the influence of the history, legacy systems and installed base on the change efforts and on the process of technology translation. While addressing different aspects of the organizational legacies, the key findings of these papers contribute to the broader research aims of the thesis.

Table 9: Summary of findings.

Research question/Aims	Findings /results/challenges
A study of the actual and potential usage of information and communication technology at district and provincial levels in Mozambique with a focus on the health sector.	
<ul style="list-style-type: none"> • What is the current use and diffusion of ICT at provincial and district levels? • How is the health information system functioning at the district and provincial levels? • How is the ICT-infrastructure and support structure and how are 'networks of ICT-support' being developed? • How is the training and human resource development in ICT and health information? 	<ul style="list-style-type: none"> • In Mozambique the ICT capacity and use at district and province levels is weak but at the same time the existing ICT users get technical support through informal networks, such as people dealing with computers in other sectors, such as education, administration etc. • The main problem in Mozambique is the low level of skill, education and general capacity within health and management information systems and ICT more generally.

<ul style="list-style-type: none"> • What are the 'good practices' and usages of ICT and information at district and province levels? Is it possible to find examples of local adaptation and locally developed solutions to problems? • What are the visible impacts of ICT? • How can 'Computer age' entrepreneurship be developed in Mozambique? • ICT in Health: Is a focus on the district level possible and appropriate? 	<ul style="list-style-type: none"> • Entrepreneurship plays a crucial role in developing ICT capacity and infrastructure. ICT-entrepreneurship needs an institutional framework of capacity building and a certain level of skill as a necessary point of departure in order to flourish. Training, education and development of capacity are therefore crucial in the further development of the health information and ICT infrastructure in Mozambique. • There a need to ensure sustainability focusing on developing educational programs and training of 'trainers' and people at several levels.
<p>Strategies to deal with legacy information systems: a case study from the Mozambican health sector.</p>	
<ul style="list-style-type: none"> • What are the strategies to deal with existing legacy information systems? 	<ul style="list-style-type: none"> • Traditional strategies to cope with LIS share a heavy technical bias, in the sense that they fail to address organizational or social issues around legacy systems. • Cultivation strategy to meet the constantly changing needs. • Inertia of the LIS needs specific strategies such as gateways. • If not flexible the HIS can easily become legacy. • A key contribution of this study is the emphasis that system design and development should be based on installed base's needs, rather than user's specifications only. • The focus is on cultivating the change within a heterogeneous socio-technical network, encompassing humans, technological components and institutions. •
<p>Strategies for development and integration of health information systems: coping with historicity and heterogeneity.</p>	
<p>What are the strategies for the development and integration of large and growing collections of IS, given the following dilemmas:</p> <ul style="list-style-type: none"> • The conservative influence of historically accumulated and institutionalized practices, technologies and perceptions (dubbed the 'historicity' of information systems) • The lacking integration and increasing fragmentation across the collection of information systems (dubbed the 	<ul style="list-style-type: none"> • As the current IS are embedded and institutionalized nationwide, a realistic strategy need to take a phased approach whereby present systems are gradually integrated into the environment. • In the case of donor-supported and -managed program, the national health authorities may not even have the required power to intervene. • Thus the existing reality cannot be ignored or done away with, whether it be the information systems, the institutions or the work practices; they constitute the point of

<p>information systems (dubbed the 'heterogeneity' of information systems).</p>	<p>departure.</p> <ul style="list-style-type: none"> The development strategy emphasizes an evolutionary, 'cultivating' approach while at the same time accepting that there will be a certain level of non-integration (often perceived of as 'mess') as chronic.
<p>The impacts of legacy information systems in reporting routine health delivery services: Case studies from Mozambique and Tanzania.</p>	
<ul style="list-style-type: none"> What is the nature and the impacts of legacy information systems in the reporting of routine health data and the everyday functioning of the health information systems? 	<ul style="list-style-type: none"> The current LIS in the health domain are partially relevant for the health domain; they are incomplete, hard coded, locked to old technologies, support a design that degrades the quality of the health data, reporting and imposes burden to health workers. In relinquishing the old information systems, a deliberate effort should be introduced to secure the health data locked in the old systems. While selecting new computer system to be used in the HISs, sustainability should be the main guiding principle. Addressing LISs implies issues of HIS structure, computer skills of the health workers, and workpractices.

The complex and overlapping information flows imposed by the LIS are illustrated in the Figures 9 and 10 below³⁹. They represent the current structure and information flows of the Health Information System in Mozambique. These information flows reflect the prevailing administrative structure of the HIS under which information is communicated from the health facilities throughout the district and province to the national level. The diagram shows that the vertical data collection and reporting is rather complex; a number of data collection tools are in use: patient cards, registers, tally sheets and forms. The data collection tools and flows of information reflect the needs of the various health programmes: Community Health, Maternal and Child Health (e.g. family planning, antenatal care, and deliveries), communicable diseases, Tuberculosis and Drug programmes.

³⁹ These figures were originally included in the paper but needed to be subsequently removed because of length concerns imposed through the review process.

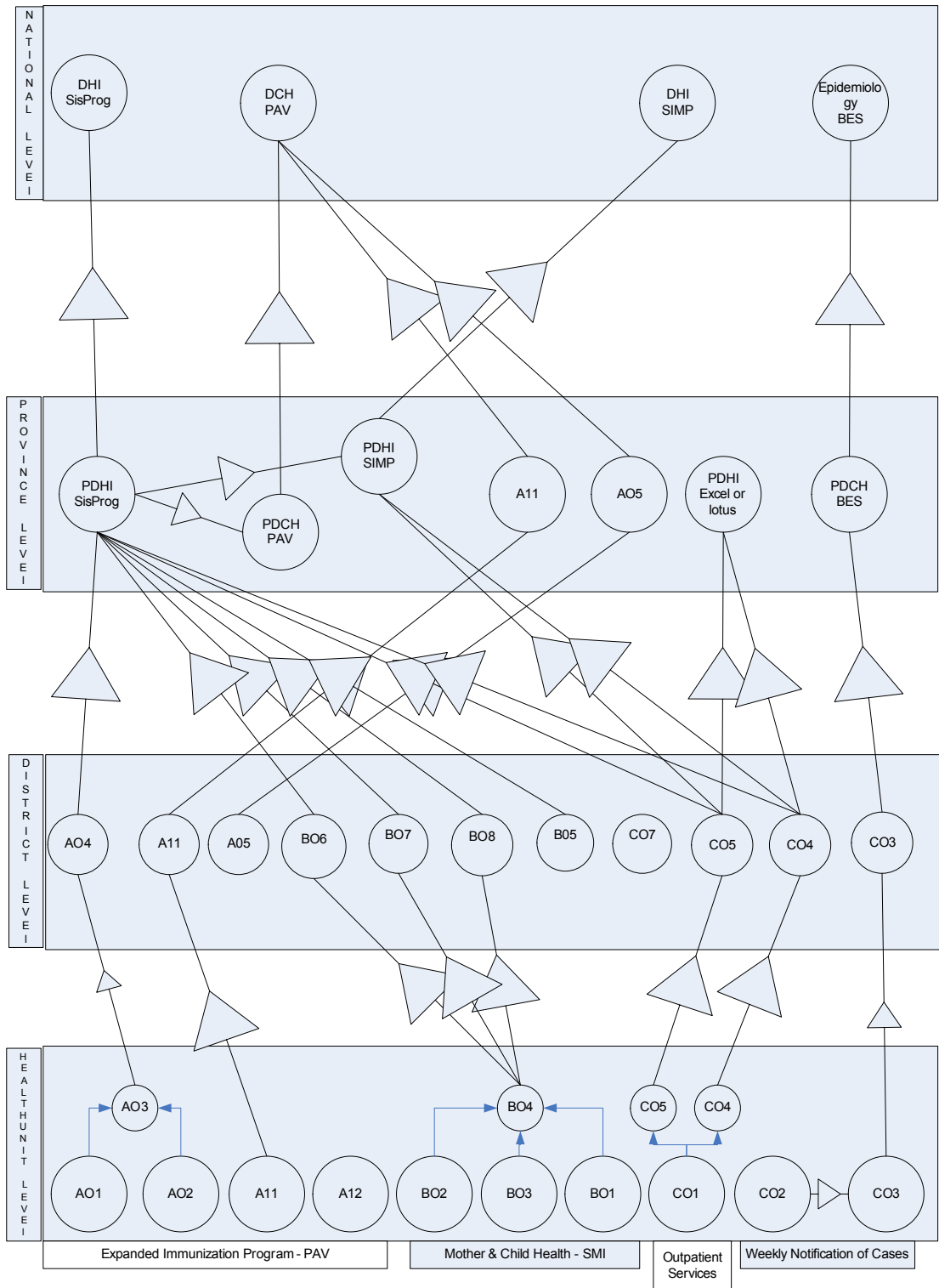


Figure 9: Information flows – one.

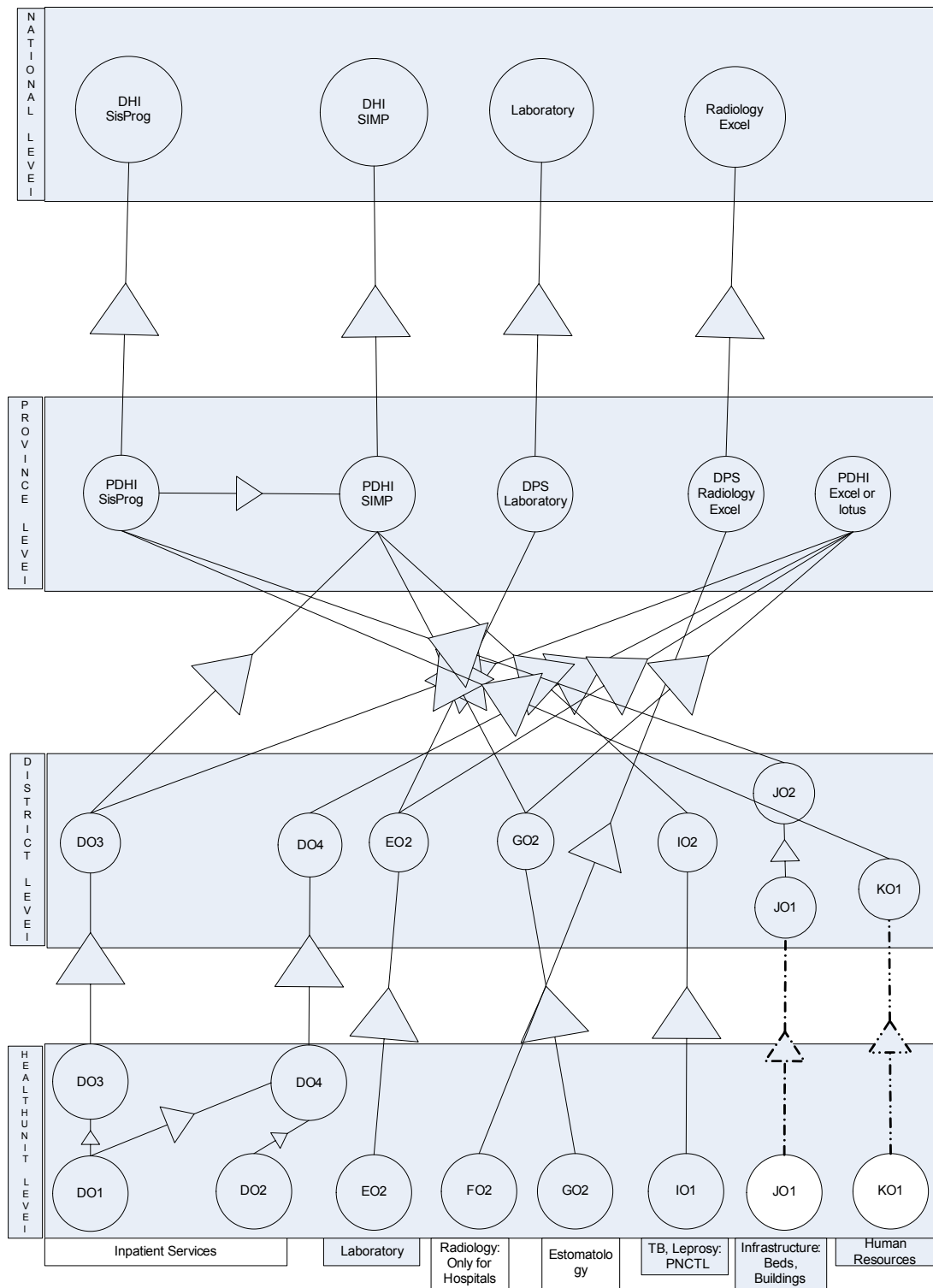


Figure 10: Information flows – two.

5.1.2. *The role of adaptation: How software is adapted to the local context*

How is the translation process organized?

Two articles were published discussing the process of adaptation and its socio-technical challenges. One is an attempt to apply the technology transfer model proposed by Bark and Heeks for the case of DHIS translation in Mozambique. The second paper is a comparative study of DHIS adaptation process in Mozambique and in India.

Table 10: Summary of findings: The role of adaptation.

Research question/Aims	Findings /results/challenges
Transfer of public sector information systems between developing countries: South-South cooperation.	
<ul style="list-style-type: none"> • How cultural, geographical and resources related concerns impact the technology transfer process? 	<ul style="list-style-type: none"> • Regardless of similarities in application domain of the system (health) and the fact that the HIS is expected to follow international standards (WHO), the data definitions have to be extended and changed to cope with local variations, such as organizational structure and routines. • Standardized domain, similar organizational structure, flexible and low tech solutions are favourable conditions for transfer of information systems to the public administration in developing countries, given their weak infrastructure capacity.
Social construction of software customization: The case of health information systems from Mozambique and India.	
<ul style="list-style-type: none"> • To understand the nature of the social construction of software customization of a PHC application in developing country contexts • To understand the implications of the customization process around internationalization-localization debates of open source and not for profit applications. 	<ul style="list-style-type: none"> • Same software constructed differently in different setting • Internationalization efforts need to consider the software development process itself • Different focuses needed on human resource development • Need to separate context dependent and context free features carefully

5.1.3. *The process of customization: The balance between localization and internationalization.*

How is the software customization done and what does it imply?

Concerning the need to find the balance between internationalization and localization, two articles were published. The first paper builds on the translation process of DHIS in Mozambique. Aiming to better understand the processes of internationalization, the second paper provides a comparative study of internationalization attempts of DHIS in Mozambique and of a telecommunication platform from Norway to a number of countries.

Table 11: Summary of findings: The process of customization.

Research question/Aims	Findings /results/challenges
The challenge of "translating" HIS from one developing country context to another: case study from Mozambique.	
<ul style="list-style-type: none"> • What does it take for an open source, Not-for-Profit, software developed in one context to be internationalized and localized so as to be used in another context different from its origin. • In this study, the primary concern was about understanding the processes involved in translating HIS in the context of developing countries. Specifically, the focus of the paper was to analyse the practical challenges of translating a HIS designed and developed in South Africa to be subsequently used in Mozambique. 	<ul style="list-style-type: none"> • Through an action research effort, five sets of key challenges to cross-country translation process have been identified: (i) language rules and lack of Portuguese equivalent terms from English, (ii) length of strings, (iii) different naming conventions, (iv) different organizational structures, and (v) inadequate knowledge. The understanding of these challenges helps us to identify the different features of translation associated with "general purpose" and "special purpose" applications.
Internationalization of information infrastructures and control: cases from Mozambique and Norway.	
<ul style="list-style-type: none"> • How can internationalization be conceptualized as to account for the context and condition of implementation? • What does the HIS customization process implies/includes? • How does the product/process perspective aids the concept of internationalization? 	<ul style="list-style-type: none"> • Approach internationalization through a blend of standards and relations • Control through standards and relations • The tension between flexibility and standardization • Internationalizing II rather than IS • Internationalization and localization not subsequent processes • Presence of technology and knowledge is not

	necessarily the condition for successful internationalization since changing socio-technical networks is maybe more challenging than creating them
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5.1.4. *The role of participation: How users exercise control over HIS*

How (potential) users are enrolled and how do they exercise control over HIS?

Two articles were published focusing on the strategies to enable participation in non Western contexts. While the first article discusses experiences of participation in three contexts, Mozambique, India and South Africa, the second focuses on the path of participation in the particular case of Mozambique.

Table 12: Summary of findings: The role of participation.

Research question/Aims	Findings /results/challenges
Contextuality of participation in design. A developing country perspective.	
<ul style="list-style-type: none"> To understand the challenges of enabling participation in non Western contexts To understand the implications of application of participation in non Western contexts. 	<ul style="list-style-type: none"> The investigation reveals the politics of design, the nature of participation, and the methods, tools and techniques for carrying out design projects are shaped with respect to the diversity of the socio-economic, cultural and political situations faced in each of these settings. Though common strategies, such as capacity development, could be found that cut across the three case studies it is the importance of the contextual nature of participatory design that emerges most strongly. There is no single algorithmic best practice regarding participatory design in IS which is applicable to all situations.
Participation in the information system adaptation process in the public sector in Mozambique.	
<ul style="list-style-type: none"> What are the specificities of participation in the context of Mozambique? 	<ul style="list-style-type: none"> Cooperation with the top level Cooperation between levels Willingness and ability to participate Role of mediation

5.1.5. *Technology translation as the process of cultivating sustainable networks*

How the challenges to sustainability addressed?

Through a comparative case analysis of the HIS in Mozambique and Tanzania, two articles were published focusing on the challenges of sustainability. The first highlight the lack of alignment between key actors and suggests specific recommendations to support the sustainability. The second article identifies critical factors contributing to the unsustainability of HIS, and suggests strategies to deal with this problem.

Table 13: Summary of findings: Technology translation as the process of cultivating sustainable networks.

Research question/Aims	Findings /results/challenges
The challenges of sustainability of health information systems in developing countries: comparative case studies of Mozambique and Tanzania.	
<ul style="list-style-type: none"> • What contributes to unsustainability of HIS in developing countries? • What can be done about it? 	<ul style="list-style-type: none"> • The major factor: misalignment of the interests, roles and responsibilities of the actors involved in the process. Effective collaboration between these actors is fundamental to sustain the changes achieved in the long run. • The interests of the actors should be aligned in a common network to address the long term users' and organizational needs. • In order to build and retain human capacity there is a need to build a conducive working environment not only for organizational but also group and individual benefits. • A conducive environment implies better workers' benefits, incentives and work procedures created by the involved actors in response to performing their attached responsibilities.
Analyzing the problem of unsustainable health information systems in less developed economies: case studies from Tanzania and Mozambique.	
<ul style="list-style-type: none"> • What are the strategies for dealing with the problem of unsustainability in less developed economies? • What are the implications for the 	<ul style="list-style-type: none"> • Integration of HIS • Local shaping of new cultures • Cultivation approach to systems development • Need for development of appropriate and

development of a unified and sustainable HIS?	<p>flexible systems, participation of the locals in shaping their own ways of doing things and proper grasp of the context of systems use, appropriate donor and institutional policies for action which will result in a better response to the organizational needs and management of scarce resources in LDEs.</p> <ul style="list-style-type: none">• The challenge faced concerned the donors' influence in shaping the technology development process and thus de-emphasizing the role of the local organization.• The focus on participation and alignment of key actors into a network may create the necessary knowledge and resources to make the HIS sustainable.• However, the local organization needs to drive this process with support and collaboration of other actors.
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6. CHAPTER SIX: RESEARCH CONTRIBUTIONS AND CONCLUDING REMARKS

In this chapter, I present the contributions of this study, based on the following two research aims that were formulated in chapter one:

- To develop a theoretical conceptualization of technology transfer based on a “translation perspective”, and,
- To understand and address the challenges shaping the translating process of a HIS software in South-North-South networks.

The first research objective is addressed in sections 6.1 and 6.2. These two sections taken together represent the theoretical contribution of this thesis. This is followed by section 6.3 where I discuss some practical strategies to deal with the challenges of technology transfer. These represent the practical contribution of this thesis. Finally in section 6.4 I present the concluding remarks.

6.1. Theoretical conceptualization of the technology transfer process

I start this section by first presenting in Figure 11 the theoretical model developed in this thesis (chapter two) to conceptualize translation. This model will be used in order to discuss my theoretical contributions and implications.

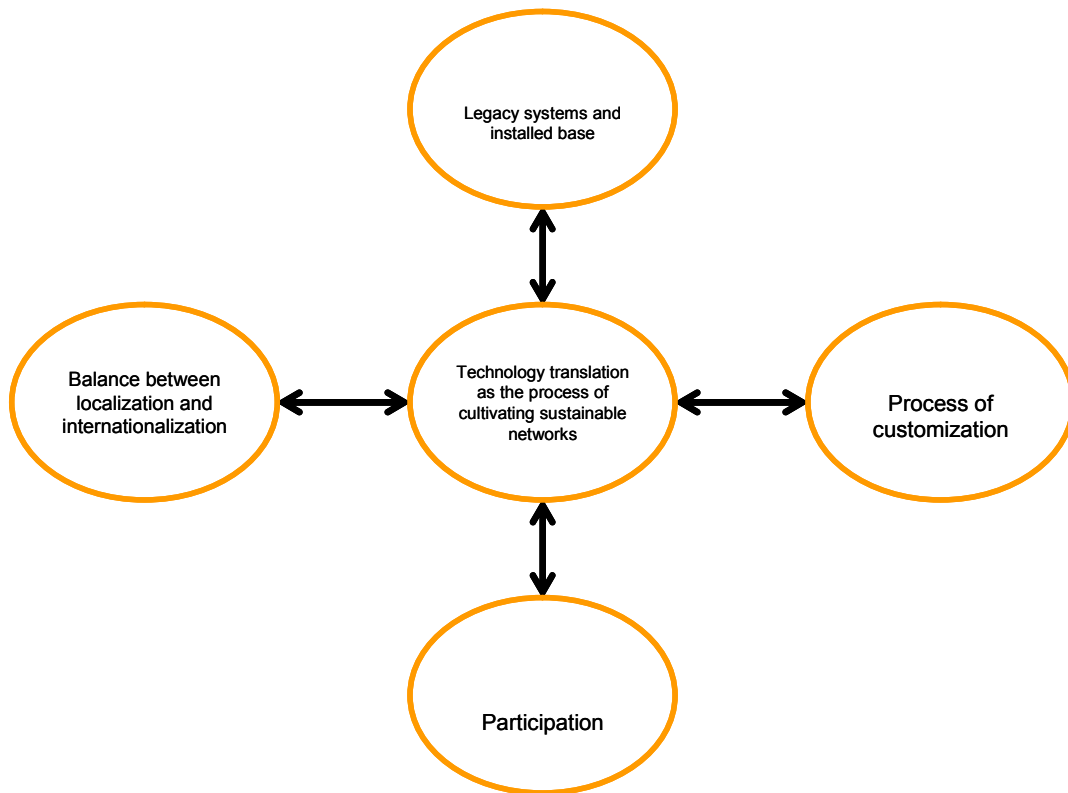


Figure 11: Factors influencing the translation process.

In discussing ‘technology translation as the process of cultivating sustainable networks’, two aspects are important. The first concerns the notion of translation itself and its relationship with the idea of transfer. The second one concerns the relationship between the concepts of technology translation and sustainability. I have argued in this thesis for the need to consider these two concepts together in the conceptualization of technology translation as the process of cultivating sustainable networks.

6.1.1. *Translation as opposed to transfer*

The concept of ‘translation’ is introduced in this thesis as an alternative to ‘transfer’ to emphasize the various kinds of complexities inherent in moving a software and

associated know how from one country (typically in the North) to another (typically in the South). Typically, the transfer perspective highlights the assumptions of diffusion that suggest rather optimistically that ICTs can be unproblematically transferred from one context to another; that technology can adjust to local conditions, and that it can stimulate changes or accelerate development processes in the local space. From a management perspective, it is often argued that international projects can buy expertise and manpower required to enable the transfer.

However, such a transfer perspective has been argued by various researchers to contribute to the continuing failure of projects, as it fails to address various challenges related to design-reality gaps (Heeks, 2002), scale (Sahay and Walsham, 2005), networks of support (Braa et al., 2004), sustainability (Kimaro and Nhampossa, 2005), participation (Puri et al., 2004), legacy systems (Nhampossa, 2004b), the software customization process itself (Nhampossa and Sahay, 2005) and internationalization (Nielsen and Nhampossa, 2005).

Instead, it is argued in this thesis that technology is developed as a result of the interaction of culture (manner or way of thinking, talking and acting), context or environment (e.g. country, organization or department), work practices, and the material characteristics of the technology itself. When technology which has been developed within a certain cultural and organizational context is transferred to another, it is confronted with serious socio-technical challenges. To overcome these challenges, this thesis emphasizes that technology needs to be translated and not just transferred from one context to another. The extent of translation depends on the ability to manage the balance between flexibility and stability; and, the ability to dynamically identify the context free (the core) and the context dependent features of the technological network being translated. This implies an alignment of interests of both the technology supplier and the recipient, influenced and influencing a heterogeneous socio-technical network (Kimaro and Nhampossa, 2004).

The challenges of transferring an IS such as DHIS from one context to another is a non-trivial task because of the various domain specific particularities. This includes identifying its content, functions, assumptions, and the process behind its design and implementation. The transfer process needs to consider the meanings embedded in the source IS, what they mean for the target context, and how networks can be created to sustain them in a useful manner. A perfect transfer of an IS can only be an illusion, and it can never be exactly mirrored in another context, not only across countries, but also even within countries. This is because an IS needs to be considered as a heterogeneous socio-technical network in which the artefact is only one of its constituents.

In this thesis, it is further argued that a domain specific IS like DHIS is constituted of aspects that have elements of both transferability and translation inherent in them. This is because some technology applications such as General Business Domain Application (GBDA) (e.g. Microsoft office applications) require a lesser degree of translation effort than others which are more domain specific (e.g. HIS/DHIS) (Nhampossa, 2004a). The functionality, content and the interface of applications such as Microsoft Office, are largely decided by the software vendor, and are relatively easily used across organizations, countries, contexts and cultures. Accordingly, improvements, changes and evolutions of the software are driven also by the vendor, aiming at maximizing the time efficiencies for testing and debugging whilst expanding the market scope. The translation of such applications, therefore, implies primarily taking care of all the engineering aspects before the software is released for distribution. In this case, it is appropriate to transfer functionality and interfaces separately, and the cooperation between the vendor and the users is not a priority, since the two are seen not as a team but as counterparts working on a contract basis.

In contrast, DHIS represents a Specific Business Domain Application (SBDA) (and also has some features of the GBDA, such as the Microsoft platform on which it is based)

which is inscribed with the business logic of the particular domain in which it is deployed, in this case public health. Moving such an application across contexts requires a process of translation rather than of transfer. This implies a greater understanding of the domain knowledge and the context of use which can not be done as only an engineering exercise by the vendor. Here, the knowledge and understanding of the meanings of specific terms, cultural values and attitudes towards technology, are important ingredients for a meaningful translation. Such a process cannot be addressed in laboratory conditions, given that it is linked to a particular business, organization and/or cultural rules. To enable this understanding, it is important for end-users and systems developers to work collaboratively with each other (Nhampossa, 2004a), where the systems developers are pulled from the context of design into that of use, and are confronted with the incompleteness of current understandings of complex cultural settings (Gregory, 1995). This implies that the translation of the SBDA is more complex and requires greater time and investment in establishing a multidisciplinary team, so as to address the technical and contextual issues with the knowledge of both engineers and users.

A key contribution arising from this analysis therefore is to not only adopt a “translation” or “transfer” approach, but a sensitive hybrid of both. While some elements of the system (for example, the operating system) can be “transferred,” elements of the user interface need to be “translated.” This implication also reinforces the argument of Rolland and Monterio (2001) to find a “pragmatic balance.” This thesis extends Rolland and Monteiro’s argument by elaborating upon some of the specific areas (more details in section 6.3) which need to be focused on in finding this balance, and also on how this can be achieved. Also, we take the argument of Suchman (2001) about the perils of “design from nowhere” further by pointing that there will always be parts of the system that will be “designed from nowhere”, while there will be other elements that should only be dealt with locally. This thesis also then contributes to the debates around the issues of local-global tensions where the

transferred elements of the software represent the 'global' and the translation aspects the 'local'. These local-global tensions are situated and negotiated within broader networks that span both the global and local.

The thesis also contributes to the literature on technology transfer by emphasizing the need to consider the balance between fluidity and stability of both the technology and the socio-technical network in which it is constituted. Such a view extends earlier studies that have used the concept of translation to analyze technology transfer. While some studies have focused on the issue of stability in developing networks of aligned interests (e.g. Madon et al., 2004; Walsham and Sahay, 1999), other studies have focused on the issue of flexibility, where the local has the autonomy to make changes (de Laet and Mol 2000). It is argued that focusing on balance leads to a richer conceptualization of this process of movement.

The present thesis contributes by offering extensions to the earlier conceptualization of technology transfer, that of for example, Baark and Heeks (1999) (technology transfer as life cycle) and Odedra (1991) (technology transfer as taking place in channels). While such conceptualizations of technology transfer may find more appropriate application in general development projects involving machinery or technological infrastructure requiring minimal modifications or adaptation, they fail in addressing the process involved in institutionalizing the transfer of a domain specific application like HIS. Accordingly, the (extended) translation perspective offered by ANT is argued to provide a more appropriate lens.

This thesis further contributes to existing literature in applying the translation perspective to the specific contexts of Mozambique and health care. Earlier applications, with a few exceptions (Macome 2003; Madon et al., 2004), have been largely confined to business organizations in the Western context. In addition to

contributing by expanding the scope of application, this thesis also contributes by conceptually extending the notion of translation.

6.1.2. Technology translation as the process of cultivating sustainable networks

The concept of sustainability is crucial from both theoretical and practical considerations in the context of the technology transfer problem. Many authors have discussed the challenges of sustainability in the context of IS more generally (Young and Hampshire, 2000) and with respect to HIS in developing countries more specifically (Braa et al., 2004). The high rate of failures of technology transfer projects (Heeks, 2001) points to the inability of systems to sustain over time and space (Kimaro and Nhampossa, 2005). However, most often, especially when studied through diffusion approaches, only the adoption of the technology is considered and the challenges associated with getting the systems institutionalized and developing the capacity to allow them to evolve over time are ignored. A key contribution of this thesis is therefore to emphasize the need to analyze these two concepts (technology translation and sustainability) in conjunction so as to develop an integrated perspective on technology transfer as cultivating sustainable networks.

Another contribution offered by the perspective developed is to examine sustainability in relation to the concepts of institutionalization and the flexibility of the system to evolve over time in response to the changing needs of the organization, as is inherent in the domain of public health. Typically, researchers have described sustainability with respect to the system taking on routinized features representing their institutionalization. For example, Kimaro and Nhampossa (2005) suggest that it is important that systems become institutionalized, i.e., that they become routinized into the everyday working of the institution. However, it is argued in this thesis that such a

perspective is incomplete as it ignores the processual aspects of the translation as such; indeed, if not flexible, the (new) system can easily itself become a legacy system.

Furthermore, the focus on translation helps to emphasize that sustainability is not a one time event, but is a gradual process that takes place over time as the technology moves from hand-to-hand, where with each movement technology needs to be both adapted and also at the same time be flexible enough to move. This implies a process of incremental change involving a socio-technical heterogeneous network that is both institutionalized and flexible enough to change according to evolving needs. A key characteristic of this definition of translation is the need for a balance between flexibility and stability at different levels and on various fronts. Sustainable systems must become institutionalized and ‘rooted’, while at the same time they must remain flexible enough to accommodate emerging changes. While a stable network of aligned interests may imply a degree of rigidity, empirical studies have shown that in fact flexibility in the network can contribute to stability of the overall network (de Laet and Mol 2000).

A transfer perspective, it has been argued, ignores issues of sustainability as defined in this thesis, and how the technology and the surrounding network can endure over time and space. The translation perspective as defined in this thesis, in contrast to the transferring perspective, is a process aimed at building local capacity, expertise, and creating a learning climate required to localize, maintain and evolve the technology over time in a manner which is of value for the institution.

I summarize in Table 14 below the key contributions to literature arising from my conceptualization of the movement of technology across contexts as the process of cultivating sustainable networks.

Table 14: Summary of key theoretical contributions to literature arising from the thesis.

Concepts	Key contribution to literature
Translation versus transfer	<ul style="list-style-type: none"> • Technology needs to be translated and not transferred from one context to another • The extent of translation depends on the ability to manage the balance between flexibility and stability; and, the ability to dynamically identify the context free and the context dependent features of the technological network being translated. • To not adopt only a “translation” or “transfer” approach, but a sensitive hybrid of both. • Some elements of the technology can be “designed from nowhere” and transferred while other elements should only be developed locally. • Emphasizing the need to consider the balance between fluidity and stability of both the technology and the socio-technical network in which it is constituted.
Technology translation and sustainability	<ul style="list-style-type: none"> • Emphasize the need to analyze technology translation and sustainability in conjunction so as to develop an integrated perspective of technology transfer as cultivating sustainable networks. • Examine sustainability in relation to the concepts of institutionalization and the flexibility of the system to evolve over time in response to changing needs • Emphasize that sustainability is not a one time event, but is a gradual process that takes place over time as the technology moves from hand-to-hand, where with each movement technology needs to be both adapted and also at the same time be flexible enough to move.

After having discussed the contribution arising from my conceptualization of technology translation as the process of cultivating sustainable networks, I discuss in the next section the four sets of challenges that have been identified to both influence and be influenced by the process of translation.

6.2. Conditions influencing and being influenced by technology translation

I first present in table 15 a summary of the four conditions and their relationship with the process of technology translation. After this, I elaborate on each of these relationships in greater detail and identify the contributions each of them entails.

Table 15: Summary of the challenges shaping the translation perspective.

Influence/factor/condition	Relevance for the extended technology translation perspective
The influence of history: legacy systems and installed base	<ul style="list-style-type: none"> • Cultivation strategy to meet the constantly changing needs. • Inertia of the LIS needs specific strategies such as gateways. • If not flexible, the new IS can easily become legacy.
The role of adaptation: How software is adapted to the local context	<ul style="list-style-type: none"> • Focus on culture and meanings rather than concepts. • Incremental and iterative process of translation according to local requirements. • Interface translation and functionality development need to occur in conjunction in time and space. • Localize/translate interface, content, functions and documentation.
The role of participation: How users exercise control over HIS	<ul style="list-style-type: none"> • Require more time and effort for understanding the culture and the meanings. • Mediation and ownership are critical to enable participation. • Multidisciplinary team representing different knowledge domain needs to mediate the process. • Sometimes, top management decisions are required to enable bottom up participation. • Emphasizing the need to take a process-product perspective rather than either of these in isolation.
The process of customization: The balance between localization and internationalization	<ul style="list-style-type: none"> • Internationalization is one of the steps in the development life cycle to support local context. • Provide tools and utilities to support local customization of interface and functionality. • Ongoing process of determination of context free and context dependent features of the HIS. • A dynamic process of translation and adaptation emphasizing not only on the product (the software) but also the process of customization itself. • Managing the process of control through the use of standards between designers and users is crucial. • Identifying the challenges and approaches to translating applications involving user and domain specific applications, health (not computer) professionals and existing LIS.

6.2.1. Legacy systems, installed base and translation

Legacy Information Systems (LIS) need to be handled in ways that are sensitive to history. LIS serve as the point of departure (and can not be ignored), and have the potential to both restrict and enable change. LIS can be both computer or manual based, and the technical characteristics are deeply embedded also with institutional legacies. The technology being transferred must be perceived as both an active and

passive element, able to stimulate processes of technological and organizational transformation, but also be flexible to evolve over time with the constantly changing needs of health programs, diseases, technology, and donor influences. Without this capability of flexibility, the new technology runs the risk of itself becoming a LIS over time (Nhampossa, 2004b, Aanestad et al., 2005). Without being flexible, such a system may be institutionalized but may not evolve, resulting in it not being sustainable over time.

Legacy systems conceptualized as installed base, can be seen to influence the technology translation as defined in terms of sustainability. LIS can be seen as institutionalized, thus rigid, inscribing technical and institutional conditions that restrict its change. This lack of balance between rigidity and change makes it thus not sustainable, requiring negotiations and strategies to create a better balance. From the point of view of my definition of translation, cultivation of this installed base thus involves the process of identifying which elements should/can be changed, as well as those that should/can not be changed, and the strategies through which these change processes can be enabled.

The conceptualization of legacy systems as installed base offers a distinct contribution to IS research as it helps to move away from a primarily technical focus, which historically has emphasized that systems can be designed and developed from scratch, as isolated and stand-alone applications with defined goals, start and ending times; as events rather than as ongoing processes. However, in the present context of globalization, ICT applications are required to integrate multiple systems across organizational and geographical borders, including institutional legacies and their interconnections with the technical. Traditional strategies to cope with LIS reflect a heavy technical bias, which I argue is inadequate, and instead the requirements of the overall installed base needs to be considered. Emphasizing the need for a shift of focus

from such a technical bias in addressing LIS, I argue, is an important contribution arising from this thesis.

6.2.2. *Process of (software) customization and translation*

The adaptation of the technology being transferred is dependent on the level of flexibility and modularization embedded, or on the reusability of the source code and core functionality of the software. A component-based development approach relying on re-use has the potential to support adaptation of the technology being transferred. The modules, once validated and tested in a situated context, can potentially be shared effectively within or across the organizational hierarchical levels. Available source code allows national/local changes, but partnership in global exchange networks may undermine this (through new releases) and push the technological trajectories in conflicting directions. There is thus the need to be locally independent while at the same time being globally networked so as to be able to take advantage of innovations fuelled by global and new knowledge (Nhampossa and Sahay, 2005; Nielsen and Nhampossa, 2005).

Technology can be perceived as a standard/structure or just a best practice which shapes the principles for successful implementation in a given context. However, different from a standard, best practices do not describe what should be the content and the functions of the HIS software, according to local needs, capacities and priorities. Accordingly, best practices do not describe how to build the network of support, or how to persuade top management to engage in such an “open garden” approach. This suggests that the adaptation process will not automatically succeed by adopting either strategy (standard or best practice) even if all resources are made available. While the standard does not reflect the required sensitivity to the rather heterogeneous contexts, best practices (open garden) can be seen as an unstructured approach, which requires more time and resources for coordination (Nielsen and Nhampossa, 2005). Therefore the technology translation perspective, as defined in this

thesis, will imply identifying the context free and dependent features of the technology as an ongoing process of cultivation.

A contribution of this thesis is the need to emphasize not only the product (the software) but also the process of customization itself. Such a focus helps to conceptualize translation and adaptation as a dynamic and process-oriented approach, situated within and also influencing the organizational context. Taking this process-product view is a distinct contribution to IS research, especially relevant in the context of globalization, as prior research on software internationalization (for example, Coronado and Livermore 2001; O'Donnell 1994; Russo and Boor 1993) have only emphasized product related features such as icons, colours, interfaces etc. Such a focus, as has been argued in this thesis, is inadequate as the process of customization itself shapes the product related outcomes, and this relation between the product and process is mediated and constructed by the social context.

6.2.3. Participation and translation

Viewed from the perspective of translation with the objective of building sustainable networks, user participation is crucial both for exercising control of the system and its institutionalization, and also to develop user capacity so that they are capable to evolve the systems in the future, thus enabling the required flexibility. The extent and quality of user participation thus fundamentally influences the process of technology translation. However, it is emphasized that user participation is a context sensitive process requiring both the mechanism of participation and its content, to reflect the local conditions, rather than being unproblematically “transferred” from the West.

Participative approaches cannot be developed in a void. In traditional IS literature participative approaches have been based primarily on experiences from Western contexts and largely confined to one organization or within a business framework. The present study offers an extension to the domain of research on participation by

trying to apply these approaches to a non-western context, identifying the challenges that arise, and possible approaches to address them. Taking a broader view than a mere focus on techniques for participation (such as focus groups or workshops), this study has also emphasized that participation is shaped by the politics of design, the institutional settings, and the role of the mediating agencies. Enabling participation in non-western contexts implies dealing with unique challenges such as lack of computers and basic literacy, the strong and historically embedded institutional and colonial legacies, heavy work load of health staff, and the high disease burdens that characterize these contexts. Such contextual particularities require unique approaches in terms of both the mechanisms and content of the participatory approaches. This thesis contributes to identifying some of these challenges.

Participatory processes in IS design have been criticized for focusing primarily on the process rather than the product that emerges from this process. This biased focus, it has been argued, has contributed to the problem of scale where inadequate consideration is given to how these products are integrated within broader socio-political networks required for their sustainability (Puri, 2003). For example, while the UTOPIA project (1981-1984) was successful in finalizing requirements and developing prototypes, it was not scaled up due to financial constraints (Bjerknes and Bratteteig, 1995: 78). This thesis contributes to this issue by emphasizing the need to take a process-product perspective rather than either of these in isolation. Also, by seeing technology as constituted within a broader socio-political network, emphasis is placed on considering technology not in isolation but in relation to these networks.

6.2.4. *Internationalization, localization, and translation*

It is argued in this thesis that the technology needs to support internationalization, so as to be used in different countries/contexts, and requires localization, so as to meet the specificities of a particular context. The emphasis of the translation perspective, as defined in this thesis, is on the balance between flexibility and stability, with particular

focus on the need to analyze the challenges related to internationalization and localization simultaneously. This involves deciding what should be the generic or the core functionality/features, and what should be context-dependent and the changeable functionalities and features.

The social construction of the software customization process emphasizes the social influences on the decisions being made and the very content of the software itself. Using a comparative case study design, Barley (1986) examined the social implications of the introduction of the same CT scanners on the social order of the radiology departments of two different hospitals. By examining the differences in the outcomes of the introduction efforts he tried to relate it to the particularities of the context such as the relationships between doctors and technicians. This study also used a similar comparative case study (Mozambique and India) design to analyze how differences in the context shape the process of customization with implications on the implementation outcomes.

Another contribution of this thesis comes from the domain of free and open source software (FOSS) applications. Typically the literature on FOSS has described system specific applications (such as operating systems, compilers, debuggers) being developed by a community of computer specialists (Bayrak and Davis, 2005). In contrast, our case though involving FOSS is different on three fronts. Firstly, the application is user and domain specific (public health) rather than system specific. Second, the end objective is for the system to be largely managed and maintained by health (not computer) professionals. Magnifying these challenges is the fact that this development is taking place within the public sector of a poor country where it is harder to get trained people, who usually prefer to work in the more lucrative private sector. Thirdly, the development effort is challenged by historically existing LIS, a challenge which is not acute in the context of system specific applications. Identifying the challenges and

approaches to translating applications within such an alternative context, I argue, is a unique contribution of the study.

In summary, technology translation can be defined in the context of this thesis as a process of incremental change involving a socio-technical heterogeneous network, which leads to the development of sustainable HIS implying that they are both institutionalized and are flexible enough to change as per evolving needs. Technology translation in this case comprises handling legacy information systems as well as institutionalized practices, and encompasses the work required to set up conditions for participatory processes, as well as the localization and adaptation processes of the technology itself, as a part of a global exchange networks.

After having discussed the theoretical contributions of this thesis in terms of conceptualizing technology transfer as a hybrid consisting of translation and transfer, and with respect to the four challenges influencing translation, in the next section, I move to discuss how these specific challenges can be addressed. This forms the practical contribution of my thesis.

6.3. Strategies to address the challenges shaping the translation process

This study has identified, both conceptually and empirically, four major challenges shaping the translation process. Strategies to try to address these challenges have also been highlighted. I elaborate on three such strategies in this section which also serve as practical contributions arising from this thesis: Cultivating the installed base, mediating participatory processes, and finding the pragmatic balance between internationalization and localization.

Table 16: Summary of key practical contributions to literature arising from the thesis.

Strategies to address the challenges	Key contributions
Cultivating the installed base	<ul style="list-style-type: none"> • Managing the risks threatening sustainability imply dynamically dealing with constantly changing needs by changing the technology accordingly and aligning or adapting the global software development with the local changes. • Two specific strategies towards cultivation: (1) replacement and add-on approach; and, (2) prototyping within an action research framework.
Mediating participatory processes in non Western contexts	<ul style="list-style-type: none"> • Adopting mediation strategies to enable communication within the strong bureaucratic and hierarchical environment of health. • Adopting a short and long term vision for dealing with skills or capacity development of health staff and other key actors in an integrated manner with local academic institutions. • Participation should also be selective, and there is a need to carefully understand the domain in which users can effectively participate
Finding the pragmatic balance between internationalization and localization	<ul style="list-style-type: none"> • There is no need to fully “reinvent the wheel” while moving software from one context to another, however sensitivity to the contextual differences and how they shape the software in different contexts is fundamental, and must be taken seriously. • Finding the pragmatic balance implies changing both the so called core (generic or context-free parts) as well as the context-dependent parts of the technology. • Developing software for different cultures goes beyond simple translations of text, numbers, date and time formats, symbols, colours, flow and functionality, and requires a deep understanding and knowledge of specific meanings of terms and concepts of the application domain. • A strategy to address this challenge of pragmatic balance is by adopting a process-product perspective. • The philosophy of the software being transferred should address the heterogeneity through modular or component-based development while keeping integration as a desired aim.

	<ul style="list-style-type: none"> • Exercise control through a blend of standards and formal and informal relations between the global and local.
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6.3.1. *”Cultivating” the installed base*

A cultivation approach suggests a shift from the design of systems to a cultivation of networks and infrastructures; analyzing design and change not of isolated IS but rather of IIs (Hanseth et al., 1996). An IS approach is associated with the assumption that systems are isolated entities and it is thus possible to specify them completely and design them so as to solve specific organizational needs. On the contrary, cultivation suggests that an installed base (as represented by the multiple actors of the LISs) is not a dead artefact since it involves an existing network of users and legacy technologies (Hanseth, 2002; Hanseth and Aanestad, 2003). So the shift from a single system focus to networks requires an II perspective that takes into consideration the multiplicity of actors and the installed base - both technical and institutional. This perspective emphasizes that an II evolves over time as infrastructures are extended and improved. In turn, these improved elements have to link with the old and what is described as the existing installed base, which heavily influences how the new elements can be developed.

In chapter three, I discussed the characteristics and the organisational structure of the Mozambican health system, in particular the human resource capacity, the organizational culture towards information, the ICT and physical infrastructure, and the financial capacity. These elements are firmly and historically embedded aspects of the Mozambican healthcare context, and represent the installed base including both the institutionalised and technological legacies. The institutionalised legacies may be a resource for change and growth, but may also resist change. In this study, the above-mentioned factors were identified as weakening the performance of the healthcare management and increasing the risks of failure of the technology transfer initiative (Kimaro and Nhampossa, 2005). Identifying and managing the risks threatening the

long-term viability of ICT initiatives (Korpela et al., 1998b) is an important aim of the cultivation process.

Different strategies have been employed by authors for cultivating the installed base. For example, Braa and Hedberg (2001) use the principle of hierarchy of standards as a guiding framework for their cultivation approach. They argue that standardization, the process by which an array of heterogeneous actors can be aligned, is far from given, and is determined by the negotiations between actors and the alliances formed. Further, they suggest that imposing universal standards in a constantly changing context (such as the health domain in developing countries) is impossible, and that there will always be local universalities playing out in a hierarchy of standards. The methodological implications of their study is the emphasis on the long-term nature of IS development projects, especially in developing-country contexts. Important lessons from their study can be derived to inform international agencies who plan technology projects in a “lift and drop” mode over short time periods. The focus then should be not on implementing universal standards, but to cultivate local standards defined and aligned within a global setting.

Similarly Hanseth and Aanestad (2003) addressed the issue of cultivating the installed base. They suggest bootstrapping as a strategy for enabling (social and technical) network growth and for cultivating the installed base. As opposed to the concept of “critical mass⁴⁰”, bootstrapping considers not only the size of the network, but also the heterogeneity of its actors, technologies in question, use areas, etc. As the installed base grows, its development and further growth becomes self-reinforcing, both enabling

⁴⁰ Traditionally, the concept of critical mass focuses on the number of users as a major factor for network growth. A common strategy in line with the concept of “critical mass” is to identify and subsidize a number of users willing to adopt the technology. If this number is high enough, the network will start growing by itself. The critical model assumes that all elements of the network are equal, and for this strategy to work, an agent is needed to do subsidizing.

and constraining further development. Successful development of an II requires, first, the creation of such a self-reinforcing process, and second, managing its direction of growth (Hanseth, 2003).

In this study, managing the risks meant dynamically dealing with constantly changing needs of the health sector, with the sector's LIS, adding new functionality to the DHIS, making visible the invisible historical data and aligning the global DHIS software development taking place in South Africa with the local changes and suggestions for improvements in Mozambique, like the need to develop a multi-lingual capability of the DHIS. This thesis suggests, the following two specific strategies towards cultivation: (1) replacement and add-on approach; and, (2) prototyping within an action research framework. These are now discussed.

Replacement and add-on approach

In an attempt to replace the institutional legacies, we followed a socio-technical strategy, whereby the DHIS was adapted following an incremental approach. The idea was to enable a smooth and harmonious integration of DHIS with the current HISs, in which the LISs would gradually be replaced. In the present study, cultivation followed a replacement-integration-add-on strategy. This implied that (1) historical health data, functionalities, reports and language support were configured in DHIS without modifying the LISs and attempts were made to connect the new tool (DHIS) to the existing LIS (e.g. SisProg) in sensitive ways, through gateways developed through an Extraction Transformation and Loading tool (Nhampossa, 2004b; Lungo and Nhampossa, 2004; Aanestad, et al., 2005); and, (2) DHIS was at the same time being integrated with other relevant tools such as SIMP. Such a strategy was instrumental in addressing the immediate and also emerging management needs of MISAU, such as new reports, and the calculation of new indicators. Also, through the linking of the LIS with the DHIS, the historical data could be extracted using the extraction tool to

show potential users including top managers, the abnormalities in the existing data. This analysis was presented in report forms to the MISAU managers so as to try and break away from the institutional inertia to change based on the argument that “we already have a well functioning system in place.”

Another element of the replacement and add-on strategy was to cultivate DHIS by replacing parts of the functionality, with the ultimate aim of including more of the information flows. This included making conscious choices of functionalities of the DHIS that could be adapted to reflect the current and underlying needs of the Mozambican HIS, as for example the Monthly Data module and the Multilanguage functionality. This gradual and ad hoc strategy goes beyond what is usually advocated in the literature on legacy systems for replacement. The II perspective emphasizes that rather than replacing one system that is under one’s control, the challenge was to replace several systems that were beyond the control of the HISP team, or any one member or department of MISAU.

Prototyping within an action research framework.

Prototyping, undertaken through iterative cycles of action research (as described in Chapter four), was instrumental in attempting to break the burden imposed by LIS or the installed base. With these action research cycles, the aim was to open the “black box”, and show the planners the data that for years had been invisible. This also helped to demonstrate the DHIS capabilities, focusing not only on its content but also on the embedded functions and the involved process of adaptation and integration of the new tool in the work context. Such a procedure helped to illustrate the inconsistencies and errors in the existing data, and to create a legitimate argument for the replacement of the LIS, such as SisProg with DHIS. The opening of the black box was enabled by prototyping the DHIS at the province and district levels so as to populate it with historical data stored in SisProg. At the same time as the inconsistencies of the legacy

systems were being highlighted, a parallel piloting process of the DHIS was being enabled (Nhampossa, 2004b).

We attempted to build a network of DHIS users within and across the national, province and district levels. However, the challenge was to do so with the scarce resources available (e.g. human, funds) and to create and maintain mechanisms or networks of support. Here an approach of bootstrapping was important since it suggests the capacity to build or implement systems with the resources available at the time rather than with those available ‘out there’. Addressing the challenges shaping the translation process, therefore, included coping with emerging challenges related to the organizational structure and work practices.

6.3.2. “Mediating” participatory processes in non Western contexts

This section discusses the strategies used to achieve participation in the context of the adaptation of the DHIS, and also to support the nurturing of an ‘information culture’. This process of nurturing involved shifting the focus of the HIS adaptation from technical design details and raw data to the use of indicators and information for action, thereby answering the why rather how questions.

Although participatory approaches have enjoyed relatively successful implementation in for example Scandinavia (given the favouring political and educational environment), it is argued that this strategy needs to be contextualized in non Western contexts (Puri et al., 2004, Nhampossa et al., 2004). A number of authors have addressed these issues by illustrating participatory approaches in IS design or implementation in the context of developing countries. Silva’s (2001) study contributes to the discussion on the process of local adaptation by analyzing the interrelationship between improvisation and power, building upon experiences related to the processes of outsourcing of an IS for hospitals in Guatemala. Concerning adaptation, his study

introduces the concept of “selective outsourcing”, in which the requirements analysis of the system is done in-house by teams from within the hospital, instead of outsourcing this activity to an external contractor, who is then responsible only for the systems development. The analysis of his study suggests that the process of outsourcing can be understood as an improvisation, which is inspired by political factors, for example, that people in power can shape the trajectory of improvisations in particular ways, and that power need not always be negative, but can often enable positive outcomes. The challenge thus is to examine how this power can be harnessed effectively to support [ICT] projects, especially through the concept of improvisation. Silva’s example also provides insights into how participation should also be selective, and that there is a need to carefully understand the domains in which users can effectively participate.

The DHIS adaptation process was conducted following an evolutionary approach ((Dahlbom and Mathiassen, 1993). The basic assumption was that foreign software can be used as a starting point (Heeks, 1999) to design, develop or strengthen local systems, by adjusting it to the socio-economic and technological context in question (Avgerou, 1996; Waema, 1996). Participatory design requires that the adaptation of the software in an organization takes place in close collaboration between users and developers, and at multiple levels in the nation, province and district. Rather than a ‘breadboard’, ‘throw-away’ or mock-up’ prototype (Budde et al., 1992; Bjercknes and Bratteteig 1987; Bucciarelli, 1994), the first prototype used in our case was a working and flexible software. This influenced the development, learning and research processes. The effort and resources required for modifying or adding new functionality to the prototype, the type and level of cooperation needed in determining the adaptability, functionality and user friendliness, was different from approaches usually described in the literature - such as approaches of Fitting, Augmenting and Working Around (Gasser, 1986).

The prototyping was conducted in conjunction with training workshops aimed at strengthening the computer literacy of the potential DHIS users (Nhampossa, 2004b, Nhampossa, 2004a). The HISP team that was responsible for adaptation of DHIS, was multidisciplinary and comprised of computer engineers, medical doctors, managers and information systems researchers. The responsibility of the team was to match the health domain needs with the required technical functionality, developing learning resources and conducting onsite training. Training was conducted in a multidisciplinary environment, in which medical personnel had the opportunity to improve their computer knowledge by interacting with ICT professionals, who in turn improved their knowledge about public health (Nhampossa et al., 2004).

Several challenges were encountered when applying participative approaches arising from the enormous discrepancies between the Mozambican and Scandinavian settings, where the participative tradition underlying HISP originated. For instance, the Scandinavian context consists of highly educated manpower, a strong commitment to democratization at the work place, positive attitudes to new technology and legally regulated relationships between managers and national trade unions. These conditions were almost absent in the Mozambican setting, requiring different approaches and strategies to enable participation.

The specific challenges of participation were defined in keeping with the nature of the project which was gradual, long-term and iteratively evolving. Such an approach also has its inherent disadvantages as immediate results are not visible. Ellingsen and Monteiro (2001) describe this as an uphill battle of evolutionary development, which highlights the problems of handling complexity and novelty: in which the question is how users can be motivated to participate/collaborate before the benefits of the project become visible? Similarly, Aanestad (2002) defines the “uphill battle” of evolutionary development as follows:

Before quite a lot of the telemedicine infrastructure (or DHIS in this case) is in place and works, its benefits cannot be demonstrated, and before benefits can be demonstrated, not many will buy into it. How can we get the first users to participate even before the benefits have started to emerge? Even if all would agree that a new technology (like telemedicine) seems to offer indisputable benefits, the problem of handling complexity and novelty still remains. How can we picture the truly novel vistas that open up and how can we get started? (Aanestad, 2002: 39).

In particular, these challenges have to do with the lack of time and resources allocated for adaptation of the DHIS, and the lack of involvement and commitment of top management. For example, while HISP was to initially implement the DHIS in 3 districts, and then subsequently in 3 provinces, this decision was not formally documented by the MISAU and accordingly instructions were not given to the province and district authorities. The result was a “chicken and egg” situation wherein the MoH first wanted to see results of the DHIS implementation (e.g. reports generated from the DHIS), but did not give the necessary approvals to allow that to happen.

In MISAU, as is common in various other developing countries, communication between top level managers and health workers normally happens in a one way and top down manner. The HISP team acted as a mediating agency trying to create an effective environment for learning by doing, as well as supporting processes of capacity development of users, especially relevant because of the extremely low levels of education of the health staff. The important role of mediating agencies in enabling participatory processes in the context of developing countries has been emphasized in recent literature. For example, Madon and Sahay (2002) describe how the combination of formal and informal information sources ensures a greater participation of slum dwellers in negotiations with government agencies. However, our case is different

from that described by Madon and Sahay in that the mediating agency involved was a university rather than a NGO. While this model has some strengths (for example, the research focus), it also suffered from serious limitations such as not having the field level capacity to address the immediate and ongoing HIS needs of the MoH.

The focus on mutual learning processes enabled bridging some of the gaps between the designers' and the users' understanding of the existing system and in envisioning the new system respectively. The developers and trainers were a team of computer specialists and medical doctors, such that those adapting the system were already somewhat familiar with the health system and learned about HIS during the training sessions. The mutuality of the learning process was achieved through recurring discussions on ways that the system should be adjusted to fit the health information processes, such that the computer personnel learned about many facets of the activities in the health system during the interactions.

Awareness and a sense of ownership creation was a key strategy adopted to build the will to participate and align the MoH needs and HISP goals. This was enabled through discussions held in HISP organized meetings, seminars, workshops and training sessions with health workers, top and middle managers and doctors. The lack of basic skills (e.g. arithmetic calculations, statistics and computer use) contributed to the inability of the health workers to effectively participate in the DHIS adaptation process. These sessions were organized differently in different places and levels, focusing on enhancement. They also helped by providing the opportunity for users to participate with constructive ideas. This assisted in identifying gaps of the current system and ways to address these gaps through the various prototyping cycles of the DHIS.

The state of being an owner is recognized to create the interest among the beneficiaries to participate (Rydhagen, 2003) in the design process. The underlying idea is that the

beneficiaries are supposed to own the project and participate in all parts of the process, from planning to evaluation (IDS, 1996). Although the initiator of the HISP project in Mozambique was an academic from Norway, the fact that the initiative, decisions and responsibility were transferred to the locally created HISP team, ensured a sense of ownership and thus created the conditions for an effective DHIS adaptation. It is evident from the study that participatory approaches can be applied in non Western contexts but follow different path and involve resources (infrastructure, human, finances), skills, political will, time and communication, which need to be addressed simultaneously.

In summary, identifying the nature of some of the tensions/challenges to participation, the underlying reasons for them, and how they could possibly be dealt with within the context of HIS in Mozambique, implied: (1) adopting mediation strategies to enable communication within the strong bureaucratic and hierarchical environment of health; (2) for dealing with skills or capacity development focus on training (short term vision) and continuous education (long term vision) of health staff and other key actors in an integrated manner with local academic institutions.

6.3.3. Finding the “pragmatic balance”

Another key challenge shaping the translation process was to find the balance between the need for creating internationalized applications on one hand, and for providing flexibility for local adaptation on the other. While the standard models and directives argued by the international agencies (e.g. WHO, World Bank) may give the impression that a HIS application designed in one context can easily be translated to another, this process in practice is very complex, given the very different socio-political-cultural contexts, which shape the HIS in various ways. There are, however, certain elements in those applications which are indeed common, and can be taken from one context to another. For example, the hardware, operating systems and integrated development environment require limited or no adaptation and can be taken from other contexts

and used elsewhere. So, while there is no need to fully “reinvent the wheel” while moving software from one context to another, sensitivity to the contextual differences and how they shape the HIS application in different contexts is fundamental, and must be taken seriously.

This is in line with Rolland and Monteiro’s (2002) argument for the need to find the “pragmatic balance” between the pressures for building global standardized system on one hand, and to allow for flexibility to localize and expand the system on the other hand. In developing HIS applications to be used across contexts, it is not enough to cover only technical issues such as separating the user interface from the functionality of the application software, but also requires a consideration of social issues such as how a training approach can also be used in multiple contexts.

Based on the practical experience of translation of DHIS, one of the challenges encountered related to understanding the initial design assumptions⁴¹ inscribed in the DHIS software by the South African development team. It turned out to be necessary to change both the so called core (generic or context-free parts) as well as the context-dependent parts of the DHIS (such as the interfaces). While internationalization of software applications is often seen as merely a technical engineering exercise, localization and adaptation are context bounded matters. The perspective adopted was that limited modifications of the generic core of the software is needed when localizing the software in a new context (Nhampossa, 2004a), as is the case for spreadsheets and text processors. Experiences from Mozambique, and also other HISP nodes such as India, Ethiopia, Tanzania, has involved reengineering much of the underlying code (Kaasboll and Nhampossa, 2002, Nhampossa, 2004a). The current study suggests that

⁴¹ Shift of control of information systems from central towards local levels, that is, toward more equal control between central and local levels; Local flexibility and user orientation—it should be easy to adapt the software to local conditions; Support for health sector reform towards decentralization and the development of health districts, that is, integrating the vertical flows at district level; Empowerment of local management, health workers, and communities; and

developing software (including the interface, relevant backend, and reporting engine) for different cultures goes beyond simple translations of text, numbers, date and time formats, symbols, colours, flow and functionality, and requires a deep understanding and knowledge of specific meanings of terms and concepts of the application domain. This understanding is shaped by particular customization processes, which can also shape the outcomes associated with the same application software in different contexts. (Nhampossa and Sahay, 2005) identified four conditions that constitute the customization process with implications on the software outcomes: the health sector context; the organization of the development team; the nature of the customization process; the nature of the installed base; and the question of language.

A strategy to address this challenge of pragmatic balance is by adopting a process-product perspective (Nielsen and Nhampossa, 2005). A focus on the process (on how to do things) helps to enhance context sensitivity in design, development and implementation strategies. The product perspective helps to focus on the particularities of the software, including the different front-ends, backends, functions, outputs/reports, and documentation. The process-product perspective, as conceptualized by Nielsen and Nhampossa (2005), suggests understanding internationalization and localization not as subsequent, but rather parallel and complementary processes, in which technical internationalization is undertaken (as a first step) to support localization and smooth adaptation of the software in a specific national locale; for example to its different language, standards, legal requirements and cultural norms. This means that for the software to be adapted and used in contexts other than its origin, it must be designed from initiation with features and code that support rules, conventions, data and format processing of a given locale. This procedure will reduce the time needed for adaptation engineering and thus simplify the localization process (Nielsen and Nhampossa, 2005).

However, the adaptation process in each context will require that both the context-free and context sensitive components of the software are revisited interactively when changes or improvements are made or new releases of the software are launched. An illustration is that although technically and from the point of view of the code, every single DHIS user can change the user interface locally to address technical aspects, practically, the DHIS user-interface is determined out of the context of use (e.g. Mozambique, India, Tanzania, Ethiopia).

The present study suggests that it could prove wise to develop a user interface to distinguish between facets which are culture-dependent and those which are culture-independent; for example developing a generic user interface in which as part of the log-in procedure, the user is prompted to indicate the language to be used for the session. The need for development of a cross-cultural user interface represents a challenge because the interface as such is the mediator between the people and the software or hardware. Differences among users such as the level of expertise, familiarity with the application and related concepts, individual learning speeds, etc. must be taken into account and incorporated into the design and development of a system such as the DHIS. Developers should focus not only on technological aspects of the software/product, but instead also on the needs and attitudes of the users. The DHIS software philosophy should address the heterogeneity through modular development while keeping integration as a desired aim.

A key challenge emerging from the process-product perspective is the management of the global/local tensions. For example, how a software/product can accommodate different user groups (e.g. global and local) and to what extent for example *user interfaces*, *functionality*, or *backend*? Or how global developments can be aligned with the local adaptations in a dynamic way, such that the underlining philosophy of flexibility, free and open source software is not abandoned. The answers to these

questions are not trivial and require long-term reasoning from the perspective of the end-user.

Nielsen and Nhampossa (2005) suggest to exercise control through a blend of standards and formal and informal relations between the global (e.g. HISP team in South Africa) and local (e.g. HISP team in Mozambique). In cases where standards (such as DHIS) as a means of control are not applicable, control can be exercised by the relations/collaborations between the global and the local actors. These relations are shaped by aspects such as resources available locally, history of collaboration, and distance between the actors. In Mozambique for example, the key actors related to the development and implementation of DHIS were not permanent field staff but primarily PhD students working part-time for the HISP project. This implied that the implementation of DHIS in Mozambique would depend upon the support from South Africa while the local human capacity developed gradually over time. At the same time, this process of blending will not solely rest with one, central/global actor, but will be distributed across the socio-technical network.

The socio-technical networks play an important role on the means and the freedom for finding the balance between internationalization and localization, and for exercising control over the software/product. The adverse conditions of developing countries (such as Mozambique) in terms of human resources and infrastructure can be addressed within this network, in which the internationalization process would enable not only the re-use of technical (e.g. DHIS) but also of human (e.g. programmers from the global or other nodes) resources and its development.

In the case presented in this thesis, a key issue is how to centrally incorporate and locally align software and processes introducing participatory design and creating flexible software solutions based on an open-source philosophy. This was not easy to achieve as the modular and three-tiered architecture implemented in the DHIS

software suggests that data storage, user interface and functionality are separate entities. This flexibility does, however, allow Mozambique to introduce changes to any of the three levels. The question thus raised is which aspects should be under local and which should be under global control? The DHIS software is being increasingly adopted by a number of developing countries, representing different contexts of use whose cultural values deserve attention and understanding. This fact makes the discussions on global software development, adaptation approaches, and finding the balance between internationalization and localization interesting topics to draw attention to.

In summary, while there is no prescriptive recipe on how the pragmatic balance can be achieved, this study suggests that technology translation processes need to consider three major balances: (1) installed base: gradual versus radical change strategies; (2) open source networks: sharing and reuse of code versus challenges with adaptation and, (3) participatory, evolutionary development: hierarchical relationships between top management and field level end users.

Gradual versus radical change strategies: As far as legacy systems and installed base are concerned, an appropriately balanced change strategy must be found. While a drastic and radical strategy may be tempting, it is often unrealistic as it requires the command of much of the resources, and assumes that the actors are in control (both formally and in reality) over the installed base. On the one hand, a gradual change strategy may be easier to implement, as it can use the existing installed base as a resource for change; it is not just a constraint. On the other hand, a gradual change strategy may be too difficult to ‘sell’ to managers and decision-makers, and the result may end up as rather conservative, being too much shaped by the pre-existing installed base.

Sharing and reuse of code versus challenges with adaptation: Within open source networks the tension between the benefits and drawbacks of sharing and reusing code, must be resolved. A high degree of sharing and reuse might imply such a tight coupling between the involved actors that local adaptations are hindered.

Hierarchical relationships between top management and field level end users: A pragmatic balance, as well as appropriate means of mediation, needs to be found between end users involvement and top management support. Evolutionary systems development strategies with a high degree of user participation need to be aligned with managements' need for predictability (e.g. of costs) and standardization across various use contexts.

6.4. Concluding remarks

The present dissertation has presented a theoretically and empirically informed interpretative study of technology transfer that evolved around the adoption, adaptation and use of a computer-based HIS. The empirical foundation of the thesis is the South-North-South collaborative network surrounding the computer-based HIS adaptation in Mozambique. In this thesis, computer-based HIS's are seen as a fundamental apparatus to support development, economic growth and health management, especially in the context of developing countries such as Mozambique. Such potential is analyzed or discussed in terms of enhancing effectiveness and improving the cost efficiency of operations, thereby serving as levers for economic and technological progress, reducing marginalization and providing the foundation for sustainable development.

From the perspective of this thesis, this discussion is organized within three themes. The first theme, which is the premise of this thesis, has been to highlight the potential of ICTs to trigger development attempts and support healthcare management. Here it

was discussed that while ICTs can provide unprecedented opportunities for supporting information-intensive social services such as health, historically, their implementation in the context of developing countries has not had the desired outcomes in relation to the investments being made. ICTs are expected, for example, to:

- Play a key role for enabling development initiatives, organizational reform (such as Business Process Reengineering), or strengthening organizational management;
- Improve the availability and integration of information; and
- Increase networking and diminish marginalization by “killing the geographical distance”.

The challenge however is to develop ICT-based solutions/applications which provide real practical value. In the context of developing countries, and in the particular case of information intensive sectors such as health, ICTs enjoy a massive application. However, in most cases the ICTs are used to handle information but in a digital format. This suggests that for ICTs to have positive impact in, for example, information management and decision making, a sound understanding of the historical role of information must be in place. Accordingly, the access to and the application of ICTs must be conceptualized to include not only reflections on knowledge about ICT and context of use, but also ICTs use in practice.

It is of crucial importance to more closely discuss and examine the actual challenges in getting ICTs to work in practice including the process of technology transfer as such.

In the context of developing countries, depressing results have been observed relating to ICT-based initiatives involving technology transfer. This motivated the second main theme which is related to the need to re-think technology transfer as the mechanism through which ICTs are channelled to developing countries. Avgerou (1996) in her study entitled “transferability of information technology and organizational practices”,

suggests that: information systems innovation in developing countries involves the transfer of technology and organizational practices which were originally designed and proved useful in other socio-organizational contexts, such as in Western countries. The underlying argument is that ICT solutions or “best international practices” from the developed world, conveyed by professional norms, standardization imperatives, and replication efforts, need to be adapted to meet the priorities and needs of the local context (Avgerou, 2001; Sahay and Avgerou, 2001).

The question however is how the adaptation can be achieved in practical terms. This question has motivated the special attention of IS researchers, professional, the popular press, and also the present thesis. For example, drawing upon her personal experiences from the rather advanced research environment in the United States, Suchman (2001) demystifies the superiority assumed by global and contextual knowledge, which promotes the illusion that everything works smoothly somewhere else. She describes attempts to apply technologies from the Western world to developing country contexts, as promoting a “design from nowhere,” which has proved to be problematic. Instead, she identifies the common need across locations for IS practice to focus on relations between actors involved in ICT production and use.

In this concern, this thesis argues for the need to abandon the diffusion kind of conceptualization of technology transfer, in which this process is seen in one frame and as one giant step of movement from the North to the South. The translation perspective provides a valuable alternative to the diffusion approach to study technology transfer. However not many studies exist, which apply such a perspective to analyze software transfer processes in general and computer-based HIS in particular to developing countries. This study is therefore one such attempt to contribute to the body of literature concerned with a better understanding of technology transfer undertakings in the context of developing countries. Therefore the contributions from this work are relevant also beyond

computer-based HIS. Learning from this work can be applied to other technology transfer initiatives such as education, banking, and agriculture.

The third theme builds on the translation perspective towards technology “transfer”. Here, the classical translation perspective from ANT was extended to account for realities in developing countries. The present thesis expands the traditional conceptualization of the “translation” in the sense that it calls attention to the need for a new understanding of networks and actors, that of fluid networks and “mutable mobiles”. This perspective becomes even more valuable when talking about technology transfer involving heterogeneous contexts, in which the diffusion model is inadequate. It is argued that in order to account for developing countries’ realities, technology, ideas or development initiatives must be flexible enough and should not be seen as isolated and self-standing pieces. The thesis describes activities within a global socio-technical network, where ideas, open source code, continuous feedbacks, adaptations and new releases suggest a need for continuous and ongoing exchange. Consequently, technology transfer should not be conceptualized as a process of passing along technology, but rather as a process in which the technology takes part in existing networked relations.

In summary, the contributions of this research firstly lie in the conceptualization of the term ‘technology transfer’ based on translation perspective. For accomplishing this research aim, concepts from Actor Network Theory and Information Infrastructure were drawn upon. Secondly, the concept is then applied to study a HIS adaptation in Mozambique, in which the importance and dynamics of the context are highlighted. Finally, by integrating the theory and empirical data, the study proposes a theoretical framework to understand and address the challenges shaping the translation process of domain-specific software, such as a HIS, in South-North-South networks.

7. REFERENCES

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8.1. APPENDIX A

BRAA, J., MACOME, E., MAVIMBE, J. C., NHAMPOSSA, J. L., COSTA, J. L. D., JOSE, B., MANAVE, A. & SITÓI, A. (2001). A study of the actual and potential usage of information and communication technology at district and provincial levels in Mozambique with a focus on the health sector. *Electronic journal of information systems in developing countries*, 5 (2), 1-29.

A Study of the Actual and Potential Usage of Information and Communication Technology at District and Provincial Levels in Mozambique with a Focus on the Health Sector

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ABSTRACT

This article presents results from a study on the use and appropriation of information and communication technologies (ICT) in Mozambique with a focus on the health sector. The three provinces of Gaza, Inhambane and Niassa were surveyed and two questionnaires addressing 1) computer users and their ability to manage ICT, and 2) health workers and their handling of health information, were used. Based on this study appropriate strategies for developing an ICT-infrastructure with the needs of the health sector as points of departure are discussed. The study is born out of a program to strengthen and further develop the health information and management systems at district and provincial levels as part of a process to support decentralisation of the health system in Mozambique. The study shows that computers and Internet are rapidly being spread to the provincial capitals and major districts in Mozambique. A main problem identified is the lack of ICT-skills and education and poorly developed infrastructure and networks of support. There are very few formal ICT companies providing hardware, and even less, software support. Maintenance and learning about ICT are to a large extent going on within informal networks of computer users in the provinces.

A main finding in this study is that development of ICT capacity and information systems at district and provincial levels in Mozambique needs to be an integrated effort across sectors. A district health information system cannot be developed in a void.

A general recommendation is to develop educational programmes ranging from training of ICT entrepreneurs and health workers and managers, to Masters and PhD programmes in ICT and health information systems. A specific recommendation related to health information systems development is to focus on the district level and to develop a strategy which encompasses and integrates all districts, both the advanced districts with computers and the majority of the districts where there are no computers.

1. INTRODUCTION

This article presents results from an ongoing study on the use and appropriation of information and communication technologies (ICT) in Mozambique with a focus on the health sector. Based on this study appropriate strategies for developing an ICT-infrastructure with the needs of the health sector as points of departure are discussed. The study is born out of a program to strengthen and further develop the health information and management systems at district and provincial levels as part of a broader process to support decentralisation of the health system in Mozambique.

Objectives of the Study

The overall objective for the study was to investigate how it would be possible for the 'marginalised' parts of Mozambique (e.g. provinces and districts) to make use of ICT to their advantage. Are there any examples of advanced usage of ICT at local levels within the health

sector, other public sectors, private companies or non-governmental organisations? We wanted 1) to study the current situation of ICT- use and diffusion, and 2) to develop appropriate strategies for how ICT could be used to support development of the peripheral levels in Mozambique. While the focus was on the health sector, the understanding was that no ICT-development could take place in the health sector without being part of a more general development process across sectors. Development within health would rely upon a wider human and technical infrastructure. The study has been exploring the following broad and relatively 'open-ended' research questions:

- What is the current use and diffusion of ICT at provincial and district levels?
- How is the health information system functioning at the district and provincial levels?
- How is the ICT-infrastructure and support structure and how are 'networks of ICT-support' being developed?
- How is the training and human resource development in ICT and health information?
- What are the 'good practices' and usages of ICT and information at district and province levels? Is it possible to find examples of local adaptation and locally developed solutions to problems?
- What are the visible impacts of ICT?
- How can 'Computer age' entrepreneurship be developed in Mozambique?
- ICT in Health: Is a focus on the district level possible and appropriate?

Two questionnaires were used in the study, addressing 1) computer users and their ability to manage ICT, and 2) health workers and their handling of health information. The research program is based at the Faculty of Medicine and Department of Mathematics and Informatics, Universidade Eduardo Mondlane (UEM) and is a collaboration between the Ministry of Health, Mozambique, University of Western Cape and the University of Oslo. The research is funded by NUFU (NORAD, the Norwegian Government). The study has been carried out in the three provinces of Gaza, Inhambane and Niassa, selected because the Medical Faculty, UEM, has their training districts there; Chokwe, Maxixe and Cuamba. These are pilot districts in the efforts to develop a district based health information system.

ICT and Decentralisation

Many countries in the Third World, like Mozambique, are in the midst of a process of decentralising their health sectors and public sectors based on information systems support. However, the introduction of decentralised ICT does not necessarily lead to decentralisation (Madon, 1993; George, *et al.* 1991) or empowerment of local users (Walsham, 1992), and is necessarily a complex problem in Third World contexts (Odedra, 1990; Braa, 1996). Mozambique, recovering from 20 years of civil war, is amongst the poorest countries in Africa and the ICT-infrastructure in terms of both human and technical capacity is poorly developed. Nevertheless, a somewhat surprising result of the study is that computers and Internet are rapidly being introduced and used in all province capitals and major districts in Mozambique. Given this, the problems related to the introduction and use of ICT to support decentralisation in Mozambique have significance for similar problems being experienced in other Third World countries.

A main finding in this study is that development of ICT capacity and information systems at district and provincial levels in Mozambique needs to be an integrated effort across sectors. A computer based district health information system cannot be developed in a void. Development in the health sector will rely upon the existence, or development, of a wider network of training and support of computer and communication software and

hardware, which we will term an ICT infrastructure (e.g. Hanseth, 1996). Thus, development of information systems in the health sector needs to be integrated with efforts to develop an ICT-infrastructure across sectors, and vice versa. Given this 'dual problem', this article will focus on: 1) the capacity to use and maintain ICT more generally across sectors, 2) the capacity to use and analyse information within the health sector and 3) how these areas may nourish each other. Problems and solutions related to the development of health information systems at district level would therefore be valid across sectors.

Another main finding in this study is that information is only used to a limited extent to support local decision making in the health sector in Mozambique. Health workers and managers at health centre, district and provincial levels are in general regarding the current health information system purely as an upward reporting system, and not as a system that may support them in their own work. Similar findings were reported from two studies with comparable objectives and methodology carried out in Mongolia and South Africa (Braa, Nermunkh, 2000; Braa, Heywood, Sunking, 1997). This indicates that the problems in developing health information systems to support decentralisation are both general and global.

Health Information Systems to Support Decentralisation and Primary Health Care

Mozambique has selected the Primary Health Care (PHC) approach of the World Health Organisation (WHO, 1978) as a strategy to extend health services to the most peripheral areas in the country. Such an approach is necessary, as both community and patient services are specific and local. The district health model advocated by WHO (WHO, 1987) and followed by Mozambique, is regarded as the most effective way of organising primary health care services (Amonoo-Larsen et al., 1984, Tarimo, Fowkes, 1989, Newell, 1989). Local analysis and use of information for decision making and management are crucial factors in the primary health care concept and in the district health system (Wilson et al; 1987, Rodrigues, et al. 1995). Health information systems in a traditional centralised health system collect data in order to make *retrospective* analysis - at a higher level. In primary health care the challenge is to analyse and use the information *immediately* and at the same level where it is collected, thus local information to support local action (Opit, 1987). Decentralisation, local control of information and empowerment are thus embedded in the concept of primary health care.

As early as 1992, a computer based health information system was introduced to the provincial capitals in Mozambique (Brown, Sitoi, Iras, 1997), representing the first national computer based information systems. The information system was designed in order to report on the activities of the various vertical health programmes (e.g. immunisation, family planning, drug distribution) from the districts, via the provinces to the national level. This design was based on upwards reporting to support the national level and the various vertical health programmes needs for information, and the needs of provincial and district health management were not focused upon. The current challenge is to change the focus of the information systems to encourage local analysis and use of information. Furthermore, the focus of the information system needs to be extended to the district level. There are 11 provinces and 131 districts in Mozambique. In the short term it is probably not realistic to introduce computers to all districts. A strategy to make all districts 'part' of the information systems will therefore have to encompass both districts with and without computers.

The article is organised as follows: In section 2 the research approach is outlined. In section 3 the study of the health information system in Mozambique is described; first the survey is described (3.1), then findings from the study of the National Health Information systems are presented (3.2), then important aspects of the findings related to use of health information is illustrated by way of a case study from Niassa province (3.3), and the general

findings from the health information survey are summarised (3.4). In section 4 the results from the study of computer usage and ICT infrastructure are presented, including the survey of computer users (4.1) usage (4.2), and a comparison across the three provinces (4.3). In section 5 findings related to the main research objectives are summarised (5.1) and recommendations are given (5.2).

2. RESEARCH METHODS

The survey in the three provinces (Gaza, Inhambane, Niassa) in Mozambique were conducted by means of two questionnaires developed by the research team, based on a similar survey carried out in Mongolia (Braa, Nermunkh, 1998) and South Africa (Braa, Heywood, Shun-King, 1997).

- A health information questionnaire assessing knowledge and actual analysis and use of information and pattern of feedback among health workers and management.
- A questionnaire on computer use, assessing the skills, training and quality of computer use among the computer users in the organisations where they are working. The focus was on identifying 'entrepreneurship' and formal and informal networks of ICT support and provision of training at district and province levels.

The questionnaires included both open ended and closed questions and were used as structured interview guides to facilitate and direct interviews and observations and to document patterns that were identified. The fieldwork for the pilot study took place in the southern provinces (Gaza and Inhambane) in June - July 1998 and in the northern province (Niassa) in November 1999.

A team of 8 UEM students and 4 pre-university school students in Lichinga (Niassa province) helped the research team with the survey. They were trained by the research team to use the questionnaires, conduct a structured interview and to interpret and report their observations and interviews. The survey visited provincial and district health management and health facilities in 15 districts in the 3 provinces. The survey of computer use and capacity encompassed most of the organisations using computers and a substantial number of the computer-users themselves in the three provinces. A total of 211 questionnaires were completed including 173 on computer usage and the remaining 38 on health information. All questionnaires were handed out and collected the same day. Most respondents were positive and enthusiastic in replying.

3. A STUDY OF THE HEALTH INFORMATION SYSTEMS

3.1 The Survey

The survey of the health information systems was supported by a structured interview guide and included 38 persons from the health sector. These interviews required specific knowledge about public health and were carried out by the research team. Results of the survey are presented under three categories:

1. Geographical distribution of questionnaires / interviews by districts and provinces (Appendix A)
2. Socio-demographic profile of respondents (Appendix B)
3. Infrastructure profile (Appendix C)

Geographical Distribution of Questionnaires / Interviews by Districts and Provinces

The 38 interviews were carried out in 15 districts in 3 provinces. In general, the majority of the respondents came from the capital cities of the provinces. However, in the province of Niassa, the majority came from the economic capital (Cuamba) rather than the administrative capital (Lichinga), because a particular focus was put on Cuamba health district.

Socio-demographic Profile of Respondents

The survey covered health post/ centre, district and provincial levels with a focus on the district (50%). All, but two of the respondents, held leading or administrative positions at their level of the health system. While the respondents from the health centres and posts were typically all in charge, the other respondents were from the district and provincial administration. The years of service are relatively evenly distributed between the age groups. The 7 respondents with superior academic level were medical doctors.

Infrastructure Profile

All province offices were equipped with computers and 5 out of the 15 district offices. The province of Gaza, situated next to the capital of Maputo, had a higher presence of computers in the districts as compared with the other provinces. By contrast, in Niassa, the province the farthest away from the capital, computers were only located in the capital.

With the respect to communication infrastructure, the most commonly used mode of sending physical messages as was through people who 'happened' to go the same way. Also popular was the use of courier services by people who were officially designated to carry mail between offices, while in most cases having other errands. There was limited use of email in the province capitals, and radio was also used for sending voice messages, especially in the remote areas where the telecommunication infrastructure was poor (for example, in Niassa). There was more extensive use of the telephone for sending voice messages as compared to the radio.

While this survey helped us to obtain a general idea of the health profile of the districts, through further interviews and observations, we developed a more detailed understanding of the Health Information System in the country. This is presented below along with a case study relating to immunization coverage in Niassa, emphasising the nature of the health information problems in the districts.

3.2 The Health Information System

Towards the end of the war in 1992, the Ministry of Health introduced a computer-based database and reporting system (SIS) at province and central levels, which was the first of its kind. The current study is part of the effort to evaluate and strengthen this system and to extend it to the district level. Figure 1 gives an overview of co-ordination and principal flow of information within district, province and national levels of the health system.

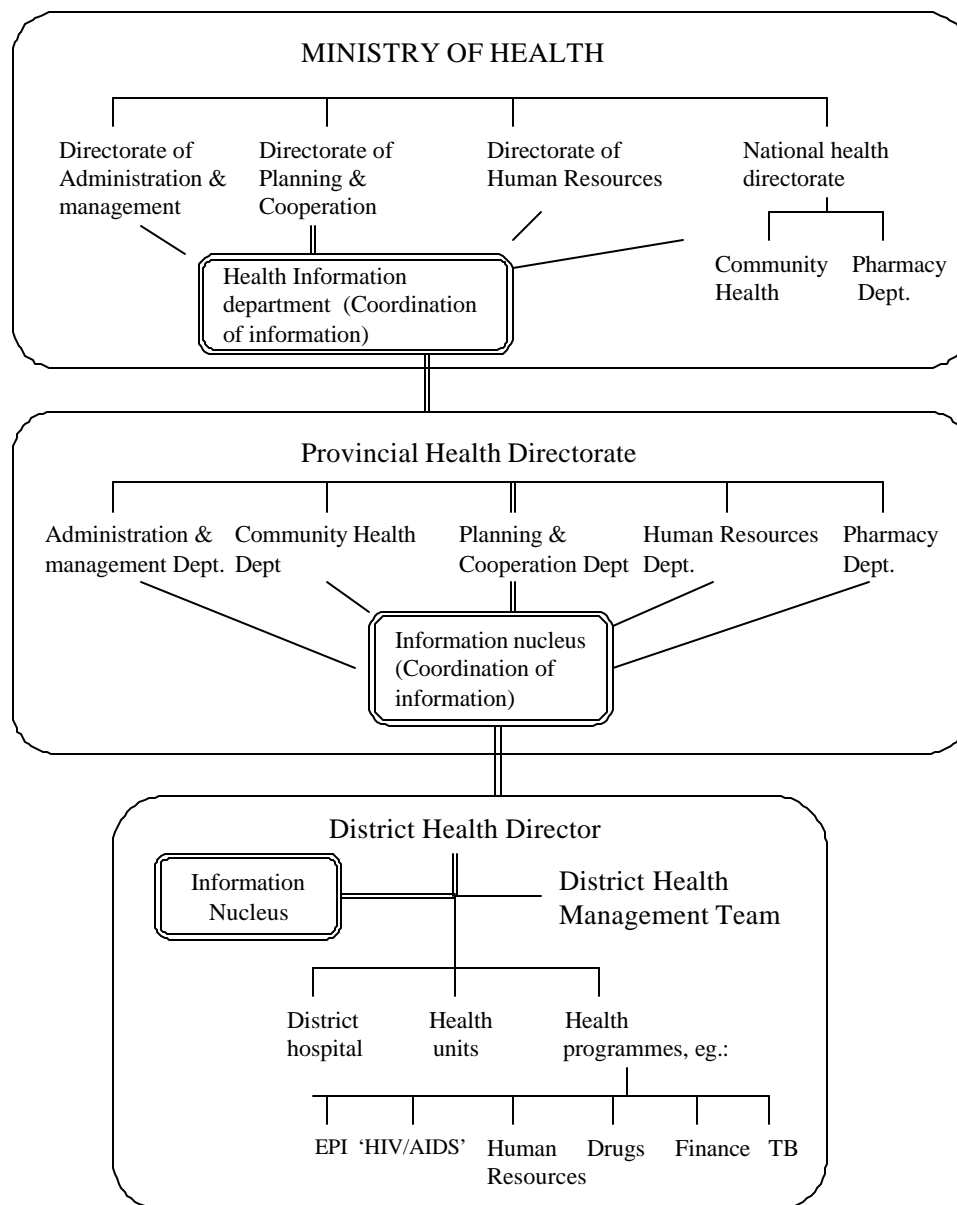


Figure 1: Organisational structure and principal channel of flow of information within district, province and national levels of the health system.

The National health information system in Mozambique dates back to 1982 and covers primary and secondary levels of health care. Data is collected at health units, aggregated and collated at district level and transmitted to provincial and national level. The system was revised in 1989 in order to simplify the system and to integrate the various programmes. However, information is still flowing from the district and province levels to the national level without being 'truly' integrated in the National Health Information System (SIS). SIS is a collection of data collection forms, procedures for reporting and aggregating data from the health facility, to the district, province and National department of Health, and a database application being used at province and National levels. Procedures, definitions and data collection forms are described in a manual. Some programmes are not integrated at all, meaning that their data flows and reporting routines are not co-ordinated and administered together with the SIS, including finance and tuberculosis. Their lack of integration represents a major obstacle to integrated planning and management at all levels. Another problem stems

from each health programme maintaining their separate reporting structures and control of which data to collect, in separate forms, within the national information system.

During the revision of the information system in 1989 the number of data collecting forms was reduced from 60 to 12 and some basic indicators were included in the forms for data collection, for use at the district and health facility levels. Most data collecting forms were based on health programs and services e.g. mother and child health, family planning, immunisation, drugs, sexually transmitted diseases and nutrition. A large and important health programme of Tuberculosis control was organising their reporting routines and data flow outside this framework. Other forms handled notifiable diseases, patient statistics and other data. Many of the forms had fields for calculation of indicators e.g. the coverage rate in the immunisation (EPI) form. Local use of information was an intention in the design of the system, which was not materialised at district and health facility levels.

Each district had a Nucleus of Health Information consisting of at least one, but often two or three people, who were responsible for data collection from the health units, collation to get an overall district picture and analysis of basic indicators before transmission to higher levels. However, the survey revealed that the information handling at district level consists basically of aggregating the forms from the health facilities into 'district forms', which are then submitted to the province. Each of the health programmes had separate data collecting forms used at facility and district levels. Every month the district office would receive a number of health programme specific forms from each facility, which were then aggregated into another set of health programme specific forms, and sent to the province. In this way, the vertical and segregated reporting structure is maintained within a common or 'integrated' channel for reporting data (see figure 2), without enabling usage of information horizontally between the health programmes at district and facility levels. This is unfortunate, because all health programmes are implemented, carried out and managed at the district and facility levels.

Another problem related to this vertical structure is that the data collection is based on the needs of the health programmes, and not on the needs of the local health services. There are therefore 'gaps' in terms of needed information that is not collected through the routine data collecting system.

One example of missing information is 'total number of patients seen', i.e. across health programmes. This information is important for district management in order to assess workload at individual facilities and to distribute resources between them. But, this information is not regarded as important by any of the programmes, so it is not collected as part of the 'official' information systems. In a few districts we found locally designed forms being used to collect this information alongside other 'missing pieces'.

The result of the current system is that data is not kept in a systematic way on a health facility basis. Due to lack of training, support, skill and supervision the intention of local analysis and use of information is followed only to a limited extent. In a later section a case of immunisation from Niassa province will be used to illustrate the importance of keeping and analysing data on a per facility basis and the necessity to integrate various sources of data.

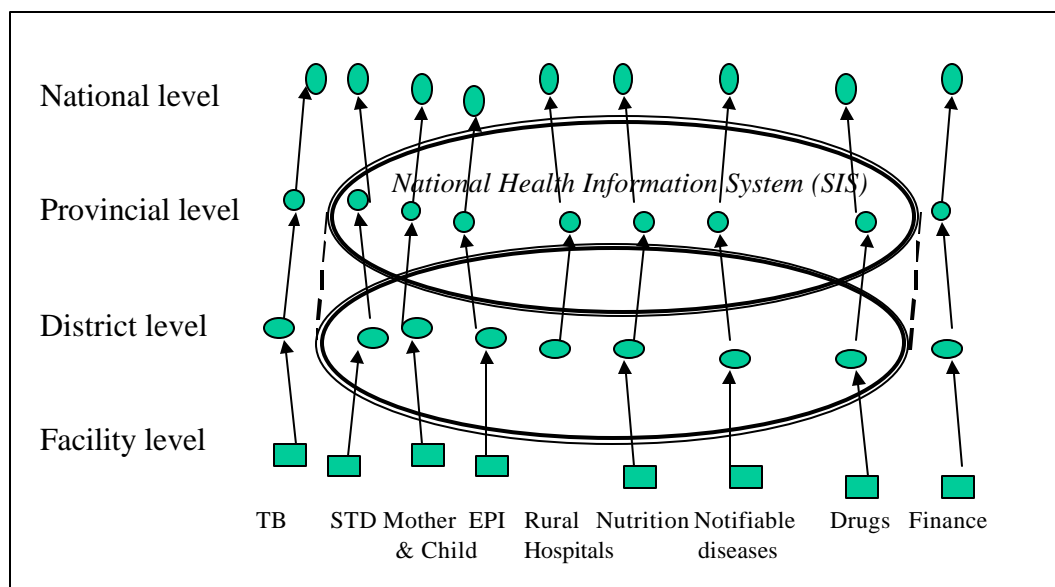


Figure 2: Flow of data on vertical programme activities. The various health programmes control what data to collect and maintain to some extent the vertical structure within the National Health Information System (SIS). Note that TB (Tuberculosis) and Finance are not part of SIS.

At the province level, data from the district forms are entered into the database application and at regular intervals transferred electronically, or in some provinces still, copied to a floppy disk and sent to Maputo. This system of feeding aggregated data to the national level is functioning in all 11 provinces. While the system is functioning well between provincial and national levels, there are major gaps and problems at the district and facility levels. As all the data entered into the national health information system are generated at health facility and district levels, the quality of data at these entry points are crucial to the quality of data at national and provincial levels. In order to extend the health information system to the districts, a database where data is organised per health facility needs to be developed and integrated with the present system.

However, as revealed in this study, the poor ICT infrastructure in Mozambique makes it difficult to introduce computers and electronic communication in most of the 131 districts. The majority of the districts have not yet seen their first computer and a considerable number of districts are without reliable electricity.

3.3 Immunisation Coverage – A Case Study from Niassa

Given that the health facilities are the entry point for all primary health care data in the national information system, the quality of the data at this level is crucial for the quality of all information derived from the information system at any levels. In order to emphasise issues at the local level, we present and illustrate the main findings of the survey by way of a case study on problems related to immunisation coverage in Niassa province in the north-west corner of Mozambique.

This case study is based on work in the Lichinga, Mandimba and Cuamba districts in the Niassa province. Immunisation was selected as a topic, because the immunisation programme has problems and the Directorate of Health in Niassa gives top priority to solving these problems. The dropout rate in Niassa province between the first and the last vaccine in a child's immunisation programme is stable at about 50%, and there is no clarity on the actual coverage rate of fully immunised children in the province.

The calculation of immunisation coverage requires both the target population (# children under 1 year) as denominator and the number of fully immunised infants as numerator. A definition of 'fully immunised' consistent with the target population (e.g. under 1 year) is also required. In the districts and health facilities visited, the coverage tended to be either around 150% (which is impossible) or around 20% (which is very low). In very few areas did they have good data or estimates of their target population, and many places did they not have a good concept of the term target population. Targets for immunisation were often set as a figure in a campaign without relation to the actual population in the area served by the health facility: 'we want to immunise 2000 children'. This invariably resulted in the 'coverage' being low.

When targets are set ad-hoc and unrelated to population at sub-district level, the district management is unable to tell good performance from poor. As a result, management of immunisation becomes difficult. At the health facility level, health workers tended to ignore the significance of the number of drop-outs from the first to the last vaccine in the immunisation scheme e.g. DPT (Diphtheria, Polio and Tetanus) which is given at 3 points over time. A health facility would have cumulative coverage graphs on the walls for the different vaccines, but no calculation of dropout rates.

In a health centre in the Cuamba district, the cumulative graphs on the walls showed 550 DPT1, 350 DPT2 and 250 DPT3 i.e. a 55% dropout rate. The target of 2500 immunised children translated to a 10% coverage rate of DPT3. These figures didn't spark any action or analysis of the problem, because the person responsible didn't interpret or analyse the data in any way and thus didn't see the significance of the difference between the targets and what was actually happening. In addition, the target of 2500 was not based on any actual population figures or estimates thereof. When discussing this case with the health worker in question, he revealed that he had no training in interpreting the immunisation data or guidance or support as to how to act on such information. He was also not equipped or trained to put procedures in place to counteract a high drop-out rate e.g. outreach activities, organising transport, vaccination campaigns or other action. The one reason why the DPT2 and in particular the DPT3 were low, he explained, was the lack of transport. There were no outreach activities, and the mothers had to bring the children to the clinic for immunisation.

The main objective of immunisation is to fully immunise children. At facility and district levels, this is not reflected in the interpretation of data, as each vaccine is treated in a similar way. The number of doses given is simply counted and displayed on graphs on the wall. The graphs may show that the 'performance' on BCG and DPT1 are good while on DPT3 is bad. One actual interpretation of this was that on average the performance is not too bad. Since only the children having received DPT3 may be fully immunised (they need for example measles as well), such an interpretation of data is not only wrong, but it also stops the needed action.

This case study shows that while there is some numerator data (i.e. number of events), there is little use of denominator data (e.g. target populations) for calculation of coverage indicators. Furthermore, there is a shortage of skill and procedures in place for using the information and turning it into action.

The 1997 census data was published and distributed to all provinces by the end of 1999, which might help to improve the situation. Before that there were no reliable population data. The previous census data was from 1977, but the movements of people during and after the war have made this census data rather useless.

The following recommendations flow directly from the case study:

- The main EPI-targets are to get the coverage rate up and the DPT1 - DPT3 dropout rate down. In order to achieve this, the information system needs to be strengthened and procedures established on how to act on information, together with training and supervision.
- Fully immunised children under 1 year need to be included as a new field in the EPI form. The present procedure is that a fully immunised child gets a 'Vacinação completo' stamped in his or her immunisation card. The additional procedure proposed is then to count all children less than 1 year and report them every month as a main 'summary' figure. This figure should then be used to calculate a cumulative coverage graph to be displayed on the wall in ALL health facilities. The 'under 1 year' constraint is necessary to calculate coverage against the target population under 1 year.
- Each district should estimate their target population based on the 1997 census, which has districts and some sub-districts as enumerator areas. The district population may be 'divided' between the health-facilities based on rough estimates of each health facility's catchment areas as proportions of overall headcount for the district.
- Health workers need to be trained in registration/collection of accurate data, how to estimate and use the target population, how to calculate the coverage and DPT1 - DPT3 dropout rates and to interpret the significance of these indicators. Furthermore, procedures on how to act on this need to be put in place e.g. which steps need to be taken if the dropout rate is high and /or the coverage rate is low.
- Ongoing support, co-ordination and supervision of the health facilities need to be provided by district and province management including the information officer. It is crucial to link the information system and the person responsible for it to the health management team and to action within program management.

In this section, some problems and potential solutions related to immunisation have been outlined. Similar exercises will need to be done within other health program areas as well (e.g. malaria, tuberculosis) to diagnose the nature of existing problems. The main approach should be to focus on a few main locally important targets, identify the corresponding main indicators and link them to possible action.

3.4 Summary of the Findings from the Health Information Survey

As illustrated by the case study and the survey of the health information system in the districts, we can make some more directed remarks. We find that the system is not functioning satisfactorily in terms of *use* at district and health facility levels. The main problems are:

- The National Information System (SIS) is directed towards upwards reporting of data and not on local use of information.
- The feedback routines from province to district and from district to health facility are poor.
- The information system is based on the needs of the vertical health programmes at the central level and not on the needs of the local level. As a consequence, data that would be useful at local level is not collected and the system is in general not enabling local analysis and use of information.
- The vertical structure of the reporting system and the way data is aggregated at district level makes it difficult to keep, maintain and analyse data to support district management. As an example: at the district level the focus would be on

the performance of individual health facilities across health programmes and comparison of health facilities. This is exactly the type of information that is not included (or in fact removed by aggregation and disguised by 'verticalisation') in the current information system.

- Lack of training and support were universally emphasised by all health personnel taking part in the study.

Given these overall findings, an overall recommendation is that much more focus need to be put on analysis and use of information for local decision making and action at district level.

Most managers and health workers interviewed stated that the feedback routines were insufficient and that they needed more feedback from the level above. It was also obvious that those managers themselves did not sufficiently emphasise feedback to their own staff. This is a pervasive problem with the information system: in practical terms, the emphasis is on reporting, and not on *use*. The forms for data collection include fields for the calculation of indicators, but the survey reveals that these indicators are only being calculated to a limited extent and when calculated, this is often done incorrectly (as illustrated by the case study of immunisation). This highlights one of the main problems identified in the study, lack of skill to 1) analyse and interpret data and to 2) turn information into action at health facility and district levels. The need for focused training and ongoing support in order to rectify this problem.

A district information system needs to be based on information from the various health facilities (health posts, health centres and district hospitals) in order to enable district management to compare and support the individual facilities. In the present information system data from the facilities are aggregated into district data and it is not possible to validate data per facility. When adding together the health facility data, all kinds of errors are aggregated into an average that makes district management difficult.

Main objectives for the district management are equity in health service provision and equitable distribution of resources within areas and health facilities in the district. An effective information system should be able to provide information on a health facility and area basis so as to enable district management to pick out areas and health facilities having particular problems, the lowest immunisation coverage, the highest patient load, the most diarrhoea among children etc. We therefore strongly recommend the development of a district database application where data is collected and stored on a health facility basis each month. However, this depends on the level of the general ICT infrastructure in the province or district. To understand the interdependency between the health and general ICT infrastructure, we present our survey of the general ICT infrastructure in the next section.

4. A SURVEY OF COMPUTER USE AT PROVINCE AND DISTRICT LEVELS

In this section we first present results from the questionnaire based survey of computer users, then we give a richer description of the context of computer usage in the surveyed areas, before summing up by comparing the three surveyed provinces. A survey was conducted on computer usage in 12 districts in three provinces, and the results are presented under three categories:

1. Socio-demographic profile of respondents (Appendix E)
2. Infrastructure conditions (Appendix F)
3. Nature of computer usage (Appendix G, H and I)

Socio-demographic Profile

A total of 173 questionnaires on computer usage were administered in 12 districts in three provinces, covering those people who were using computers in their respective institutions. The distribution shows that in the provinces of Gaza and Inhambane nearly 16-20% of the computers were concentrated in the province capital. In Niassa, on the other hand, the concentration of respondents is comparatively higher in the economic capital of Cuamba. This trend of distribution of computers is similar to what we have observed in the survey of Health Information Systems in the same provinces. Overall, 63% of the computers were found in the public sector and the rest in the private and non-governmental sector.

A relatively large proportion (60%) of the respondents had less than three years of service and we found the oldest age group (with more than 10 years of service) to be the most intensive computer users (more than 3 times a week). This finding contrasts with the more popular belief that younger people are more intensive users than older people. The explanation is possibly that computer usage is regarded as prestigious and the basis to enhance job opportunities, and is thus used by those people who have greater power in the organisation, viz., the more senior people. This interpretation correlates well with our observation of the junior staff: 'The bosses always take the newest computers, even though we are the ones who need them most.' There was also a male dominance in computer usage, and skewed towards the more educated people.

Infrastructure Conditions

An important aspect of infrastructure development in developing countries is the manner in which computers are acquired, since they shape processes of subsequent support. On a positive note, we found that 67% of the institutions themselves bought the computers and only 26% came through processes of donation or gifts. We found that only 16% of the computers were currently not working, and the technical problems related to lack of spare parts and missing consumables, as ink cartridges and paper. This low level of problems could be due to the fact that nearly 79% of the machines that were less than 2 years old. This indicates the relatively new nature of the ICT phenomenon in Mozambique.

Inadequate skills and training were universally seen as a major bottleneck to the spread of computerisation. Poor knowledge of English, and lack of adequate documentation in Portuguese were impediments to training and skills development. Because of poor availability, very few users were able to work with the Portuguese version of MS Windows. We found that the original CDs and documentation of Windows was not available in most offices.

Maintenance and support plays a crucial role in shaping use of computers. We found there were no locally based companies providing support, and the users were typically dependent on "friends." The formal support structure, when it existed, was mostly from Maputo. Nearly 73% of the users collaborated with other institutions forming informal networks of support to *learn, acquire new software, and to solve problems.*

Computer Use

An analysis of attitudes showed that computer usage was seen as prestigious and important in order to improve job opportunities. Nearly 94% of the respondents did not see computers as 'low level' work. Word processing was the major task among the computer users. Most respondents had learnt computer use through a course (62%), and 88% stated that they needed more training. Poor availability of training courses was a bottleneck and there were few plans for new courses in different institutions for the future. Also, existing courses were only introductory in nature and took place with no systematic follow-up. Poor documentation

and manuals also contributed to users feeling uncertain towards the software, emphasising the need for more *education* and support to develop capacity to handle the software.

There was very little local adaptation or development of software taking place. A main overall finding is that very few users were using particular application software to address their particular needs reflecting the low level of human resources capacity. There is an urgent need to develop training and education programmes to increase the ICT capacity nation-wide. Based on these surveys and other interviews we also have developed a profile of three provinces, which we present below.

4.2 Computer Usage in Three Provinces

In this section we describe the context of computer usage in the three surveyed provinces. While Gaza and Inhambane provinces are close to the capital Maputo in the extreme south of the country, Niassa province is the province farthest away in the north. Furthermore, Niassa is considerably less developed in terms of general infrastructure, human skills and economy, as compared to Gaza and Inhambane.

Gaza Province

Gaza province is just north of Maputo and consists of a relatively well-developed coastal area and a vast sparsely populated inland bordering South Africa and Zimbabwe. Six out of the eight districts were surveyed. In Xai-Xai, the provincial capital of Gaza, most major organisations were using computers and the first local Internet provider was about to be established in June 1999. Before that, Internet connection was possible through a 'router' to the national Telecom Internet provider Telenet in Maputo, but with no local support. The first computer repair and training company had been working for nearly a year, and two new competitors were about to start. In one of the major centres in Gaza, Chokwe district, as many as 21 organisations using computers were identified and a computer training centre had been running for nearly two years. The latter company had trained more than hundred students from both the private and public sector. Furthermore, we identified and interviewed computer users in 5 districts (out of 8), revealing a rather flourishing computer scene in the province. The survey also revealed that the level of skill and formal education was low, and computers were mostly used as 'type writers and calculators' (i.e. general software), with few cases of use of application software were identified. Knowledge of programming was limited and very little application development happened. The gradual diffusion of computers and computer usage in Chokwe and Xai-Xai differ, but both places it has developed through informal networks, individual entrepreneurs and some institutional linkages.

Gaza was among the first provinces in Mozambique to implement the computerised provincial health information system and they are among the best performers in the feedback and use of health information. The health sector was among the first to introduce computers in Gaza. Furthermore, the health information system was among the first and is still among the very few application systems designed to support the particular needs of an organisation at the provincial level. In addition to the district around the provincial capital, two more health districts are using computers. Since the present health information system is province-based and only includes data aggregated at district level, the computers in the health districts are only used for general work. The goal of the research programme is to change this situation by developing a district based health information system.

In Xai-Xai, and to some extent in the rest of the province, the informal network of computer users developed around two individuals who were trained in ICT in an international aid organisation. Later, one of them started the first computer company in Xai-Xai, while the other became responsible for the technical parts of the health information system and organised computers to other health districts where he had friends who shared his interests.

When asked about how they get support, help and training, most computer users we interviewed in XaiXai, and in the nearby districts, referred back to these two early computer entrepreneurs and the capacity represented by them.

In Chokwe a similar pattern was identified. Here the crucial actor and network builder was the NGO training centre and the entrepreneur responsible for initiating, developing and running the centre. A catholic NGO initiated the centre and provided a loan. The centre was made sustainable in that the fees from the students are used to pay salaries, maintenance and to pay back the loan. All computer users interviewed in Chokwe referred back to the training centre and the person responsible for it when asked about how they got support, help and training.

Inhambane Province

Inhambane province is just north of Gaza province. In general there are few differences between the two provinces in terms of economical, social and educational infrastructures. The capital city Inhambane, which is divided into two parts –Inhambane cidade district where the governmental staff is established and Maxixe district, which is the commercial centre of the province located on the main arterial road of Mozambique.

The survey visited more than 43 organisations in 5 districts. In Inhambane more than 39 organisations in private and public sectors using computers were identified. Three of these organisations were private computer software training centres serving the entire province and representing the cluster of capacity in Inhambane. One of these private training centres was relatively advanced and provided a range of courses. It was started by people trained in Maputo and had been running for two years by the time of the visit (started 1997). Another training centre was run by a catholic school and was well off in terms of equipment and resources. The third centre was smaller and was initiated and run by a Zimbabwean based in Beira, the second biggest city and economic centre in Mozambique located north of Inhambane. The two latter centres had been running one year by the time of the visit (started 1998). While two of the centres are supported from Maputo City, the third is supported from Beira. The support is in terms of hardware and software maintenance, training of trainers, access to new computer programs and internet connection.

In Cidade de Inhambane there were several organisations (public schools, state organisations, NGOs, banks) with electronic equipment and some with feasible internet access.

In Maxixe the International Bank of Mozambique has set up an on-line system of electronic banking including ATMs. In Maxixe and Massinga, which is also situated along the main road, there were some other bank organisations with electronic communications and with Internet access.

All the organisations visited that were using computers had problems such as:

- Relatively weak level of access to the new information and communication technology;
- The users of computers were not sufficiently independent, because of shortage of training centres, and needed more training to handle the technology ;
- A lot of computer related equipment is not used because of poor level of skills or lack of computer maintenance. Computers were abandoned due to minor damage or technical problems;
- Electronic communication is unknown and people rely on radio or telephone;

Niassa Province

Niassa province is a poor and little developed province in the north-west corner of Mozambique, bordering Malawi and Tanzania. There are two major centres, Lichinga, the province capital, and Cuamba, an agricultural centre and important trading district located along the railroad line close to the Malawian border.

In Lichinga we identified more than 30 organisations in private and public sector using computers. Less than ten of these were linked to foreign organisations. Taking the size and remoteness of Lichinga, and the general level of economic development in the area into account, this is a surprisingly high level of computer distribution. The provincial department of health was among the earliest and most important organisations using computers. The same catholic NGO as in Chokwe has established one of the two computer training centres in Lichinga, though the skills among the trainers were poor. The important actor and 'bricoleur' in the building of a network of computer users and developing of human capacity in Lichinga was a Brazilian missionary who was both the local Internet provider (with 18 organisations as subscribers) and the general problem solver. Moreover, he was about to organise an Internet café.

Most organisations visited reported that they were in substantial need of relatively basic computer skill, maintenance and support. Thus, there is a great demand for ICT entrepreneurs, who would be able to make a good living, but there were simply no people around with sufficient skill.

In Cuamba district a similar pattern was identified. A substantial number of organisations used computers and the lack of skilled people was similar to that of Lichinga. Of the important local actors was a Portuguese NGO running a training and resource centre. However, the person responsible had too many other commitments, and the centre stood idle for nearly one year. To solve this capacity problem they are now training four local 'talents' to a level that they will be able to run the training centre on their own. The economic viability of the centre is based on fees from students and from people who use the computers in writing letters, CVs etc.

Another important actor is an agricultural university, funded and run by a Dutch catholic NGO, which has a computer laboratory, but without an Internet connection. Their main problem is the same as the general problem in Niassa, in that they don't have people with sufficient skills. Two of the four 'talents' who were being trained at the training centre are attached to the agricultural computer laboratory, and will thus improve their skills in the future.

A third important actor is an American NGO working in the health sector. They are 'intensive' computer users and represent a considerable expatriate capacity, which spill over to the local computer community through various forms of interaction and by training their own local staff.

In the districts of Cuamba, Chokwe, Maxixe and Xai-Xai (i.e. all three provinces) the International Bank of Mozambique has set up a system of electronic banking, including ATMs. As a consequence, these places established Internet connections and so represent a private sector initiative that has boosted ICT across sectors.

4.3 Comparing the Provinces: Institutional Development and Entrepreneurship in the Computer-Age

Outside the capital and the few major centres we found that use and development of ICT relied upon bricolage and tinkering in informal networks of computer users supporting each other. There was typically no technical or software support provided, private or public. 85% answered that they could not get technical assistance from a company in the province.

Computer users in these remote parts of the world tend to 'survive' through what Lévy-Strauss (1966) calls *bricolage* and tinkering and by building informal networks of computer users supporting each other. 72% answered that they were collaborating with other users in the province in order to learn and to solve problems. The bricoleur is the road-side 'bush' mechanic you meet in Africa who gets the car going by way of 'magic' - or by whatever is at hand in an improvised way. The informal networks supporting computer users in the provinces surveyed illustrate a similar tendency. This is related to the less stable and more uncertain technical environment in the third world. The network of support, taken for granted in the first world, is not present to the same extent. In all centres surveyed there were typically one or more resource persons and the institutions supporting them, who formed the 'nucleus' of an informal network of computer users.

In *Cuamba* a Portuguese NGO represented by one person provided training. The Agricultural University is present as an institutional base for a computer and Internet centre, provided support and sufficiently skilled personnel.

In *Lichinga* a Brazilian priest was the 'Mr. ICT' and several individuals ('talents') were eager to become part of a process of ICT development. Three training centres provided a framework for training, but did not have sufficient skills. The provincial government had a considerable number of computers but limited skill and planned to establish a new training centre. Thus an institutional base is potentially present, but needs nourishing and support.

In *Xai-Xai* two friends with training from the same foreign aid organisation became the important actors in developing the ICT network in the province. While the one was acting through the provincial department of health, the other was creating the first computer company in the province. The health sector introduced computers in three districts but did not follow this up with implementing appropriate application software to address the needs of these districts. Partly for this reason, the introduction of computers in the health districts did not spark new rounds of innovation and development.

In *Inhambane* the main ICT actors were those people who started and were running the three training centres. People who were trained and got their support from the outside, Zimbabwe - Beira and Maputo respectively started two of these centres. The third was started by a local relatively rich organisation, a catholic school. These three centres make up a cluster of capacity, which is stronger than those existing in the two other surveyed provinces.

In *Chokwe* the initiator and driving force was the catholic NGO funding the training centre. This seems to illustrate what might be an ideal interaction between entrepreneurship and institutional backing. The demand for computer training was considerable, as is illustrated by the 20 odd organisations using computers in Chokwe. The skilled entrepreneur - or the entrepreneur able to skill himself - and the funder who wanted to support the training centre joined forces. Lichinga was similar to Chokwe in that the same Catholic NGO supported a training centre. The demand was even greater than in Chokwe, while potential entrepreneurs were present, but, due to lack of skill not much happened. This indicates that entrepreneurship in the computer-age differs somewhat with the general view of the entrepreneur as one who invents and finds new way to do things and who dares to break the rules of normal behaviour as given by the social and cultural structures (Barth, 1981). In Lichinga, it was not enough to act as an entrepreneur, some skills and learning from the relatively 'abstract' field of computers was as important. Computer technology is a much more 'black-boxed', hidden and abstract technology than a car, for example. In order to nourish entrepreneurship in the computer-age, a much more enabling environment in terms of institutional involvement, education and training needs to be created in education, health and governance.

5. SUMMARY AND RECOMMENDATIONS

5.1 Summary of the Research Questions

In this section we will summarise our findings related to the broad research questions outlined in the introduction.

What is the use and diffusion of ICT at provincial and district levels?

The study showed that computers and Internet are rapidly being spread in all provinces and major districts in Mozambique. As an example, in Lichinga in the far north 35 organisations are using computers and there are 18 Internet users. Nevertheless, the development is uneven and only the major districts and provincial capitals are part of this ICT-development. Most users are using the computers only as advanced typewriters, i.e. word processing. It is worth noting that the National Health Information System was among the very first computer applications in the provinces. While it is still rare to use application software developed in order to address particular needs, the health sector is a forerunner in this area.

How is the health information system functioning and how is information being used at district and provincial levels?

The National Health Information System is functioning well in technical terms. However, as the study reveals, the system is basically an upwards reporting systems and the use and analysis of information at district level is poor. Also at provincial level, the use and analysis of data is sub-optimal. However, there exists the basis to nurture further use.

How is the ICT-infrastructure and support structure and how is the 'network of ICT-support' being developed?

The ICT infrastructure including support is poorly developed. With only very few companies dealing with hardware and software support in the provinces. Only 8.7% of all respondents answered that they got support from a company in the province and most users relied upon support from the capital. Most users (72%) were collaborating with other computer users in the area in order to solve problems and learn more. Thus, the informal network of computer users makes up the important part of the local human resource infrastructure and network of support. A few skilled and advanced users will typically make up the nucleus in such a network. A main problem is that also those early computer entrepreneurs need more training and education. A central element in an ICT policy would therefore be to aim at improving the skills of these activists and use them to train others and to improve the ICT knowledge base and capability at provincial and district levels.

How is the training and human resource development in ICT and health information?

There exists a big market for computer training. In all province capitals and many of the districts we found ICT training centres. The problem, as mentioned above, was that the trainers themselves needed more education! The focus of an ICT policy should therefore be to train and *educate* the trainers. The survey of health information reveals that skill in use and analysis of information is low and training *and* education programs are needed very urgently.

Are there any good practices and usages of ICT and information at district and province levels? Is it possible to find examples of local adaptation and locally developed solution to problems?

There are very few examples of locally developed or adapted applications (e.g. in spreadsheet) which are addressing some local needs. Computers are most often used only as

advanced typewriters, and a considerable number of computer users answered that they needed locally adapted software to address some particular needs or problems (52.6%). While only 8.7% answered that they had such locally adapted or developed software, 64.2% felt that they needed help from programmers in order to develop such software. Thus, the organisations using computers needed particular application software, but there are no companies or individuals with sufficient skills available that can help them. The poor programming capacity is a big problem. Again, education of programmers, or more advanced ICT education and training is an important policy recommendation.

Are there any visible impacts of ICT?

Internet connectivity is now found in all provinces. In many places this is the direct result of the establishing of ATMs by the International Bank of Mozambique (BIM) making online banking among the more tangible impacts of ICT. As an example: in order to carry out this study we did not have to carry large amounts of cash (literally millions of Metecais), we could get the money needed deposited in Maputo and draw them immediately after in Cuamba, 2000 kilometres to the north. In addition to online banking it is still too early to look for tangible impacts on socio-economic development caused by Internet connectivity. Though, as a small impact, we heard both in Lichinga and Cuamba that Internet connectivity was expected to make it easier to attract doctors and to get them to stay there for longer periods.

How can 'Computer age' entrepreneurship in the Third World be developed?

'Computer age' entrepreneurship is a crucial question for ICT development in Africa and the third world, and it is an important area for further empirical research. A comparison with the 'roadside' or 'bush-mechanic' you find all over Africa is relevant and highlights some important issues: The traditional cars in Africa, as Land Rover and Peugeot, represent an 'open technology'. Through practice the mechanic will learn how the parts are functioning and working together. Parts can be repaired and replaced by way of tinkering and bricolage. The same makes of cars are in circulation for years and there is an abundance of second hand spares.

Computers are different from cars; they contain 'invisible black boxes' that are difficult to 'decipher' and can be understood only through practice and experience. The educational entry level for a computer age bush-mechanic is much higher than that of a traditional mechanic. There are still traditional mechanical improvisations possible regarding ICT repairs and spare-parts, like e.g. refilling of ink-cartridges. But improvisation will more often than not include searching the Internet for digital spare parts like e.g. new or old drivers for screens, printers etc. Furthermore, there is an abundance of makes of hardware and versions of software, which are changing rapidly. This highlights the importance of the wider infrastructure, in particular:

- Human resource development. Training and education of the computer age bricoleurs and entrepreneurs.
- Internet connectivity and telecommunication.
- The possibility of getting spare parts.

The example of Lichinga tells us that, of the above three issues, human resource development is the most important now: The demand is there, represented by 35 organisations using computers. Internet connectivity is there and the entrepreneurs are there, represented by a number of young people taking computer courses. The problem is that the

courses are not taking the entrepreneurs far enough. What is lacking is appropriate skill, i.e. education and training and training of trainers.

ICT in Health: Is a focus on the district level possible and appropriate?

A main finding of the study is that the health information system needs to focus on the district level, because this is the level where the Primary Health Care approach is implemented and where all data is collected. Analysis and use of information at district level is necessary in order to improve health management and services, but it is also necessary in order to improve data quality at all levels. Data needs to be used and controlled at the entry point in order to ensure quality (see case study from Niassa). Thus the health facilities need to be supported and included fully in a district based information system.

Another finding of the study is that computers and ICT infrastructure are concentrated in the province capitals and major districts. Thus, a strategy towards a district based health information system needs to be based on the fact that most districts will not get computers in the next few years. The challenge is therefore to develop ways to integrate the districts which don't have computers in the district based information systems, by support from neighbouring districts, which have computers, and from the province.

This strategy is not based on a not yet developed ICT infrastructure with computers in every district. Thus in terms of ICT the strategy is possible and appropriate. The problem is, as showed by the study, related to training and education of health personnel in health information systems and management.

5.2 Recommendations

The case study of immunisation in Niassa and the findings from the health information survey revealed that local analysis and use of information at district and facility levels were crucial to improved health service provision and health management. Development of district information systems was found to be crucial to the strengthening of the district based health system and a primary health care approach. Given this and the importance of strong institutional actors outlined in the discussion above, the health sector has the potential to be an important institutional actor in the development of the information and communication infrastructure and human capacity at peripheral levels in Mozambique. The health sector needs appropriate ICT and the process of development of capacity, learning, entrepreneurship and innovation needs strong institutional actors. The health sector thus has the potential to be an important arena for diffusion of ICT and for learning and development of institutional capacity.

Policy Recommendation

Develop health information and other information sectors within an integrated approach to ICT. The development of the health information infrastructure relies upon the state of the wider ICT infrastructure. In order to overcome the 'chicken-egg' problem when the ICT infrastructure is too weak, the policy suggested here is to use the health sector as a 'development vehicle' to boost development of the general ICT infrastructure. The health sector is well suited in this respect. This is because:

- The health sector extends to the most peripheral levels of the society,
- Effective use of information is crucial to PHC delivery and health management,
- A routine reporting system from the health sector posts to the national level, for which computerisation at provincial and national levels is already in place.

The suggested process towards developing a district based health information system and the use of electronic communication to report data and exchange information is well suited as a vehicle to enable more general development of capacity and infrastructure in a province. If such a process within the health sector gains sufficient momentum, other sectors like education and local government administration, individuals and institutions may join forces to develop the information and communication infrastructure by providing a critical mass of capacity building, learning and innovation in the process.

A primary finding of this study is that the main problem in Mozambique is the low level of skill, education and general capacity within health and management information systems and ICT more generally. The study of ICT in the three provinces shows that entrepreneurship plays a crucial role in developing ICT capacity and infrastructure. Furthermore, the study shows that 'ICT-entrepreneurship' needs an institutional framework of capacity building and a certain level of skill as a necessary point of departure in order to flourish. Training, education and development of capacity are therefore crucial in the further development of the health information and ICT infrastructure in Mozambique. In order to ensure sustainability the program addresses this problem by focusing on developing educational programs and training of 'trainers' and people at several levels:

- A joint PhD program between the faculty of medicine and the department of informatics at the Eduardo Mondlane University has been started. The aim of this program is to take part in the further development of the health information system at district and provincial levels and the development of the ICT infrastructure more generally.
- The program aims to support the development of masters program in public health and informatics at the Eduardo Mondlane University. The development of the PhD and Masters programmes in an integrated effort is important in ensuring sustainability.
- Develop and run a district level training program on analysis and use of health information for management and health care delivery. Develop this programme into a training scheme where trainers are trained and activities gradually spread countrywide. This training scheme will be integrated with the masters program and aims at continuous education of health managers and more basic training of health workers.
- Develop courses and support the development of a network of support and training on computer and communication software and hardware. Important here is to train the trainers at the various training centres.
- Develop a district based database application which store data at health facility organised per district and which enable the calculation of indicators on health post and district levels. The database needs to have facilities for storing population and community based data as well as data on each health facility. The database needs to be fully integrated with the present provincial information system.
- The overall objective of the programme is to support the development of the information and communication infrastructure and human capacity at district and provincial levels in Mozambique. The programme will use the development of good practices of usage of information for management within the health sector as a means to subsequently spread the approach and model to other public sectors (e.g. education, agriculture) and the community in a more comprehensive approach.

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HEALTH INFORMATION SYSTEM SURVEY

Appendix A: Geographical distribution of the respondents

District / Province	Number	%
Xai-Xai Cidade (capital)	6	15.8
Bilene	1	2.6
Chibuto	1	2.6
Chokwe	3	7.9
Manjacaze	1	2.6
Guija	2	5.3
Total Gaza Province	14	36.8
Massinga	3	7.9
Morrumbene	2	5.3
Maxixe Cidade	3	7.9
Homoine	1	2.6
Inhambane (capital)	4	10.5
Total Inhambane Province	13	34.3
Cuamba	5	13.2
Lichinga-sede (capital)	1	2.6
Lichinga Cidade	3	7.9
Mandimba	2	5.3
Total Niassa Province	11	28.9
Total	38	100

HEALTH INFORMATION SYSTEM SURVEY

Appendix B: Socio-demographic profile of respondents

B1. Respondents by different levels of health system

Level in the health system	Number
Health centre /post level	11
District level	19
Province level	8
Total	38

B2. Respondents by years of services

Years of service	Number	%
0- 4 years	13	34.2
5 - 19 years	11	29.0
20 - 38 years	12	31.5
Not valid information	2	5.3
Total	38	100

B3. Academic level of respondents

Academic level	Number	%
Basic level: 10 years of school	14	36.8
Medium level: 12 years	17	44.7
Superior level: more than 12	7	18.4
Total	38	100

HEALTH INFORMATION SYSTEM SURVEY

Appendix C. Infrastructure profile

C1. Availability of computers

Does your institution have a computer?	Number	%
Yes	17	44.8
No	20	52.6
No information	1	2.6
Total	38	100

C2. Existing communication facilities

Communication: How are you sending your routine reports to the level above?	Number
Courier	22
Radio	4
Telephone	15
'Send with people going the same way'	25
E-mail	4
Other, including Postal services	11

COMPUTER USAGE SURVEY

Appendix D: Geographical distribution of the respondents

District / Province	Number	%	Cum. %
Bilene	2	1.2	1.2
Macia	2	1.2	2.3
Manjacaze	5	2.9	5.2
Chibuto	4	2.3	7.5
Chokwe	11	6.4	13.9
Xai-Xai Cidade (capital)	36	20.8	34.7
Total Gaza Province	60	34.7	34.7
Homoine	1	0.6	35.3
Massinga	3	1.7	37.0
Maxixe Cidade	10	5.8	42.8
Inhambane (capital)	29	16.8	59.5
Total Inhambane Province	43	24.9	69.6
Cuamba	16	9.2	68.8
Lichinga-sede (capital)	54	31.2	100.0
Total Niassa Province	70	40.5	100.0
Total	173	100	

COMPUTER USAGE SURVEY

Appendix E: Socio-demographic profile of respondents

Type of organisation	Number	%	Cum. %
Public sector	109	63.0	63.0
Private sector	39	22.5	85.5
Foreign Non Gov. Org. (NGO)	10	5.8	91.3
Not valid information	15	8.7	100

Years of service - correlated with usage	Num ber	%	Cum. %	Using pc > 3X week	Using pc every week + more (i.e. 3X week)
One year or less	37	23.4	23.4	15 -> 40.5%	28 -> 75.7%
1 - 3 years	39	24.7	48.1	20 -> 51.3%	31 -> 79.5%
4-9 years	37	23.4	71.5	18 -> 48.6%	29 -> 78.4%
10 – 30 years	45	28.5	100	27 -> 60.0%	34 -> 75.6%
Not valid information	(15)	(8.7)			

Academic level	Number	%	Cum. %
Basic level: 10 years of school	48	27.7	27.7
Medium level: 12 years	94	54.3	82.0
Superior level: more than 12	28	16.3	98.3
Not valid information	3	1.7	100

COMPUTER USAGE SURVEY

Appendix F. Infrastructure profile

Mode of acquisition	Number	%	Cum. %
The computer was a gift	45	26.0	26.0
The computer is borrowed	1	0.6	26.6
Bought by your self	117	67.7	94.2
Rented	2	1.2	95.4
Other	7	4.0	4.00
Not valid information	1	0.6	100

When you have technical problems Can you get assistance from a company in the province?	Number	%	Cum. %
Yes	7	4.00	4.00
No	152	87.9	91.9
Don't know	3	1.7	93.6
No information	11	6.4	100
Total	173	100	

COMPUTER USAGE SURVEY

Appendix G. Collaboration and informal networks of support

Are you collaborating with other institutions and persons regarding computer usage and problems (1)?	Number	%	Cum. %
Yes	127	73.4	73.4
No	36	20.8	94.2
Don't know	1	0.6	94.8
No information	9	5.2	100
Total	173	100	

Appendix H. Attitudes towards working with computers

Do you consider working with computers to improve your job opportunities?	Number	%	Cum. %
Yes	139	80.3	80.3
No	32	18.5	98.8
Don't know	2	1.2	1.2
Total	173	100	

Do you consider working with computers to be 'low level' /clerical?	Number	%	Cum. %
Yes	7	4	4
No	163	94.2	98.2
Don't know	3	1.8	100
Total	173	100	

Do you consider it prestigious to work with computers?	Number	%	Cum. %
Yes	111	64.2	64.2
No	51	29.5	93.6
Don't know	11	6.4	100
Total	173	100	

For what purpose are you using the computer :	Number	%	
Text processing?	Yes	153	88.4
	No	15	8.7
Make reports?	Yes	151	87.3
	No	18	10.4
Data entry?	Yes	144	83.2
	No	26	15.0
Make graphs?	Yes	114	65.9
	No	53	30.6
Analyse data?	Yes	113	65.3
	No	54	31.2
Financial programmes?	Yes	85	49.1
	No	83	48.0

COMPUTER USAGE SURVEY

Appendix I. Training and learning to use the computer

How did you learn to use the computer?	Number	%	Cum. %
Computer course	107	61.8	61.8
Learned from colleagues	46	26.6	88.4
Learned through books	4	2.3	90.8
Learned by my self	15	8.7	99.4
No valid information	1	0.6	100
Total	173	100	

Appendix J. Local software adaptation, adjustment and development

Local needs and adapted software		Number	%
Have you adapted or developed Software locally?	Yes	15	8.7
Do you have particular needs	No	150	86.7
Local software applications?	Yes	91	52.6
Do you need programmers	No	48	27.7
Help from programmers	Yes	111	64.2
Do you have particular needs For more software?	No	39	22.5
Have you got requests for particular information or analysis?	Yes	127	73.4
	No	28	16.2
	Yes	81	46.8
	No	80	46.2

8.2. APPENDIX B

NHAMPOSSA, J. L. (2004). Strategies to deal with legacy information systems: a case study from the Mozambican health sector. IN IRMA (Ed.) Innovations through information technology. New Orleans, Louisiana, USA, Idea Group Inc. 475-479.

STRATEGIES TO DEAL WITH LEGACY INFORMATION SYSTEMS: A CASE STUDY FROM THE MOZAMBICAN HEALTH SECTOR

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Abstract

When implementing reforms in the public sector in general and in the health sector in particular, special attention needs to be taken of the role of existing legacy information systems (LIS). Traditional strategies for system change were developed within a frame of one (or few) isolated which can be developed from scratch, and moved from old to new architecture. The existing infrastructure – installed base of LIS – is typically not seriously considered when implementing changes. A theoretical perspective is developed drawing upon concepts from LIS and Information Infrastructure (II) related literature. This theoretical perspective is drawn upon to analyze experiences from an ongoing attempt to introduce new health information systems(HIS) in the context of Mozambique. The paper concludes by proposing some strategies to deal with existing LIS

Keywords: Information systems, health information systems, legacy information systems, information infrastructures.

1. INTRODUCTION

In implementing ICTs, an issue of concern is the existing legacy information systems (LIS), which are normally old and locked, lacking source code and documentation, and tend to be stored in various proprietary formats, making sharing data between different systems difficult. Strategies to address these LIS need to seriously considered, whilst designing and implementing new systems.

In Mozambique, various constraints have been identified through assessments of the present National Health Information System (NHIS) (MISAU, 2003; bMISAU, 2003), amongst them was the presence multiple LIS and the related absence of a unified information and communication infrastructure. As a result, the existing systems are unable to provide health managers with information on essential indicators which would cross-link different resources with activities, such as relating to different health programs. The aim of this paper is to describe the nature of these LISs, the problems they gave rise to, and discuss some approaches to deal with them.

The available literature on LIS recommends strategies based on the assumption of isolated systems which fail to address the full scope of the problem involving multiple LIS. These LIS cannot be replaced not from scratch but need to be built upon existing systems (Hanseth, 2002). This paper draws upon the theoretical perspectives of information infrastructure (II) and LIS to analyze the potential challenges arising from LIS whilst introducing change. Specifically, the aim of the paper is to document how LIS represent an obstacle to introduce change, and to describe strategies to cope with the technical and socio-political issues of LIS. The empirical basis for this analysis comes from an ongoing action research study to introduce computer based health information systems (HIS) within the Primary Health Care (PHC) sector in Mozambique.

The paper is organized as follows. Two perspectives that help to understand the complexities of changing or replacing existing LIS are described in the following theoretical perspective section. Section three describes the methodology used in this paper. The case study follows in section 4, and it focuses on the challenges contributed to by the existing LIS. Section 5 includes the discussion which focuses on strategies to deal with LIS. The paper ends with a conclusion section.

2. THEORETICAL PERSPECTIVE

The perspectives of LIS and II are first described, followed by their integration to provide the theoretical basis for this paper.

2.1. The legacy systems perspective

When an organization attempts to change its information system (IS), it encounters problems related to the existence of a massive, complex and inflexible base of software, often referred to as LIS (Bisbal, 1999), which is historically embedded and thus cannot be abandoned overnight.

Somerville describes LIS as socio-technical computer-based systems that include software, hardware, data, and business processes (Somerville, 2001). LIS are typically too slow, unreliable, and inflexible for handling new, more diverse and demanding tasks (Scott, 2001; Kelly et al., 1999; O'Callaghan, 1999). The functions of LIS are difficult to understand making their replacement an extremely challenging task. Replacing a LIS is a risky business strategy for at least three reasons (Somerville, 2001). One, there is rarely a complete specification of the LIS, as the original documentation may have been lost. Therefore, there is no straightforward way of specifying a new system, which is functionally identical to the system that is in use. Two, business processes and the ways in which LIS operate have been designed to take advantage of the software services and to avoid its weaknesses. If the system is replaced, these processes will also have to change, with potentially unpredictable costs and consequences. Three, important business rules may be embedded in the software and may not be documented elsewhere. Replacing the LIS may lead to a loss of business rules, thus contributing to managers' fear of change.

The need to deal with LIS in an effective way is critical as a business relies on the services provided by the LIS and any failure of it would seriously influence the day-to-day running of the organization. The LIS, over time, differs from the original, due to external and internal factors, such as changing laws, management changes, structural reorganization, and redefinition of information needs. These changes generate new or modified software requirements, so the LIS is inevitably expected to also change. The degree of change is however context specific, and difficult to implement in practice.

Bisbal (1999) suggests three approaches to change or replace LIS: Wrapping, Migration and Redevelopment. Wrapping is to take an existing LIS into a new and more accessible software component. This is done by surrounding existing data, application systems and interfaces with new interfaces, thus giving old components a new and improved look. Migration is about retaining the original LIS data and functionality and moving the LIS to a more flexible environment (new platform) causing minimum disruption to the existing system. Redevelopment is about developing the LIS from scratch, using a new hardware platform, architecture, tools and databases. Usually, in the process of replacing a LIS the above three approaches are combined in varying degrees.

Somerville (2001) suggests that the strategy to evolve a LIS should be based on the results of the system quality and business value assessment. Low quality and low business value LIS should be scrapped. Low-quality and high-business value LIS make an important business contribution but are expensive to maintain, and so should be re-engineered or replaced if a suitable system is available. High-quality and low-business value LIS should be replaced scrapped completely or maintained while high-quality and high business value must be kept in operation using normal system maintenance.

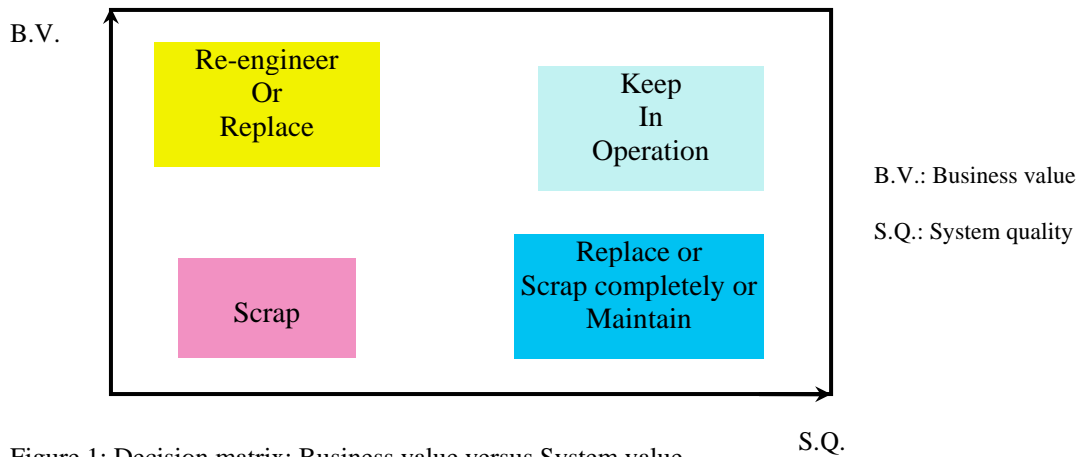


Figure 1: Decision matrix: Business value versus System value

2.2. The information infrastructure perspective

Contemporary thinking in IS research seeks to analyse design and change not as IS but as Information Infrastructures (II) (Hanseth et al., 1996). Traditional IS design strategy, assumes that systems can be developed from scratch, as isolated and stand-alone applications with defined goals, start and ending times: as events rather than as ongoing processes (Orlikowski 1996). Such a perspective is limited in the present context where technological solutions seek to integrate multiple systems across organizational and geographical borders, for example Enterprise Resource Planning systems (Hanseth, 2002). An II perspective which seeks to look at systems as inter-connected socio-technical networks is more appropriate to understand the challenges of introducing change when there are multiple LIS already in place, requiring integration.

Key characteristics of II as outlined by Hanseth (2002) are:

- ✓ They evolve over a long time where the existing infrastructure - the installed base - strongly influences how the II can be changed or designed;
- ✓ II is part of large heterogeneous socio-technical network, encompassing humans, technological artefacts and institutions;
- ✓ II supports information sharing among a large community of different users and needs;
- ✓ II are not defined from scratch, but rather evolve incrementally over time.

Hanseth (2002) outlines some key concepts that help to understand II: increasing returns and positive feedback, network externalities, path dependency, and lock-in and cultivation. However, for this paper, only concepts to lock-in and cultivation concepts are drawn upon. The concept of lock in emphasizes that as the community using the same technology or standard grows, switching to a new platform becomes increasingly complex since past selections influence future development (Hanseth, 2002), A classical example of a lock in is provided by the evolution of the QWERTY keyboard layout which is based upon the design of the manual typewriters of more than a century before. The size of the installed base today makes the coordination effort required to switch to a new layout huge (David, 1985).

The concept of cultivation emphasizes that new IIs cannot be designed using top down kinds of methodologies like waterfall, but need to be nurtured gradually, bottom up and incrementally. A classical example of such an approach is seen in the evolution of the Internet (Abbate, 1999). The basic approach consists of changing a small part of the infrastructure and make sure the newly added parts work in consonance with the existing network. Cultivating an II implies building a new one such that the new features also obtain their value from the size of their installed base.

The II and LIS perspectives outlined briefly here taken together provide the theoretical basis for this paper. The II perspective emphasizes the need to respect history of existing systems and their interconnections in the design and implementation of change. The LIS perspective elaborates on the characteristics of these existing systems and thus provides insights into how they should be considered in designing new IIs. These theoretical ideas are drawn upon to analyze an ongoing effort to introduce change in the HIS in Mozambique, a context characterized by multiple LIS.

3. RESEARCH METHODOLOGY

The research is situated in the context of the Health Information Systems Programme (HISP) being currently implemented in Mozambique since 1999. HISP is an ongoing, large-scale action research initiative that operates as a global network within the health care sector across a number of developing countries (Braa et al., 2003). HISP includes the design and development of a not for profit open source software, called DHIS¹, designed for use at the district levels of the PHC care sector as a health data analysis tool (Braa and Hedberg 2002). HISP involves an evolutionary and bottom-up approach to system development, whilst building rapport and human resources capacity at all levels of the organization using participatory prototyping methodologies (Braa and Hedberg 2002). Such an approach is in line with current efforts by the health authorities to decentralize primary health care delivery through flexible systems and build up of capacity at the local level to use these systems effectively.

HISP is currently ongoing in three provinces of Mozambique including Gaza and Inhambane in the south and Niassa in the north. A key challenge in this effort has been to address the multiple existing LIS – at both the technical and political fronts – whilst introducing the DHIS. The HISP team consists of medical doctors and computer scientists, including the author of this paper who is a computer scientist involved with the research problem of systems design and development. Data collection has been carried out in various ways such as interviews with health workers and users of HIS at national, provincial and district levels, participant observation, group discussions, training seminars, and the use of the participatory prototyping approach where feedback from users are obtained. A key aspect of this research has been the socio-technical analysis of the existing LIS in the health sector.

The LIS were assessed through acquiring available documents about the existing HIS, data collection tools and procedures, whilst discussing issues with health staff about the business processes supported and the system quality. A variety of materials, including available CD's, floppy disks, and available reports and documentation were gathered to access the technical content of the LISs in use.

4. CASE STUDY

A long term assessment of the NHIS here called SIS² was done to obtain an overview of the system including its role, linkages with other existing systems, information flows, and functionality. The Ministry of Health (MOH) consists of multiple, parallel and fragmented systems (Sitóí and Bruno, 1999) representing the needs of different health programs and departments. This multiplicity is reflected in different technological solutions representing a complex and disparate installed base including applications built on MS-DOS and MS-Windows operating systems, using DBASE, Visual Basic, Access, Excel, and Lotus. Below, a summary is provided on the technical details of the different LISs developed and in use at the MoH.

Name of System	Platform	Kind of Application	Purpose of the system
SISProg	MS-DOS	Data base	Management of health data at National and Province levels
SIMP	MS-Windows	Spreadsheet	Integration of the various systems at the MoH

¹ District Health Information Software.

² Sistema de informação para saúde in Portuguese for health information system.

BES		Data base	Weekly Disease surveillance
Pharmacy	MS-Windows	Data base	Management of drugs related data
SIP	MS-Windows	Data base	Human resources management at National and Province levels
SIM_ Org	MS-Windows	Data base	Management of maintenance related data
SIGETS	MS-Windows	Data base	Management of logistics and stocks related data
SISTAFE	MS-Windows	Data base	Management of finances related data
HIV/SIDA	MS-Windows	Data base	Management of HIV related data
DO3, DO4	MS-Windows	Spreadsheet	Management of infrastructure related data at Province level
Tuberculoses	MS-Windows	Spreadsheet	Management of TB related data
CDS/ISIS	MS-Windows	Data base	Documentation management
“GIS data_USAID”	MS-Windows	Data base	GIS data on infrastructure

The technical features of the various LIS need to be understood within the historical and socio-political context of their evolution. Like many other developing countries, Mozambique too is engaged in a process of public sector reform through decentralization and introduction of computer based systems. The implementation of health public reforms has been problematic due to reasons of inadequate resources, excessive dependency on international aid. Since nearly 80% of the health budget comes through international aid (Beattie and Kraushaar, 2000), different agencies sponsor their own programme specific systems leading to the nurturing of parallel IS. The simultaneous presence of several international consultancy companies, funding agencies, and the absence of clear MoH policy on their roles creates the risk of duplication of initiatives and resources use. For example in 1998 the MoH approved and signed a contractual agreement with a consultancy company for developing and defining the informatics policy for the MoH (Sitóí and Bruno, 1999). The consultancy company started its work in September 2000 without coordination with other ongoing HIS initiatives like the HISP.

As a result of these multiplicity of interests and the different technological solutions that are developed, the HIS in totality lacks uniformity, compatibility, and is incapable of communicating and sharing information between programs. These issues are explored in greater depth through the example of the SISProg. SisProg³, which represents the National HIS (NHIS), is expected to play the role of integrating the various systems. SisProg was the first computer system of the MoH developed and deployed at the national and provincial health directorates in 1992-1994 (MISAU, 1994; Lungo, 2003). The system was developed on “dBaseIII” relational database management system on Microsoft DOS. This system did not support a mouse, and while it can run in a MSDOS window in Win95, but not on Win98, using 80386 and 80486 hardware (Skobba, 2003).

The problems of the system are contributed to by the design of the manual system in which data is compiled. Figure 2 depicts two paper forms (A04) where the data elements in the columns 2, 3, 4 and 5 on the old form were combined into one column (VAT 2a a 5a Dose) in the new form. Here the

³ SisProg - Sistema de Informação Para a Saúde, in Portuguese for health information system.

health worker is supposed to fill the value for the first (1a) dose in the column 1 and the sum of 2, 3, 4 and 5 doses in the column named VAT 2-5. The next step is to enter these two numbers in SisProg software, which becomes problematic because there is no data element named (VAT 2a a 5a Dose). As a result, there is non-uniformity and ambiguity in the business rules, making comparisons and integration across facilities and time difficult if not impossible.

Problems in the use of the SISProg were also contributed to by the limited computer skills of the health workers. As a result, they did not have the capacity to deal with the already inflexible design of SISProg. The absence of the source code and relevant documentation also created problems in adequately maintaining the existing system. The SISProg example presented here was typical of the other LIS comprising the NHIS.

GRUPO ALVO	V.A.T.					(5)	(6)	(7)
	1ª	2ª	3ª	4ª	5ª			
MULHERES GRÁVIDAS								
MULHERES DE 15 a 49 ANOS								
CRIANÇAS DA ESCOLA								
TRABALHADORES								

GRUPO ALVO	VACINA ANTITETÂNICA		TOTAL APLICADAS	TOTAL DESPERDIÇADAS
	PRIMEIRA DOSE	De 2.ª a 5.ª Dose		
MULHERES GRÁVIDAS				
MULHERES DE 15 a 49 ANOS				
VAT	1.ª DOSE	2.ª DOSE		
CRIANÇAS DA ESCOLA				
TRABALHADORES				

Figure 2: Old and new paper forms for data collection

The consequences of the technical limitations of SISProg are summarized below.

1. Lack of portability across different computers

Despite the purchase of new PCs, the MOH could not port SISProg to this new hardware because they did not have the installation files for SisProg. (See Figure 2 which shows photos of a health office equipped with two computers, one for the old database (the old one), and the new one for secretarial purposes.

2. Long start up time

It takes long time to accomplish tasks that could have been performed in short time with powerful computers. For example, it takes up to 8 minutes for the computer to start.

3. Problems of printing and transfer of files

If users want to include health data in their reports in word processors, they have to print the data, and then re-type them on their reports because the computers are not able to copy-paste large amount of data. In addition, if they want to transfer the data to another computer they have to use diskettes regardless the size of the files.

4. Incompatibility across programs

To generate a customised graph of the health data, users used to print the data and retype them in spreadsheet software like Microsoft Excel since the SisProg generated graphs cannot be copied to word processor programs because is generated in MS DOS program



Figure 3: Despite the existence of new powerful computers, the LIS are running on the old computers.

5. DISCUSSION: Strategies for dealing with LIS

In attempting to break the burden imposed by LIS, the HISP strategy was to open the “black box”, and make visible the data to planners that for years had been invisible. This opening helped to show the inconsistencies and errors in the existing data, and helped to create a legitimate argument for the replacement of SISProg with DHIS.

Opening the black box was enabled by prototyping the DHIS at the province and district levels so as to populate the DHIS with SisProg health data. This data was then analyzed using the DHIS tools so as to evaluate the capacity of the DHIS as a health data analysis tool. This analysis also served the additional purpose of providing “live data” in various DHIS training workshops and onsite training of health workers. These interactions helped to analyse the quality of the health data, and make visible data to planners that was “invisible” till date. Three options were available to make the data visible: key in data from the filled paper forms; develop an extraction transformation and loading (ETL) software in order to automatically extract data from SisProg and export to DHIS; to purchase a ready-to-use ETL tool. The second option was selected as it was more suitable for customization for local needs in an efficient manner. The ETL allowed populating the DHIS with health data from January 1999 to March 2002, quickly generating required reports, and presenting these to policy makers in the MOH. This process helped to demonstrate the flexibility of the DHIS as compared to the SISProg.

The LIS perspective informs that the chosen strategy for introducing change should depend on system quality and its business value. This perspective suggests the assessment of the viewpoints of the different stakeholders on these two dimensions. SISProg is business critical, as data supposed to be provided by it is required on a monthly basis by the stakeholders. However, despite being business critical, in practical terms its business value is very low as the data from it is recognized by most as being not trustworthy. The quality of this system is poor, and maintaining or upgrading it is not a viable option given the absence of source code, documentation and the fact that it is locked into very old versions of operating systems. While the MoH’s needs, priorities and requirements have significantly changed over time, SisProg has remained locked-into the platforms from 1992-94. The data elements to be collected have changed several times since 1992, but these changes were not reflected in the SisProg software as it was technically not possible to do so. The inflexible design of SISProg has made it very complex to evolve with the fast changing needs and priorities of the MOH. In its current state, SISProg represents a massive, long term investment making it difficult if not impossible to extend or change (Bisbal, 1999).

This analysis suggests SisProg to belong to the low-quality and low-business value category and thus should be scrapped. In recognition of this, the MoH has introduced a new system called SIMP in 2001 in their attempt to integrate the various systems as to captures a wider range of information (MISAU, 2003). SIMP was developed as a temporary technological solution, and is capable of presenting most of critical indicators for the different health services of the MoH. The idea behind SIMP is to bring information from different sources together in one database, addressing the existing problems of lack of integration and flexibility.

Sommerville (2001) argues that ineffective legacy systems such as SISProg should be re-engineered or replaced if a suitable system is available. A recent assessment of the the NHIS by the MoH has described DHIS as a suitable system to replace SisProg as it can fulfil the existing functions of the LIS and is flexible for changes and evolution (bMISAU, 2003). Changing over to DHIS from SISProg represents the strategy of migration since DHIS replicates the business rules, functionality and data elements of SisProg, whilst providing greater flexibility and analysis tools. This strategy helps to avoid disturbance to the MoH through shutting down as may happen in redevelopment. This strategy also helps to use available capacity, requiring lesser training efforts.

Concerning LIS, the general assumption and starting point of the suggested from the literature strategies is that skilled manpower, financial resources, political will and setting and the LIS’s source code, system’s specification and documentation are available and are aligned. This is not the case for Mozambique due to existence of a multiplicity of challenges hindering the implementation of changes or replacement of LIS: (1) direct influence of the funding institutions and the expert knowledge, advice or consultancy that accompanied the aid, (2) existence of a number of parallel systems and (3)

competing initiatives. Additionally, in Mozambique there was no clarity about the planned and expected functionality of the LIS and the administrative system is centralized. Indeed the LIS were designed and developed under top down approaches, thus addressing the central needs and priorities. For example the DHIS was not used by the health authorities, because a formal sanction was not given by the central stakeholders, regardless the recognition of its usefulness.

The work environment of the LIS should be taken into account (Kelly, 1999) when introducing changes as is locked to organizational and individual complexities, which forms the installed base (Braa, 1998) that heavily shape the change. Therefore a cultivation strategy as suggested by the II thinking seems more appropriate to apply in such chaotic setting where the needs are frequently changing and having control of all factors involved is not possible. The cultivation process that the HISP project has pursued in Mozambique included: (1) Developing ETL software which enabled extracting legacy data to an open source software, the DHIS, which is networked and compatible with the old one, and is superior to, representing a more flexible system with additional features and advantages, (2) Setting up an academic program and involving students or researchers interested in topics related to legacy issues like working with both proprietary and open source software, to overcome the challenges related to skills and the technical expertise required and lacking in developing countries and (3) Setting up a collaborative research project and enrolling decision makers from the MoH along with a multidisciplinary team of students, academicians and senior Professors in information systems.

6. CONCLUSION

In this study, the primary concern was about the processes involved in dealing with LIS in the context of developing countries. Specifically, the aim of the paper was to study and analyse the challenges of attempting to change or replace existing LIS within the public health sector in Mozambique. Different standard strategies for replacing LIS were discussed, and appropriate strategies for the health context in Mozambique were analyzed. A key contribution of this study is the emphasis that system design and development should be based on installed base's needs, rather than user's specifications only. The focus is on cultivating the change within a heterogeneous socio-technical network, encompassing humans, technological components and institutions.

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8.3. APPENDIX C

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STRATEGIES FOR DEVELOPMENT AND INTEGRATION OF HEALTH INFORMATION SYSTEMS: COPING WITH HISTORICITY AND HETEROGENEITY

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Strategies for development and integration of health information systems: coping with historicity and heterogeneity

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Abstract:

Health is crucial for development, and well-working health information systems are required for sound decision making and effective use of resources. However, establishing working information systems in developing countries is truly a challenge. Moreover, strategies for the development and integration of large and growing collections of information systems escape simplistic recipes. This is a pressing practical problem globally, as well as analytically under-researched within the IS field. We aim to contribute to the understanding and development of such strategies by underscoring two core dilemmas: (i) the conservative influence of historically accumulated and institutionalized practices, technologies and perceptions (dubbed the ‘historicity’ of information systems) and (ii) the lacking integration and increasing fragmentation across the collection of information systems (dubbed the ‘heterogeneity’ of information systems). The empirical underpinning for our analysis is an action research project, the Health Information Systems Program (HISP), which aims at improving existing sub-optimal health information systems in developing countries. HISP provides a particularly poignant illustration of the challenges related to historicity and heterogeneity of information systems as these are implied in the politico-historical context. Our empirical material is a cross-national comparative analysis of the current reporting systems for administrative health data in Mozambique, Tanzania and in the state of Andhra Pradesh in India. Several problems are associated with the existing systems and the need to change or replace them is recognized. For example, due to the donor- and aid-dependent economies of most developing countries, there are often other specialized health care programs e.g. targeted towards specific diseases like malaria, tuberculosis and HIV/AIDS. These programs usually have their own reporting systems, and the result emerging over time is a disintegrated and heterogeneous collection of systems. The challenges associated with attempting to change such large-scale, heterogeneous and fragmented systems involve complex dilemmas. As the current information systems are embedded and institutionalized nationwide, a realistic strategy need to take a phased approach whereby present systems are gradually integrated into the environment. In the case of donor-supported and -managed program, the national health authorities may not even have the required power to intervene. Thus the existing reality cannot be ignored or done away with, whether it be the information systems, the institutions or the work practices; they constitute the point of departure. Analytically, we draw on recent socio-technical conceptualizations of large, integrated systems - so-called information infrastructures - especially through recent elaborations in the theoretical foundation in actor-network theory (ANT). The development strategy we suggest emphasizes an evolutionary, ‘cultivating’ approach while at the same time accepting that there will be a certain level of non-integration (often perceived of as ‘mess’) as chronic.

Keywords: strategies for development of information systems, legacy systems, cultivation, fragmentation, actor-network theory, action research.

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1. Introduction

Research reports from implementation processes of information systems in developing countries are hardly uplifting reading. When “implementation” is recognized to extend well beyond the merely technical realization of an information system, there is a substantial body of literature describing the economical, social, political and technical problems that tend to undermine these efforts (See Walsham 2001; Avgerou 2002; Heeks 2002). Key reasons include the scarcity of resources and poor infrastructures (Mosse and Sahay 2003), embedded political controversies (Adam and Myers 2003; Puri 2003) and inability to sustain the use and spread of the information system over time (Braa, Monteiro and Sahay 2004).

These general concerns for information systems in developing countries are intensified when it comes to the specific domain of health care. Providing improved access to the health care sector is a highly prioritized aim of any (developing) country. There is also growing acceptance for the potential role of information systems in achieving this. Furthermore, as a consequence of recent critiques of traditional models of development (Sen 2000), improved health care is viewed not only as an *indicator* of development; it is a *driver* of development with rich spill-over effect. In the words of the 1993 World Development Report: “Because good health increases the economic productivity of individuals and the economic growth rate of countries, investing in health is one means of accelerating development. More important, good health is a goal in itself” (World Bank 1993). Strengthening health care provision through improving the information systems in developing countries is accordingly intrinsically linked with promoting development in general. Yet, the very notion of ‘development’ gets problematized as a direct result of the critiques of post-colonial reasoning. This critique directs attention to the centeredness (read Western bias) of narratives, language and rhetoric – including ‘development’ – by “a critical reflection on knowledge production from both the interior borders (imperial conflicts, hegemonic languages, directionality of translations, etc.) and its exterior borders (imperial conflicts with cultures being colonized, as well as the subsequent stages of independence or decolonization)” (Mignolo 2000:11, see also Spivak 1999).

The aim of this paper is to crystallize out strategies for (lacking a better phrase) the development and integration of information systems in developing countries through a cross-national comparative analysis of an ongoing effort within health care in three developing countries. The health care sector provide a poignant instantiation of what we argue are two core challenges around which generalized strategies need to be constructed. Firstly, there is a *historicity* stemming from the manner sediments of earlier solutions, entrenched routines, prevailing perceptions and social institutions constitute and solidify existing practices. For example, in their study of GIS, Walsham and Sahay (1999) illustrates how the colonial heritage of the British rule is reproduced in present practices of Indian central bureaucracy. Legacy systems are another example of installed base, and in developing countries they are typically old, poorly maintained, commanding scarce resources, and the vendors or developers, often expatriate aid workers, are long gone. The historical-political ‘installed base’, subsuming legacy information systems, need to be addressed drawing on evolutionary, small-step, cultivation strategies.

Secondly, there is an intrinsic *heterogeneity* in both technical and institutional terms. In most developing countries several donor agencies are present. For instance, Mozambique has been an attractive target for aid, and the health care sector is dominated by a large collection of donor agencies (with external aid constituting an estimated 75% of the overall health budget) in addition to semi-autonomous governmental and international agencies. These agencies typically focus on specific, more or less confined areas through targeted, so-called ‘vertical’ health programs each with their own associated information system. This gives rise to fragmentation on a technical level, evident in the plethora of non-integrated information systems. The resulting political economy entail that no one agency, including the national health authorities, is in ‘control’ in any strict sense. This indicates that development strategies for information systems need to incorporate elements of improvisation (Orlikowski 1996; Ciborra 1997), in addition to, we argue, recognizing that a certain level of non-integration is inherent (Law and Singleton 2005).

In sum, then, we seek to extract generalizable strategies applicable to the development and integration of information systems that embed the historicity and heterogeneity of

this context. Empirically, we draw on an ongoing research project established in 1994, called Health Information System Program (HISP, see www.hisp.org). HISP is, in varying configurations and stages of implementation, currently present in 9 developing countries. We compare and contrast three of the participating countries (Mozambique, Tanzania and India) to make explicit the contingent or situated nature of the strategies we propose.

The next section of the paper elaborates our conceptual framework. Through an account of our experiences with information systems in developing countries, we briefly review the manner in which issues of legacy systems and non-integration have traditionally been conceptualized and approached as a predominantly technical challenge. Moreover, we illustrate how dominant approaches to the issue of integration of information systems aim for complete or total integration, doing away with all fragmentation. We also explain how elements of recent socio-technical conceptualizations of large, integrated systems – called information infrastructures – provide a fruitful, alternative perspective. Section 3 outlines our research approach. The case narratives from the three countries are presented in section 4. The analysis in section 5 is constructed around the two themes of historicity and heterogeneity of information systems. The concluding remarks in section 6 crystallize our suggested strategy and offer some reflections on its generalizability.

2. Conceptualizing historicity and heterogeneity in IS

2.1 IS implementation process in developing countries

Implementation of information systems in developing countries is usually characterized as problematic, and failure stories abound (Heeks 2002). Many bottlenecks in the development, implementation and use of effective IS have been identified, ranging from physical conditions, e.g. unreliable power supplies or telephone lines that affect the operation of technology, to the lack of economic resources and techno-scientific capabilities to support ongoing usage and maintenance of the technology, through to issues of technology management and utilization (Avgerou 2000). A substantial literature base describes economical, social, political and technical problems that undermine efforts of the implementation and use of ICTs (Walsham 2001; Avgerou 2002). In the domain of

health care these general concerns are intensified. Providing improved access to the health care sector is a highly prioritized aim of any (developing) country.

A well-working health care information system is a necessary part of any nation's effort to maintain and improve the health of its citizen's, and inadequate information support is viewed as the major obstacle for to efficient management of the health sector (Lippeveld et al. 2000: p.1). Further, health systems are often poorly designed, in a top-down manner and without participation of the health workers. Developing countries, particularly in Sub Saharan Africa are reported to have high rates of pandemic diseases such as HIV/AIDS, malaria, and tuberculosis that have significantly raised costs on human and social capital as well as significant drain on already constrained resources. These obstacles severely jeopardize the health and utilization of health care for their populations especially the disadvantaged group; the poor, women and children. Consequently, developing countries, have been continuously challenged to improve their health delivery system to upgrade the health status of their people through the use of IT to plan, monitor and evaluate health services (Braa and Hedberg, 2002) as well as communicate more effectively within and across organizational hierarchies so as to promptly deal with such epidemics

Unfortunately, the health information systems that operate in most developing countries demand massive data collection and reporting, but there is with none or very limited use of the information. The systems are designed according to the data-led approach where massive data is collected but with limited use, rather than the action-led approach where the focus is on information that supports management decisions and emphasis on data collectors as the main information users (WHO, 1994; Lippeveld et al., 1997). The data handling is carried out to reflect the need of the higher level bureaucracy rather than information needs for local actions (Sandiford et al. 1992). A further problem is that health information systems do not become part of organizational routines because of lack of ownership and insufficient support and capability of health workers. This often happens as a result of its inappropriate design approach that excludes key actors in the process (Korpela et al. 1998). The inappropriate design approach results in inflexible

information systems incapable of evolving along with dynamic institutional and technological changes (Bisbal et al. 1999).

The highly appraised – but ultimately overly idealized – ambitions of “health for all” (WHO 1978) turned out to be difficult to achieve, and alongside growing impatience and frustration with this, a number of more targeted programs have been put in place. These programs have concise and well-defined aims and are dubbed ‘vertical’ rather than the more generic ‘horizontal’ programs. Typical examples of these are the tuberculosis, vaccination, malaria, or HIV/AIDS programs. The reason why we emphasize these types of programs is that they embody technical solutions, established work routines and social institutions that are often poorly aligned with the national systems for reporting of (routine) health information. These programs often have an independent decision-making structure and an internal system for information reporting and resource distribution. The result is several parallel and overlapping information flows, a lack of integrated analysis, and a high burden of registration on health workers in the primary health care facilities. Some form of integration of these stand-alone programs is thus often in the topic of the health sector reforms, implying also an integration of the various information systems associated with them (Alvares 2004, Chilundo 2004).

However, improvement of existing systems and integration of the various parallel systems often presents challenges of a generic character. For example, a frequently mentioned obstacle for health information systems reform is related to legacy information systems, as the existing computerized systems are often typically old, non-changeable for various reasons, and do not support data sharing between different systems. Together with the fragmentation problem related to the existence of various data collection routines, tools, reporting systems and programs inside the same national health system this presents complex issues that warrant further examination through the IS literature.

2.2 Legacy systems and fragmented information systems

2.2.1 Strategies to cope with legacy information systems

The problems of non-evolving and technically outdated information systems have been recognized by the IS community for some time (Sommerville 2001). Old systems may be expensive to maintain, as they use obsolete hardware and non-supported representation formats, e.g. programming languages that few people know making hiring of skilled staff a challenge. Fault tracking may be tedious if documentation is missing or when system understanding is limited. For the same reasons the old information systems may also be difficult to extend or change in other ways. The systems are seldom interoperable with other systems due to lack of clean interfaces. However, legacy systems become a problem because they can not just be scrapped and forgotten. They may be deeply embedded in the organizations they support and be of critical business value. They may for example contain important business rules that are crucial to the organizations' processes, and are thus a major part of the company's knowledge base. The legacy systems' inertia or resistance to change is not only costly, but may also hinder organizational development. Legacy systems have shown a surprisingly high degree of survival. The year 2000-problem made legacy systems capture the attention of IS managers to a larger degree than before, and today e-commerce and back-end integration makes it a current issue. Much of the research literature in this area has a focus on developing methodologies and associated tools for migration, system analysis or reengineering. In general the strategies for handling legacy systems fall into three categories with varying degrees of radicalism (Bisbal 1999):

- *Wrapping* the old software components into new more accessible components. This means to create new interfaces to programs, applications and interfaces. This is seen as a partial and short-time solution, which may even make maintenance even more complicated. The technique of 'screen scraping' is one well known variety of wrapping, and providing web interfaces to access legacy data would be another.
- *Migrating* the system, i.e. moving it to a more flexible environment, e.g. to an object-oriented or component-based platform. The data and the functionality should be retained. Migration is thus a middle ground approach, aimed at causing as little as

possible disruption to the existing operational and business environment. There are several actual transition strategies: a) cut-and-run b) phased interoperability c) parallel operations.

- *Redevelopment* (and reengineering) means to rewrite the system from scratch, to make a new system. This often involves substantial amount of analysis of the old system to make sure it is correctly understood.

These three approaches share a heavy technical bias, in the sense that they fail to address organizational or social issues around legacy systems.

2.2.2 **Strategies to cope with fragmentation**

Organizational and technological changes may lead to a slowly accumulating portfolio of various disparate information systems within an organization. Integrating the subsidiaries of large multinational companies or mergers of companies with different information systems makes the issue highly relevant for the business oriented part of the IS community. In the context of aid receiving countries, a significant source of heterogeneity is the donor-driven semi-autonomous activities described earlier that may exist partly or wholly beside national structures. The ensuing fragmentation and sub-optimal use of scarce resources are taken to justify the need for tighter integration. With better integrated systems one would avoid redundant operations cut back on administrative overhead. The vision of tighter, or indeed, ‘seamless’ integration of the many health information systems, is pronounced also in efforts in Western health care. As argued in Grimson, Grimson and Hasselbring (2000:49):

“[S]hared care depends critically on the ability to share information easily between care providers. Indeed it is the present inability to share information across systems and between care organizations automatically, that represents one of the major impediments to progress toward shared care and cost containment”.

The quest for integration, however, has been prolonged, or as Kumar and van Hillegersberg (2000:23) phrase it “integration has been the Holy Grail of MIS since the early days of computers in organizations”.

The approaches and technologies for integration vary widely and there is not one generally shared scheme of classification or relative ordering. For the purpose of this paper we will discuss the various solutions along a continuum from conservative to radical approaches, relating to the degree of intervention (see figure 1). In one end of the continuum, accepting ‘loose integration’, is the conservative approaches that aim at ‘living with’ fragmentation. One example of this would be to provide web-enabled (browser) access to various underlying data sources through a portal solution. In the other end of the continuum, pursuing ‘tight integration’, fragmentation is attempted eliminated, e.g. through replacing the various disparate systems with one comprehensive, fully integrated system. Implementing an Enterprise Resource Planning (ERP) system would be a typical example of one system that is expected to cover all functionality previously contained in multiple systems. In between are a variety of other forms of integration where standardization at a certain level is the basis for interoperability.

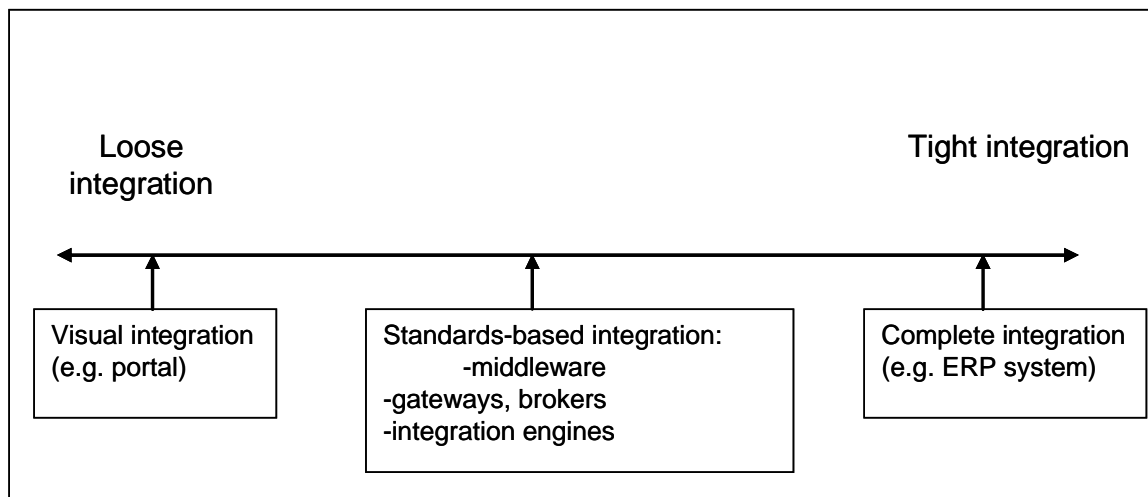


Figure 1 Conceptualizing a continuum of approaches to the integration of information systems

While the tight forms of integration requires the aligning of data formats, functionality, and business logics, looser forms of integration may specify standards that allow a certain heterogeneity ‘behind the stage’. This corresponds to imposing standardization on

different levels. Standards-based integration may again be envisioned along a continuum between ‘tight’ and ‘loose’ approaches, as the kind of standard may vary widely. Integration may be based on shared standards for structural elements, such as standards defining the underlying information models. Less ‘tight’ standards may be interoperability standards, e.g. defining an XML-based syntax that allows exchange of data structures between various systems. Middleware integration aims at the syntactic level and comprises e.g. CORBA (Common Object Request Broker Architecture), database gateways and transaction monitors. Gateways and brokers (which again may be generally standardized or based on ad hoc, proprietary interfacing) allow the continuous existence of multiple systems, each with their internal organization and logic. For example, most solutions for Enterprise Application Integration offer generic adapters for specific (ERP) systems.

Our critique of the legacy systems literature applies also here. With a few exceptions (cf. Webster 1995; Chilundo and Aanestad 2005), the challenges have predominantly been conceptualized as being purely technical in nature. As integration of information systems seems to be primarily a practitioners’ issue rather than an academic core topic in the IS field, there is but scattered critical and analytical literature on the organizational and political challenges associated with integration, e.g. when an organization integrates its systems with the subcontractors’ information systems, there is an element of exertion of power camouflaged in technology (Webster 1995). Hence, we argue that a critical and theoretical literature on integration needs to acknowledge the socio-technical nature of the phenomenon, i.e. how integration meshes also with organizational and political issues (Monteiro 2003). Furthermore, there is almost no problematization about the vision, viz. the goal of complete and ‘seamless’ integration. It is implicitly or explicitly assumed that full integration and true interoperability is desirable (Hasselbring 2000). This is highly problematic as growing empirical evidence as well as analytical insights questions the attainability of this.

To this end, we outline a body of research studying large-scale socio-technical ensembles as information infrastructure. Drawing on insights from actor-network theory (ANT), this

body of work underscores how integration also is a socio-technical process of negotiation, *and* a process that does not always succeed.

2.3 Lessons from an Information infrastructures perspective

In contrast to the relatively delineated, predictable, and manageable information system, an information infrastructure is open and evolving. An information infrastructure serves multiple users and use areas and is a shared resource for a community. In most definitions of information infrastructures the historical and pre-existing, the ‘installed base’, is allocated a crucial role. However, within this theoretical framework the installed base is understood as not just technical, like in most of the legacy systems literature. Work routines, organizational structures and social institutions are very significant elements of the installed base and may resist change attempts (Hanseth and Monteiro, 1997). Rather than pure technical artifacts, information infrastructures are complex heterogeneous actor-networks (Star and Ruhleder, 1996; Monteiro and Hanseth, 1995).

2.3.1 Evolution of information infrastructures

We use the information infrastructure metaphor in order to emphasize the challenges that information infrastructures pose to change attempts and the long timeframe for any development (what normally gets lumped together as ‘maintenance’). In formulating a theory of information infrastructures, the Internet has been used as a paradigmatic case (Abbate 1995; Hanseth, Monteiro and Hatling 1996), as well as studies of other infrastructural systems like the electric power grid (Hughes 1987; David and Bunn 1988). In accordance with the infrastructure metaphor we may see information infrastructures as ‘sunk’ and deeply embedded into our societies and communities. The sheer size and degree of embeddedness are one important reason that information infrastructures evolve gradually. Changes have to be linked to the previously installed base, either as extensions, revisions or replacements. To some degree, these large networks evolve beyond a single actor’s control, and are so complex that traditional approaches to managerial control and governance seem to have significant limitations (Hanseth et al. 2001; Ciborra et al. 2000).

2.3.2 Multiplicities and complexities of information infrastructures

In recent elaborations of actor-network theory (ANT), which is the analytical underpinning of the theory of information infrastructures, there is a highly relevant shift in attention. Law and Singleton (2005) outline a very useful chronology of ANT into three phases. The first phase of ANT studies described how networks of control were established; how scientific and technological stabilization and closure emerged (cf. Latour 1988). It is worth noting that the applications of ANT in IS are almost entirely based on this version of ANT. What Law and Singleton dub the second phase of ANT is characterized by a preoccupation with slowly evolving, gradually transforming networks (Law and Singleton 1995). An iconic representative is Laet and Mol's (2000) account of the Zimbabwe Bush Pump. Here they map out the continuous, evolving transformation of the pump as it get amended, extended and modified as it makes its journey across the southern parts of Africa. Its ability to embrace multiple identities, configurations, and shapes, or its 'fluidity' was crucial to its success, as it allowed its functioning in different environments. In contrast, the third and most recent phase of ANT highlights the essential multiplicity of networks and their dis-continuous changes. This multiplicity entails a recognition that objects do not merely vary according to perspective but "objects become ontologically complex, multiple and (in some cases) mutually exclusive" (Law and Singleton 2005:342). This perspective on networks, and by implication information infrastructures, focuses on how ordering efforts involved in the integration and standardization of information systems *relocate* disorder; order for one in one place is simultaneously disorder for another in another place. As Berg and Timmermans (2000: 6-37) point out:

"[T]hese orders do not emerge out of (and thereby replace) a pre-existing disorder. Rather, with the production of an order, a corresponding disorder comes into being...The order and its disorder, we argue, are engaged in a spiraling relationship – they need and embody each other"

Latour in a similar manner underline how ambitions and intentions are never realized:

“There is a drift, a slippage, a displacement, which, depending on the case, may be tiny or infinitely large” (Latour, 1999: 88)

Furthermore, due to the multiplicity and complexity of the underlying networks, the very ordering efforts in themselves may *produce* the disorder:

“[T]he two orders [referred to, i.e. two alternative clinical treatments] we have described produce the very disorder they attempt to eradicate” (Berg and Timmermans 2000: 45)

John Law makes a similar point, but pushes further by underscoring the ultimately dysfunctional nature of preserving the ambition of full integration with the implied completeness and perfection:

“So what’s the argument here? The answer is: it’s an argument about imperfection....That there are always many imperfections. And to make perfection in one place (assuming such a thing was possible) would be to risk much greater imperfection in other locations...The argument is that entropy is chronic.... Some parts of the system will dissolve” (Law, 2003: 11)

In sum, this third phase of ANT, largely unexplored in IS research, problematizes the nature and implications of key challenges related to information infrastructures: attempts to intervene and change may produce unexpected consequences; attempts to impose order in a collection of information systems through integration of multiple networks or standardization may only relocate or generate new dis-order (Hanseth et al. 2005). It underscores how complexities via non-alignment are neither transient nor accidental – but *endemic*.

2.3.3 Strategies for change: cultivation revisited

The conservative power of the installed base, its resistance against change necessitates an incremental nature of growth. Consequently, researchers have emphasized the role of pragmatic rather than ‘utopian’ strategies. When facing the challenges of design, realization and change of information infrastructures, evolutionary and iterative

approaches to seem highly appropriate and indeed inevitable. Design and change are involved and open-ended processes of socio-technical negotiations, which evolve according to a non-predictable dynamic. ‘Cultivation’ rather than ‘construction’ is suggested as a way to handle and live with the limits of managerial (or political) control over such phenomena (Ciborra et al. 2000; Dahlbom and Jahlert 1996). Rather than plan, prescribe and construct growth, it will seek to strengthen and nurture growth, through constant care, continuous assessment and a commitment to revise strategies that do not work well (Aanestad 2002).

In this paper we discuss challenges of organizational and institutional change project linked to technology implementation project on a large scale (the nation-wide health care sector). In addition to handling the challenges of size and scale through incremental strategies, however, we also need to address the sector’s institutional fragmentation as described above. Political legitimacy must be secured in a situation where there may be frequent political discontinuities, and a change project will need to navigate in the presence of foreign aid agencies and non-governmental organizations (NGOs) with various interests and agendas. This calls for approaches that are ‘on the guard’ continuously, and where threats and opportunities are monitored, assessed and reacted to on an ongoing basis.

The second phase of ANT as outlined above draws attention to the improvisational nature of development processes (Orlikowski 1996). The third phase substantiates the naivety embedded in efforts of embracing – “integrating” – comprehensive and dynamically shifting configurations of information systems. Integration, as a means to overcome a deep and self-reproducing source of heterogeneity is unattainable (in a strict sense) given such a perspective. This has obvious, yet largely uncharted, implications for management and control of information systems development processes through the source and type of complexities and risks involved.

In concluding, a relevant strategy will need to address the two core challenges identified above:

Earlier solutions, entrenched routines, prevailing perceptions and social institutions constitute and solidify existing practices, and cannot be changed in one instance. The historical, techno/socio/political ‘installed base’, of which legacy information systems is an important instantiation, need to be addressed drawing on evolutionary, small-step, gradual strategies.

The technical and institutional heterogeneity (in terms of number and kinds of actors, donor agencies, NGOs, official authorities etc.) with the ensuing fragmentation of information systems needs to be handled pragmatically. As no-one, including the national health authorities, are in ‘control’ in any strict sense, a relevant strategy cannot be based on a planning or control approach, but rather needs live with a reasonable level of non-integration.

Our empirical contribution is to exemplify the challenges associated with these dynamics, and to analyze them as instantiations of historicity and heterogeneity. We thus aim to contribute theoretically by fleshing out the implications of the theoretical basis for our work, and offering examples of actual strategies for approaching and addressing these challenges.

3. RESEARCH APPROACH

3.1 Research design

Our empirical material describes attempts to change the routine health information systems in Mozambique, in mainland Tanzania and in the Indian state of Andhra Pradesh. Due to its size and the provincial autonomy in terms of health care administration we focus on the state of Andhra Pradesh rather than India as a whole (see table 2). These three settings are discussed in a cross-national comparative perspective highlighting important similarities and differences relevant for our study. Some similarities that are of vital importance in shaping the health care sector are: The countries have all been under former colonial rule and are still recipients of foreign aid (although to varying degrees), some of the major health problems are similar, and the communication and transport infrastructure are weakly developed outside the major cities. The action research project HISP (Health Information Systems Project, which is described further below) is involved

also in other countries, among which South Africa and Ethiopia could be possible candidates for this study. However, the three settings we describe here share the characteristic of a rather centralized and hierarchical health care administration, while in South Africa the provinces and in Ethiopia the regions enjoy considerable autonomy, leading to a different set of issues and concerns. In both Mozambique and Tanzania there was a nation-wide, partly computerized general health information system, while Mozambican health workers also had to report through additional reporting systems. In India a plethora of paper-based reporting systems were in use, but not one general system. These three settings thus pose various configurations of the problems related to legacy systems and fragmentation, and most importantly: examples of different strategic approaches to these challenges. Moreover, the timing is also different: HISP has been present in Mozambique since 1999, in India since 2000 and in Tanzania since 2002.

The Health Information Systems Program is a large-scale, ongoing action research project that has as its primary goal “to design, implement, and sustain Health Information System following a participatory approach to support local management of health care delivery and information flows in selected health facilities, districts, and provinces, and its further spread within and across developing countries” (Braa, Monteiro, and Sahay 2004; 343). It has, to use Zuboff’s (1988) vocabulary, an ambition to *automate* selected (manual and paper based) routines, and, with considerably more difficulty, to *informate* clinical decision making through decentralization. HISP is a relatively loose network of different countries, or more specifically, of institutions within these countries. Its goal is explicitly related to supporting the peripheral or local levels of health care, but in order to achieve this, the national health authorities must become involved. Thus, central to the network is formalized and contractual agreements between universities and health authorities, including two joint Master’s programs (in public health and informatics) and a PhD program. The HISP team at the University of Western Cape in South Africa is the principal hub in the network of developers for the District Health Information System (DHIS) software which is being spread through the network, to the other partner countries which include India, Mozambique, Tanzania, Ethiopia, Malawi, Mongolia, Vietnam and Nigeria. The DHIS software was initially Microsoft Access based but is

made available free of cost. HISP is currently in the process of moving to an open-source platform, while the functionality is continually extended. There is also a platform independent and web-enabled version by globally distributed teams of informatics students and professional software developers. More details on the history, the institutional basis, the organization, and the funding arrangements of the HISP can be found in (Braa, et al., 2004; Braa and Hedberg, 2002; Braa, Heywood and Shung Kim, 1997; Braa et al. 2001 and at www.hisp.org).

3.2 Data gathering

The HISP is a long-term and distributed action research project, where several actors beyond the authors of this paper play key parts. We harbor a broad understanding of ‘action research’ as a goal directed research methodology where the aim is to understand large socio-technical systems in order to change them (Baskerville and Wood-Harper 1998). In our accounts from the three countries we build upon multiple data sources, and we find it necessary to elaborate on some aspects related to this.

The HISP activities within a new country have largely followed the same template. In accordance with the action research cycle, first the aim was to generate an understanding of the actual situation through conducting surveys and situational analyses, both in health facilities at the peripheral level and in administrative offices at higher levels. The observations from these surveys were recorded and analyzed within an interpretive framework (Walsham 1995; Klein and Myers 1999), and reported in separate publications. The actual methods used in these surveys were: interviews, (participant) observation, questionnaire, and document analysis. Though varying from country to country, the surveys would initially be centered on general issues of computer literacy and health reporting systems, later to be complemented with more focused analyses on e.g. data quality issues and actual work practices at the peripheral health facilities. Also the computerized systems in more central locations were examined. When appropriate we will refer to published reports from these studies, while it should be noted that most of the paper’s authors were also personally involved in these initial phases in one or several of the countries.

Based on the findings from the initial studies, the intervention phase commenced. While this was different in the different countries, it usually included: Participatory workshops with health care personnel from pilot sites, import of the software and subsequent translation, adaptation and customization. In conjunction with the implementation of the software, onsite sessions and training was offered to the prospective users. The participants in the HISP training venues has been a source of data on health sector achievements, challenges and shortcomings, and these meetings has helped to document the daily experiences of health professionals. As training is often accompanied by follow-up activities, it has been possible for HISP members to observe in situ the main factors affecting the performance of HIS in its dynamic relationship with health workers, from the district managers to laboratory clerks. This phase of entrance and start-up is also fairly well documented, especially for Mozambique where several of the doctoral candidates have submitted and defended their PhD theses (Chilundo 2004; Mosse 2005). Most of the authors have also been personally involved in this implementation phase, although with different focus and work tasks.

In this paper our focus will be what we see as a third phase; that is on the actions needed in order to ensure sustained presence in the countries after the initial intervention. Here is it also that we depart from the orderly schematic depictions of action research with its iterative cycles of analysis, intervention, and evaluation. In our setting this did not happen in well-defined and planned cycles, neither was there any stable definition of who the 'clients' were at all points. There was much more turmoil and ad hoc actions, as emergent opportunities called for a mix of planned and non-planned action. This was the case for the HISP team administration locally (within one country), but related to the global HISP network. In this paper our main emphasis is to describe and focus on this 'navigation' work as a symptom of general problem complexes facing IS in developing countries. Thus we base parts of our account on experiences from the ongoing daily work of the authors who are the central members of the HISP teams from Mozambique and Tanzania. In addition to structured and planned research work their daily work involves technical problem solving, sorting out financial matters, and political negotiations. In Mozambique, the collaboration with the Ministry of Health (MoH) and provincial and district

directorates of health has been intensive since 1999. Copious amounts of data have been gathered in the form of meeting minutes, reports, and presentations. The Tanzanian authors of this paper makes up the Tanzanian HISP team, and have thus played a central role in similar collaboration with the national health authorities. Comprehensive empirical material is thus available for these two countries. However, while India has been visited by two of the authors for fieldwork, we here have to base our account on secondary data sources to a larger degree. Our account of HISP India's history is mainly based on published research papers, and in addition we have performed informal interview and email queries with HISP India team members on particular details.

Table 1 Overview over the type of empirical material used in this paper together with an indication of the role of the authors in the various phases of HISP

	Analysis phase	Intervention phase	Sustaining HISP
Mozambique	Survey 1999 reported in (Braa et al., 2001) <i>(Authors involved)</i>	Field work reports and research papers <i>(Authors involved)</i>	No published accounts, reliance on primary data sources <i>(Authors involved)</i>
Tanzania	Surveys carried out since 2002. (e.g. Mukama, 2003) <i>(Authors involved)</i>	Field work reports and research papers <i>(Authors involved)</i>	No published accounts, reliance on primary data sources <i>(Authors involved)</i>
Andhra Pradesh in India	Initial analysis 2000 (unpublished report) <i>(Authors not involved)</i>	Research papers <i>(Authors briefly involved)</i>	Research papers, interviews with HISP India members <i>(Authors not involved)</i>

3.3 Data analysis

We thus build our accounts on the authors' ongoing sense-making when faced with a multifaceted reality. We construct a narrative structure, which by necessity is a post-hoc rationalization that is deliberately created to focus on some aspects rather than others. We are all HISP 'partisans', a fact which fundamentally shapes our account. We believe that the fundamental assumption that changes in the health information systems is needed and beneficial is widely shared. Conceptions will differ with regard to the actual way of doing this, and not all actors see HISP as an optimal solution. The authors' shared goal is on sustaining HISP activities, and we belong to an academic community with more or less shared theoretical resources and understandings of the challenges involved. Thus our accounts may very well be contested by other involved parties, both with regard to their fundamental composition (e.g. in terms of cause and effect-statements), but also the

interpretations that we offer. We claim to have maintained a close attention to the empirical material, and while we do not claim any intellectually or morally superior role, we still want to maintain the relevance of our admittedly situated and partial account.

Numerous people are associated with the HISP project in very diverse roles. Some are intensely involved in fieldwork, surveys, implementation, user training, and ongoing support. Other researchers work with more directly towards the health sector's management in order to secure political and financial support. The two Norwegian authors are associated with the project mainly through supervision responsibilities, but supplemented with field visits. In addition there are multiple Master students involved in various countries, as well as professional software developers hired on a contractual basis (see table 2). The views and interpretations are diverse, and not all involved HISP members share the same opinions about the evaluation of HISP, the quality of DHIS or the best strategy to choose. When presenting the empirical material, we will identify and discuss where we believe some of HISP's weak spots are. We have attempted to validate our interpretations in various ways, first and foremost among fellow HISP members, and through the ongoing dialogue with the Ministries of Health, particularly in Mozambique. The composition of the team of authors, with some authors intensely involved and other distant from the field also allowed for reflections on interpretations.

Table 1 The different roles and number of participants in the HISP network

Role/Country	Mozambique	Tanzania	South Africa	India	Vietnam	Ethiopia	Norway
Master Students	2	2		1		6	10
PhD students	4	3	1	1		4	2
Researchers				1			6
Consultants	1				1	1	
Hired programmers	2			8	5	5	
Vendors			1		2		

Our understandings of the challenges have been shaped also by the process of applying the conceptual and analytical tools presented in section 2. Our accounts and the interpretation of them have evolved along a route similar to the three phases of Actor-network theory. Our first initial approach was on understanding HISP as a new actor in

relation to the existing ‘installed base’ of previous paper-based and computerized systems. A better empirically grounded understanding of the challenges led us to emphasize the need for incremental and gradual strategies, in line with the second phase of ANT. However, in reviewing more recent theoretical contributions, our focus was reshaped to also encompass the inherent, and inescapable, heterogeneity of the health care sector. In this continuous process or reorientation we gradually became able to conceptualize also the generic nature of these challenges.

4. THE HEALTH INFORMATION SYSTEMS

In this section we will describe the historical background for the routine health data reporting systems, as well as the current perceived problems with these systems. (Due to the existence of a computerized information system in Mozambique and Tanzania, we will provide more detail on these two countries). We then proceed to describe the interventions from the HISP action research project.

Table 2 Cross-national comparison of country profile, health care sector and status of health information systems.

Country profile	Healthcare	Current computerised HIS
Mozambique		
Population: 19.2 million (UN, 2003) Area: 812,379 sq km Official language: Portuguese GNI per capita: US \$210 Battered by colonial rule, civil war, floods and famine. Transport and communication infrastructure weakly developed outside the cities. One of the poorest countries in the world, heavily reliant on foreign aid.	Life expectancy: 37 years (M), 40 years (W). Under-5 mortality rate 158 (2003) Malaria, TB, HIV/AIDS are the greatest threats Centralized health sector, strong presence of donors and NGOs SIS: national health data reporting systems launched 1982, with the aim of integrated and uniform reporting. Consists of tally sheets, report forms, register books, procedures and definitions. Local collection, aggregation and upward reporting of data with little feedback and local use of data. Severe delays and data quality problems, high work load on health workers	SIS-Prog: Dbase application launched in 1992 with external support aiming to computerize the SIS and support the needs of the entire organization. Only Immunizations (EPI) and Mother and Child Health (MCH) modules were computerized. Source code and documentation damaged. System can not be reinstalled, modified or extended to cope with medical, technological, or organizational changes. Other computer systems: BES (weekly disease surveillance), HIV/AIDS, TB, pharmacy data, human resources, maintenance data, logistics, stocks, EpiInfo (epidemiology), SPSS, SIMP (Excel-based integration of other data)
Tanzania		
Population: 34.4 million (2002 census)	Life expectancy: 42 years (M), 44 years (W) Under-5 mortality rate	MTUHA: MS Access based, developed locally by local vendors,

<p>data)</p> <p>Area: 945,087 sq km</p> <p>Major languages: English, Swahili</p> <p>GNI per capita: US \$290</p> <p>Transport and communication infrastructure weakly developed outside the cities. One of the poorest countries in the world, heavily reliant on foreign aid</p>	<p>165 (2003)</p> <p><i>Malaria, TB and HIV/AIDS are major killing diseases</i></p> <p>HIS centralized with four hierarchical levels</p> <p>MTUHA: national health data reporting system developed 1991 to replace various parallel subsystems. Consist of 12 register books and three types of tally sheets, all in a mixture of Kiswahili and English</p> <p>Local collection, aggregation and upward reporting of data with little feedback and local use of data. Severe delays and data quality problems, high work load on health workers with no motivation</p>	<p>but source code and documentation not retained by the MoH. All maintenance and extensions need to be re-negotiated and occur on a contractual basis.</p> <p>Other systems: STD, HIV/AIDS, TB and leprosy, etc. Specific reports collected by program managers, based on data from MTUHA forms but using forms different from MTUHA.</p>
India (Andhra Pradesh)		
<p>Population: 75 million (AP)</p> <p>Area: 2,75,068 sq km (AP)</p> <p>Major languages: English, Hindi, Telugu (AP)</p> <p>GNI per capita (India): US \$530</p> <p>Varying infrastructural conditions. Independent democracy since 1947, economic reforms have led to dynamic economy, but still major poverty problems. Aims at reducing aid dependence</p>	<p>Life expectancy (India): 63 years (M), 65 years (W). Under-5 mortality rate 87 (2003)</p> <p>India has a third of world's new TB cases, high child and maternal mortality, and has seen a rapid increase in HIV/AIDS infections</p> <p>Health care administration is the responsibility of each state, but within the state HIS centralized with five hierarchical levels. Bureaucratic.</p> <p>In 2000: No overall reporting system, but ca. 1200 data elements were collected and reported in ca 40 manually generated monthly reports. The Primary Health Centre is the main source of data. massive duplication of data and variety of reporting formats constituted high work burden</p>	<p>No computerized system. Ongoing implementation of FHIMS and DHIS</p> <p>Multiple separate report for vertical programs</p>

4.1 Mozambique

4.1.1 Country profile and health care sector

Having inherited a completely shattered health system from the Portuguese, after independence in 1975 Mozambique's health care policies and strategies were based on the PHC approach (WHO 1978). The attempts to build a health service sector were seriously hindered by the Civil War, which lasted until 1992. The country is still in a pre-transitional demographic state, with a predominance of infectious and parasitic diseases, linked to limited access to health care, poor sanitation, inadequate nutrition and unsafe water supply, thus compounding for the high morbidity and the mortality of the population. Since 1992, tremendous efforts have been put in place to revamp health services provision, and along these efforts, management and planning have received paramount importance. With its 19 million inhabitants, Mozambique is among the poorest countries in the world. The Health Information System is recognized by the Ministry of Health as critical for the success of health programs (MISAU 2000). It builds on an installed base consisting of the paper-based information system called SIS, dating back to 1982. The SIS covers governmental health facilities at the primary and secondary levels of health care, while private or NGO-run facilities do not use the SIS reporting system. Data is collected at health units, aggregated and collated at district level, and transmitted to provincial and then national level. Most of the data collecting forms are based on the needs of specific vertical programs, e.g. immunization or mother and child health. Major problems are related to data collection and reporting: absurd values proclaiming excellent program coverage in most districts of Mozambique indicate that cooking of data is an established practice. 760% measles coverage was once reported for a northern district a few years ago; although this is an extreme case, coverage values ranging from 100% to 250% are indeed not uncommon. The data collectors are typically nurses who have to deal with data chores besides their regular work and often after work hours. The lack of career paths in health information means that dedicated personnel, catering for activity data as their exclusive occupation is rare, although this would significantly boost quality and use of information generated in the health sector.

4.1.2 Current computerized health information system

In 1992 the SIS was complemented by a computerized system, the SIS-Prog, which was developed by an expatriate who has since left. By 1994 the SIS-Prog was used in the 11 provincial Health Directorates and at the national level (in the Ministry of Health, National Health Information Systems (NHIS) section). The SIS paper forms are collected from districts and the data are entered into the SIS-Prog at the provincial Health Directorate, which then reports to the MoH. The computerized system was intended to cover 10 of the common paper forms for regular reports, but only 4 forms are computerized fully. The computerized forms belong to the immunization and the mother and child health programs. The system is based on dBase III, DOS-based, running on Microsoft Windows 95. The system reflects its top-down design, e.g. the unit of analysis is the provincial level (Braa et al, 2001). The Mozambican Ministry of Health does not have the source code to the SIS-Prog; it cannot be found anymore, and this poses several problematic constraints. One is that the system is running on old and slow computers, which constitute an extra work burden, and it can not be installed on newer computers. In order to create graphical reports, staff currently prints out the data from the SIS-Prog and manually re-enter the numbers into Excel sheets. Another constraint relates to the data elements, which are hard coded into the system and thus not changeable. The practice of hard coding of such semi-permanent data (e.g. organizational units, data elements or reporting frequencies) makes the systems inflexible in itself. Together with the lack of national control in the HIS development process and the consequent reliance on expatriate staff it leaves the authorities with little room for flexible improvement of the systems. Due to changes in the paper forms which have not been replicated in the data entry screens in the computerized system, possibly up to 25% of data are entered into the wrong data fields (Mavimbe 2003). The hospital form was not included in the SIS-Prog and has never been used in its paper form either. This partial coverage has resulted in the use of many Excel forms to capture hospital data in the provinces. The computerized systems themselves also contribute to the situation of low data quality, as validation and verification procedures are missing. In the SIS-Prog system the default value is 'zero' instead of 'null'. This makes it difficult to say whether the actual report contained zero as its value or whether there is just a missing number due to non-reporting.

Mozambique's aid dependence is extremely high, and it remains the largest single recipient of foreign assistance in Africa (Chilundo 2004). During the civil war, external agencies and NGOs carried out emergency health interventions, the legacy of which is continued strong donor presence and weakly developed national structures for comprehensive planning and management. The consequence for the health information systems is that in addition to SIS and SIS-Prog there are multiple other reporting systems, most of them belonging to vertical, disease-specific programs: malaria, tuberculosis, leprosy, HIV/AIDS, and the weekly epidemiological bulletin (BES) for notifiable diseases. Besides general concerns over waste of resources, the multiple reporting systems create an unacceptable high work burden on already overworked primary health workers.

4.1.3 HISP in Mozambique

HISP in Mozambique started officially in 1999 with the Eduardo Mondlane University and the Ministry of Health as partners. Prior to that a pilot project funded by NUFU had surveyed the level of computerization in some districts, with a particular emphasis on health care (Braa et al. 2001). Based on the contact established here, formal cooperation was established. However, despite the commitment from the Ministry of Health, the HISP work was for some time not backed up with strong official support. There is consequently no full-time staff employed within the HISP program and attempts to have the MoH place liaison officers have been protracted. A major part of HISP activities, including training and follow-up, is carried out by doctoral and master students as part of their research duties.

Three districts in three different provinces were selected as pilot implementation sites, and the District Health Information System (DHIS) software originating in South Africa was translated from English to Portuguese and adapted to fit with the Mozambican context. The initial strategy was to replicate the data elements and reports from the existing SIS-Prog, while carrying out training workshops for health workers at district

and provincial levels. Training focused on data quality, use of information for local decision-making and use of DHIS software to handle data.

Mozambique was the first country after South Africa where the HISP was established. Contrary to the relative independence of South African provinces in terms of decision making, the Mozambican health sector is more centralized. Both donors and the health authorities focused on the provinces as scenes for reform and improvement, while the HISP agenda was to focus on the district level. This led to the realization that there was a dilemma with the bottom-up approach that needed more careful attention. Through the work of Master students, the old SIS-Prog database was analyzed, migration tools were developed and data was exported into a full national database (Skobba 2003; Lungo 2003). This allowed demonstration to the Ministry's and province administrations officials of the added functionality available with the software. Further customization ensued, with changes to user interfaces, improvement of reporting tools and stable links to SIMP, in response to requests from the Department of Health Information at the Ministry of Health. A GIS tool is being finalized and has captured interest from provincial managers. The utilization of the capacity presented by doctoral and master students has benefited the process of localization of DHIS software, and also ensured continuing involvement and awareness building among students and lecturers.

4.2 Tanzania

4.2.1 Country profile and health care sector

Tanzania has around 35 million inhabitants. Despite political stability and ambitious political and economic reforms, its aid dependence is considerable. Inadequate immunization, drug shortages, poor nutrition and unsafe drinking water make the population vulnerable to diseases such as measles, dysentery, cholera and tuberculosis. Malaria remains one of the nation's biggest killers, however HIV/AIDS has spread rapidly causing tuberculosis to become another threat. There are four administrative levels, where village health posts that provide basic preventive services, dispensaries and health centers comprise the lowest level, and the other levels correspond to district, regional and referral hospitals. Vertical programs like the Expanded Program on

Immunization, Essential Drugs Program, TB and Leprosy, Control of Diarrhoea Diseases, Mother and Child Health previously had separate and parallel systems of data collection, compilation and reporting (Mwangu, 2003). The national health authorities regarded this collection of different ad hoc systems as too fragmented, top-down-oriented and ineffective for local decision-making. Tanzania's current health information reporting system, called MTUHA, was intended address these issues. When conceived in 1991 it was intended to cover all levels in the health sector (health facility level, district level, regional level and national level), to include all vertical programs (i.e. stand-alone, disease-specific programs) and private facilities, and to support the agendas of health reforms through decentralization (MoH 1993). The roll-out of MTUHA was accomplished in 1997. A health facility compiles health data collected at the health units and from outreach activities including home based health delivery services and services at the village health posts. At the facility level, there are twelve registers and three types of tally sheets, and all registers, tally sheets, report forms and manuals are in a mixture of Kiswahili and English. Despite the aims that the MTUHA would be developed primarily for use at the health facility, to provide information suitable for local management and planning, its actual design process did not include the end users, but mainly MoH officials and donor representatives (Mwangu 2003). Only the MTUHA forms are currently used for data collection, but based on these data also program-specific reports are manually generated and collected by program managers.

4.2.2 **Current computerized health information system**

Simultaneously, in 1992, a software developer developed a MTUHA database application based on dBase IV, which was implemented in the MoH headquarters as well as in the 20 regional offices of the Tanzania mainland. During the early period of its use, between 1993 and 1995, several software bugs were detected and change requests were collected. The first developer had left the country and therefore another foreign developer was contracted to make an improved version of the MTUHA database to include new needs.

In 1997 the paper-based MTUHA system was subject to a major evaluation and several recommendations for change were given. For example, new reporting forms were added

and the reporting frequency for health facilities was changed from monthly to quarterly. As a result, changes in the DBASE IV system were required, but the developer suggested it would be wiser to start a new development project instead of changing the old version. Further, the developer proposed the development of new software by a software company based in Dar es Salaam with development costs paid by the donor. The software company based on its expertise chose to develop the software based on Microsoft Access. The new system was developed over 7 months in 1998 (Kimaro and Nhampossa 2005). The MTUHA software in use is currently incomplete, not all data can be entered in their appropriate formats. For example, form F005 in the software allows entering only data from government owned health facilities, but not private health facilities, which also report the same data format. Other examples are mismatches between data fields of the paper forms and the database capture forms. The data entered through the form F002 can not be viewed; there is no report that shows them (Lungo and Nhampossa 2004). As the Ministry of Health did not own the source code of the software, and commanded no funds toward updating it, changes were not made until recently, when a new development project has commenced.

4.2.3 **HISP in Tanzania**

In July 2002 HISP started piloting its activities in two health districts of Bagamoyo and Kibaha. This happened in collaboration with the national health information systems unit in the Ministry of Health. The activities included implementation of the DHIS software and training on computer and DHIS use, as well as conducting research on data collection, flow and use. While continuing to provide user support in the two pilot sites, in 2004 the project was expanded into three health districts in the city of Dar es Salaam (Ilala, Temeke, and Kinondoni).

Although the HISP team has tried to involve stakeholders in all levels, there is not yet an institutional strategy to assist HISP with financial or human resources. HISP is currently staffed by three PhD students financed through Norwegian scholarships, and is consequently perceived as 'just a research project'. On the one hand, MoH officials said they were ready to give support to HISP. On the other hand, while running the DHIS and

MTUHA database in parallel, the MoH officials seem reluctant to switch over to an alternative system because of fear of losing reputation. "...we do not want to move quickly this time with something which we have not realized its output, the policy makers need to be convinced of the DHIS..." (HMIS unit manager). The decision to allow the DHIS to run in parallel with the MTUHA has had negative impacts for HISP, as the MoH support has been diverted. This goes for lack of participation in the design process, the MoH taking decision which totally excludes DHIS, as well as creating increased work and confusion for health workers as to which system they should use.

4.3 The reporting systems in Andhra Pradesh, India

4.3.1 Country profile and health care context

The responsibility for provision of public health care services in India is decentralized to the states. Within the states the health sector is relatively bureaucratic and centralized, with five administrative levels through which reports flow. Compared to Mozambique and Tanzania, India's dependence on foreign aid is very moderate, and the official policy aims at reducing this dependency even further and ultimately to move from being an aid recipient to becoming an aid donor. In 2004 the external proportion of financial resources for public health expenditure was a marginal 3.6 %. Still major health problems persist mainly related to poverty problems and communicable diseases. The maternal and child mortality rate is high, and tuberculosis and HIV/AIDS have a significant impact on health. In the Indian state of Andhra Pradesh around 1500 Primary Health Care Centers and around 7500 Sub Centers cater for the 75 million inhabitants. Several vertical health programs exist and are administered by the State Directorate of Health, including the family planning, malaria, leprosy, blindness and tuberculosis programs. The programs are integrated at the point of service delivery, but maintain separate reporting systems.

4.3.2 HISP in India

Around 2000 there was no state-wide general reporting system (comparable to the SIS and the MTUHA) in Andhra Pradesh; neither was any computerized systems used. A situation analysis by HISP members commencing in December 2000 concluded that staff at the primary health centers was collecting around 1200 data elements and generating

around 40 reports manually each month (e.g. ‘Immunizations’ and ‘Sterilizations’ reports). There was a high level of redundancy in the datasets; data was collected repeatedly to comply with the different report formats, and data was collected even for programs that had long been wound up (Puri et al. 2004). These findings formed the basis for a participatory process of redesigning the reporting system and identifying a Minimum Data Set. By September 2001 the more than 1200 data elements had been reduced to around 400, and the reports had been restructured and reduced to 10 (Puri et al. 2004). In January 2001 these reports were implemented in nine Primary Health Centers in Kuppam constituency in Chittoor district, and a partnership was established with a local computer company that would be responsible for training, providing local support and software development. The DHIS software was adapted and translated to Telugu, the main local language. The main routine reports were automated so that health workers would see some value of the software to their everyday work, and also other kinds of reports were created. This was both specific reports as designed and requested by the district management, and other reports that would facilitate local analysis. (Nhampossa and Sahay 2005).

The introduction of the HISP project was linked to a central politician; so it came in through ‘the political door’, (Braa et al. 2004). This fact strongly shaped its future trajectory, for example the decisions related to its expansion was very much shaped by the ad hoc response to political matters (Nhampossa and Sahay 2005; Sahay and Walsham 2005). Soon HISP encountered challenges from another computerization project that was supported by the health bureaucracy in the state. The FHIMS (Family Health Information Monitoring System) project was funded by the World Bank and was geared towards collecting patient data rather than statistical routine data. FHIMS is organized around household records containing information on immunization and disease statistics etc.. As part of the FHIMS project all of the state’s around 1500 PHCs would be equipped with PCs and dial-up connection to the district servers. However, HISP could be perceived as a competitor for this project, and the future of HISP in the state seemed threatened. Rather than challenging FHIMS, a strategy of compromise was followed, and it was proposed to integrate the DHIS software with the FHMIS system in a way that was

seen as relatively non-interfering with the FHMIS software. The strategy of offering DHIS as an added value was successful, and provided HISP with an opportunity to ‘ride on the back’ of FHIMS during its expansion to the whole state (Braa et al. 2004).

4. DISCUSSION AND ANALYSIS: DILEMMAS OF LEGACY AND FRAGMENTATION

In this analysis we highlight two selected themes that emerge from the case narratives:

- *Historicity*: the genealogical character of the ‘installed base’ of work, practices and technology, i.e. how historical sediments or imprints of the past live on through various manifestations
- *Heterogeneity*: the sources and implications of the fragmentation and lacking integration of the different information systems

This needs to be recognized as an analytical distinction motivated primarily for reasons of clarity of the presentation. In its empirical and dynamical unfolding, the two themes spill over.

4.1 The historicity of information systems

4.1.1 The social fabric of the ‘installed base’

The notion of ‘installed base’, despite its connotations to a purely technical notion, is in the theory of information infrastructures as outlined in section 2 above a socio-technical notion (Star and Ruhleder 1996; Hanseth and Monteiro 1997). It makes perfectly good sense to talk about the installed based of the social, and the case of Tanzania illustrates this well.

The original intentions of the Tanzanian MTUHA system were to integrate the various disparate systems used for the vertical health programs, to support decentralization, and to facilitate local ownership and use of data. These visions were not realized in the development of the MTUHA, which today is an inflexible system with partial coverage.

We see the deep and long-standing inequalities between aid recipients and aid donors as one of the reasons for this. For example, in the Ministry of Health (MoH) local

competence was insufficient both in regard to systems development and project management, as well as contract negotiations. Within the existing socio-political hierarchy the funding donor commanded the financial resources and cooperated directly with the system developer with relatively little involvement of the Tanzanian MoH (Kimaro and Nhampossa 2004). The prescribed (and accepted) role of MoH was that of a receiver, who should not interfere with the process. In the words of the manager of the Health Information System Unit:

“What the MoH wanted was just the software and we did not bother with its specifications”.

This resulted in a less than optimal situation concerning user participation during systems design and ownership of the system and maintenance responsibility. Currently the MoH does not own the source code, and has to raise additional funds if errors shall be corrected or the system shall be updated. The persistent, pervasive and sedimented character of such inter-institutional arrangements warrants the label of an ‘installed base’.

The social, organizational and institutional aspects of the installed base may also partly explain the limited success of HISP in terms of stimulating local data use. The fact that most health facilities are understaffed and inadequately financed, often in addition to being remotely located, has made it difficult to organize training of health workers at health facility level. However, even when training has been conducted it may not have been as effective towards changing work practices as was expected. For example, since the data compilers may be trained health workers who are involved in direct health service provision, and these primary work tasks and other duties take precedence over documentation and computer use (Mosse and Sahay 2003). Over time this leads to little practice with the system which can ultimately lead to forgetting about the DHIS’s functionality. Follow-up visits to Tanzanian health facilities in the two districts where DHIS was first installed showed that the trained health workers perceived the DHIS as just a tool for storing data, and that no attempts had been made to use the data for local decision making. On the one hand this problem is related to education and lack of particular skills of statistics and data processing. On the other hand this is a consequence

of the current form of organizing the health service provision. Currently, there is a separation between the data compilers, who only process data, and the managers who ideally should use this information for decision making. The data compilers interpret DHIS as something useful for their primary work tasks, i.e. as a data repository. However, in general there has been little commitment towards HISP from the district management. Health information officers have participated in the training programs of HISP, but not district managers, since they claim to never have time. In addition, we have seen examples of opportunistic behavior, where people who are not involved with the data collection, participate in order to get the training allowances. The socio-technical installed base in this context also comprises kinship and patronage networks, a characteristic that may further undermine top-down and formalized change attempts.

The fact that the course participant is not always the person who is responsible for data collection, leads us onto an important problem area. HISP's first intention, to improve the existing data reporting practices, seems to be easier to achieve than the second intention: to stimulate local data use, decision making and management. The first of these steps replicate the existing system and thus requires less changes of the installed base than the second, which depends on the reorganization of roles and responsibilities. The second goal is thus more difficult to achieve, as it does not only entail these challenges related to organizational politics, but also extends beyond the sphere of control of HISP, or even of the national health care authorities. It will require policy and regulatory changes, as well as the realization of the proclaimed decentralization. (i.e. actually redistributing both power and financial resources). This also involves the donor and aid organizations practices related to funding arrangements. For example, it turned out to be almost impossible for district managers to follow a HISP suggestion and change the reporting frequency from quarterly to monthly in order to make it easier to trace poor quality data.

Even minor changes to the installed base may be hard. The work required to establish the DHIS as just a data repository was significant, and comprised training on computer use and the DHIS software, as well as ongoing software and hardware support. Offering the data compilers a new tool for their job may not seem a large step, but registering data on

a computer rather than in paper forms or books may actually be more cumbersome if we consider low computer literacy, frequent power shortages and other well-known features of a rural, developing country context. However, this ‘investment’ may generate one short-term benefit, specifically related to the excessive work demands that arise from the multiple vertical programs with their own reporting requirements. With the DHIS software it is possible to automatically generate diverse reports, which can be tailored to fit with each health program's or actor's format requirements. Thus, if the data are entered into DHIS, the health workers are able to generate the required reports with less work.

The cultivation strategy for the development of information systems need to incorporate an evolutionary perspective of the change of also the social as well as the technical. The HISP approach is to simultaneously address the need for practice-relevant knowledge during training courses, as well as to contribute to the building of general competence through study programs for Master and for PhD students and health care officials.

4.1.2 **Fragmentation stemming from the installed base**

The case of SIS-Prog in Mozambique shows how the problems of legacy systems and fragmentation are directly related. The inflexibility of the legacy system, SIS-Prog, led to fragmentation. This happened along at least three routes. As Latour points out, actions are overtaken by their intentions thus producing unintended consequences:

“that action is slightly overtaken by what it acts upon; that it drifts through translation; that an experiment is an event which offers slightly more than its inputs” (Latour 1999:298)

The first way in which the SIS-Prog lead to systems fragmentation is quite straightforward. As the ‘SIS dream’ of complete coverage never came close to realization, the previous separate reporting systems from the vertical programs continued to live beside SIS. While there is a general recognition that this is a suboptimal situation, neither HISP nor other actors have addressed the issue of systems’ integration with full force. Secondly, since the system (SIS-Prog) cannot be extended or updated, actual

changes in the health care provision will not get replicated in the system. Examples of this are facilities that are opened or closed, or new treatments that are offered. For example, in 2001 the Hepatitis B vaccine was introduced, to be administered as a joint shot together with the DTP (Diphtheria, Tetanus, Pertussis). The SIS paper forms were not timely updated and the data entry screens in the SIS-Prog system could not be changed to accommodate data on the new tetravalent vaccine. The result was not being able to ascertain how many children were vaccinated in the intermediary phase on the introduction of the new vaccine, as new and old SIS forms coexisted and the structure of SIS-Prog made it impossible to add new fields. Different ad hoc solutions to this dilemma were used and the result was non-standardized reporting, i.e. fragmentation. Similar examples of consequences of fragmentation due to legacy systems are well known also with information systems in the North.

The third fragmentation mechanism is also a direct consequence of the inflexibility problems associated with SIS-Prog. New applications were developed to cater for the needs that SIS-Prog could not address. Today there are separate applications for financial data, human resources, drugs, logistics, epidemiology reports, etc; in total 13 computerized systems are in use within the Ministry of Health (Nhampossa 2004). In addition there are other non-computerized systems, so that e.g. data collected on malaria could be reported through up to four different reporting channels (Chilundo and Aanestad 2004). The resulting multiplicity of systems is depicted in the figure below.

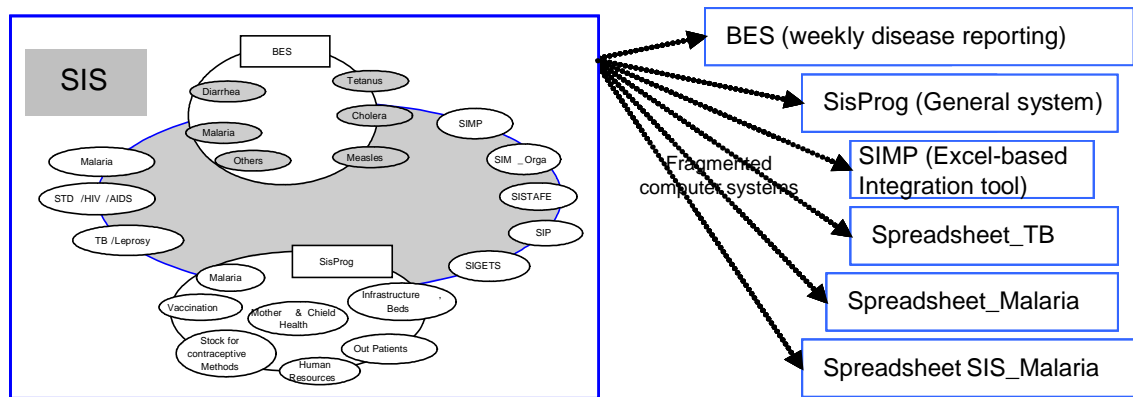


Figure 2 Multiple, fragmented information systems in the Mozambican health sector

When confronted with this 'spaghetti' of systems HISP employed a gradual strategy. It was gradual both in terms of functionality of the DHIS software and in terms of geographical spread. As a starting point the HISP team in Mozambique replicated the existing data entry screens and form of SIS-Prog, which covered the Immunization and Mother and Child Health programs. In one sense this was an added value in itself because the new software was more flexible than the old. If DHIS replaced SIS-Prog, one could now add or remove health facilities, reporting frequencies could be adjusted, and data elements could be changed. This modification could not be done to SIS-Prog since the source code was not available.

This strategy to a certain degree relied on promises of future benefit from the software. Demonstrator sessions were conducted for central officials in order to get clearance and access to health care facilities. Prior to these sessions real data from the existing system (SIS-Prog) were used to populate new DHIS databases (Lungo 2003; Skobba 2003). This allowed HISP researchers to show how the software would help improve the analysis of data. However, full implementation at all facilities (e.g. in a province) would be necessary before benefits were visible to the top management. As HISP was starting in three pilot districts in three provinces, it encountered a dilemma related to this gradual bottom-up approach. Later the strategy was modified through the establishment of 'cluster centers'. The office in a district center with relatively stable electricity and some regularity of transport was computerized and served as a hub. Staff from other health centers/districts were supposed to come to this center to do the data entry into the computers.

Another step in the gradual strategy was to link to SIMP via a gateway. SIMP is a crucial spreadsheet-based application used to integrate the data from all the other subsystems, and was developed to satisfy the need of data for planning purposes at the provincial and national levels. The idea behind the gateway was that the useful but frail SIMP tool can continue to be used, while DHIS can replace SIS-Prog behind the stage. Currently the DHIS can transfer data to SIMP; and this function has been tested in the Inhambane province where the full implementation of DHIS is under way at a faster pace than in the

other two pilot provinces. Then the next step can be taken from there, and when large enough, DHIS can also replace SIMP. Technically this is already possible, DHIS can create all of the required reports, but this version has not yet been implemented. The lack of progress in this respect is partly related to the choice of a gradual strategy. This gradual strategy has been appropriate and indeed necessary, but it is also risky and problematic. HISP in Mozambique has experienced some uncertainty regarding its status vis a vis MoH. Since HISP is presented as an incremental, bottom-up project that relies on 'cheap labor' (students), this implies that it lacks the legitimacy and backing of strong donors. This resembles the 'big is beautiful' dilemma, where a large and ambitious project was perceived as more attractive than a more modest and viable project (Ellingsen and Monteiro 2003). Consequently HISP has experienced a lack of top management support; there is espoused, but not realized support. The DHIS software was endorsed as the backbone for the "new" health information system in Mozambique by the MoH as early as 2001, but the much-awaited decision concerning ownership of the DHIS by MISAU has been delayed. The result of this decision would affect DHIS's sustainability, for example the MoH could play the role of the owner of the product and HISP could contribute with the technical support. However, HISP Mozambique can not only rely on political goodwill and wait for a full-scale and complete implementation. The project also needs to act to provide short-term benefits in order to not become marginalized. Currently, in an evaluation performed by an expatriate technical assistant the ambitions of DHIS were significantly curbed. HISP Mozambique has protested against this evaluation, as it further diverted support and induced hesitation from the Ministry of Health. The technical assistant involved with the evaluation used the temporary void in order for the Ministry of Health to consider the use of his own package, named Modulo Basico. HISP Mozambique fears that in this institutional arrangement the seeds for another legacy system are being planted, as the technical assistant may end his contract within months, possibly leaving with his know-how and source code. As another move to counter the threat of becoming marginalized, a GIS application (developed by an Indian HISP member) was linked to DHIS. This application allows visual representation based on the collected routine data, and can show maps with e.g. distribution of malaria cases, or coverage of district health centers. This kind of application is valuable for management,

and the introduction of this application was explicitly related to the need for increased top level support in order to not become marginalized.

In conclusion, we see that the gradual and stepwise strategy may be necessary, but not sufficient. Negotiations and contests emerge, and the project needs to engage with other actors beyond its sphere of control. This political nature is even more evident in the Indian case, to which we will now turn. Then we will return to Mozambique in order to discuss the various stakeholders associated with the multiple vertical programs.

4.2 The politics of integration

4.2.1 Integration as the forging of alliances

In section 2, we pointed out the way integration in IS predominantly has been conceptualized as a technical challenge, triggering technical means or mechanisms for integration. The case of HISP in Andhra Pradesh in India, vividly demonstrates the manner in which integration becomes embedded in deeply political processes of negotiation.

India's aid dependence is far less severe than the two African countries, and consequently local authorities tend to have more power. This is evident in the possibility to actually change the reporting format in Andhra Pradesh, and to create the Minimum Data Sets. Such a standardization process needs to happen as a joint bottom-up and top-down process. However, the significant role of donor influence is visible in the strong financial backing of the Family Health Information Monitoring System (FHMS) project. The way HISP has needed to relate to this project is a poignant example of the political character of such processes (ICT for development). This implies navigation, ongoing and ad hoc improvisation.

The FHMS project was funded by the World Bank and supported by the health bureaucracy in the state. This project was about to start within one district in Andhra Pradesh (Nelgonda) when the HISP activities commenced. HISP was perceived as a competitor by the health bureaucracy (commissioner for health and family welfare), and

the future of HISP in the state seemed threatened. Arguments were that the state did not want multiple systems, and that the forms had already been designed. Rather than challenging FHIMS, a strategy of compromise was followed, and it was proposed to integrate the DHIS software with the FHMIS system. The data (patient information) would be registered in the FHIMS, and an export file from the FHIMS would be converted to a text-file and imported into the DHIS, where facility-based analysis could be conducted. This was seen as relatively non-interfering with the FHMIS software. In addition, this solution was focused on data collection at the district level rather than the PHC where FHMIS was to take place. Along with this, a district level database was proposed for all the 23 districts, and the possibility to link these routine data to a recently developed GIS system was offered. As we write, this offer has been accepted by the state, and HISP is currently preparing implementation in two districts. The strategy in the two districts will be different; in one district the DHIS bridge will be employed at the district level only, in the other districts the DHIS bridge will be implemented in all 84 Primary Health Centers. The latter is a more costly approach, with regard to resources for training, persons involved and work load. It will, however, offer access to non-aggregated data, and can thus generate a more powerful analysis tool than a district level approach. The two approaches were deliberately different so as to gain experience and be able to select the most appropriate approach at later stages. Thus this strategy has been successful, and has provided HISP with an opportunity to 'ride on the back' of FHIMS during its expansion to the whole state (Braa et al., 2004). For example, HISP has taken advantage of the fact that as part of the FHIMS project all of the states around 1500 PHCs would be equipped with PCs and dial-up connection to the district servers; thus alleviating the need to spend scarce HISP funds on duplication of hardware.

However, the HISP team has taken care to not be too closely involved or implicated with the FHIMS as it is perceived to encounter serious problems already. The HISP strategy is explicitly opportunistic, as statements from the HISP India manager show:

"We do not want anything to do with the FHIMS software. There are no contractual agreement on updating and maintenance of the software between [the development

company] and the health authorities and we don't want to be left with that job. [...] We just want the plain text file from its report generator. We have designed the bridge so that when FHIMS die, we will just disconnect the bridge and live on" (HISP India project manager).

In India the role of political negotiations has been paramount. HISP has had to navigate in the rough waters of ever-changing political constellations. It has had to relate to both national and international actors. The expansion from the initial pilot district (Chittoor) to the Madnapally revenue was not initially planned, but occurred only because the political champion asked HISP to do it (Sahay and Walsham 2005). Political discontinuities following elections and related to the frequent transfer of bureaucrats, which is routinely done in order to curb chances of corruption, poses large challenges for a project like this, where skillful improvisation and navigation has been of paramount importance.

4.2.2 **Striving for perfection**

The problem of overlap and redundancy between Mozambique's many reporting systems is recognized at all levels of the health care sector. Despite the general agreement, actually attempting to integrate information systems from vertical programs is a complex and politically charged activity. The information systems are different in non-arbitrary ways, and these differences relate to their history, how they are shaped by the characteristics of the problems (disease) addressed, and how they are embedded into different institutional settings, both at local, national and international level. A study of the reporting practices of three major programs in Mozambique, the malaria, tuberculosis, and HIV/AIDS programs describes significant differences between the reporting systems (Chilundo and Aanestad 2005). The prevalence, incidence, mortality and morbidity of the diseases, but also the attitudes to the disease and the way treatment is organized shape the programs. For example, one of the major concerns in the treatment of tuberculosis is to avoid the emergence of drug resistant tuberculosis bacteria. Thus treatment is provided under a rigid regime involving close monitoring of drug administration to avoid a black market, and a patient-centered information system allows the program personnel to closely monitor the treatment progress for each individual. In contrast, the voluntary HIV

testing centers do not register personal information beyond demographic data like age, sex, etc. The main reason for this system is the social stigma attached to the HIV disease, as well as the fact that the centers do not offer any treatment opportunities. In that case, person-based information might be needed, e.g. in order to track potential other infected persons, e.g. sexual partners. So far, when treatment for HIV/AIDS has not been available, the incentive for testing has not been substantial. The policy has been geared more towards prevention, e.g. through information campaigns and condom distribution. In such a situation, the data needed (and recorded) are rather related to prevalence and changes in this. The situation is similar with regard to malaria, which in general is coped with (through traditional medicine, or with first-line drugs available at the black market), often without accessing health facilities.

The success of the tuberculosis program's approach may partly be explained by the fact that the program deals with few cases relative to other communicable diseases. The disease is not acute and the treatment program is long-term, and thus the reporting is performed only quarterly. The disease is well known and treatment strategies are well-established. Moreover, the program has strong financial backing, and is perceived as successful. It thus has a long-standing and strong institutional basis, which extends beyond the national borders. The infrastructure to deal with the HIV/AIDS pandemic is not equally well established. Compared to tuberculosis, HIV is a recent disease, and successful treatment strategies have not been generally available until recently, and treatment is still out of reach for most afflicted in the developing countries.

Differences are not just between the programs, but also between the actors involved (Chilundo and Aanestad 2005). While the overworked health worker gives little attention to data collection, information plays a crucial role for management. The Ministry of Health recognizes the problem of fragmentation and the ensuing sub-optimal functioning of the reporting and monitoring systems. To the Ministry, the activity of monitoring the effect of interventions and hopefully demonstrating progress is significant, as it is requested by both the donor community and the general public. In general, the donors' main interest is to ensure that their financial support is being well utilized and has

desirable impacts. Controlling and supporting programs that are disease-specific or limited in other ways will provide more effective means for this kind of control, while round-sum budget support may be intractable in terms of monitoring where the money goes. Some of the national aid organizations may be accountable to their home constituencies, from which there may be political demand on e.g. the mechanisms for control over the money flow to avoid corruption, or with regard to targeting towards needy groups etc. While concerns such as these may be a reason to sustain vertical programs, the donor community shares the concerns, and in Mozambique, the major donors cooperate towards integration. Ten of the major donor organizations pool their financial support into the Common Fund. However, this alignment does not cover all actors. The WHO has been met with criticism that their projects in general rarely are synchronized with the country's emerging processes aimed at developing their health systems. E.g. an evaluation of the Roll Back Malaria initiative found that the initiative was not linked up to sector-wide approaches, nor was it linked to the World Bank's poverty reduction strategies or its program of debt relief for heavily indebted poor countries (Yamey 2002). Apart from these donor organizations with a long-term involvement, other actors have recently appeared on the scene to combat the endemic diseases. One is "The Global Fund to Fight HIV/AIDS, Tuberculosis and Malaria" from the Bill Gates Foundation. Another major actor is The Bill Clinton Foundation working against the HIV/AIDS pandemic, and in particular targets low-cost medication to avoid mother-child-transmission. In general, such initiatives tend to establish separate control structures. However, some work is also going on in Mozambique to ensure that these private funds and the UN organizations are channeling their financial support through the Common Fund.

Consequently, the integration of information systems should not be perceived as primarily a technical issue, but rather as a complex and politically charged activity where multiple institutional influences and different, possibly competing, rationalities need to be aligned. The multiple reporting systems, the actors and their interests should serve as a poignant reminder of our message that seeking for just one order may be futile and even dysfunctional. Orders, or rationalities or logics are multiple, and this multiplicity cannot

be eliminated; it must be negotiated, lived with and handled in sensible ways. Lacking integration of IS, signaled by redundancies in data fields, functions or modules, regularly and understandably spawn efforts of tighter integration. However, in line with recent elaborations of ANT and the theory of information infrastructures (as elaborated on in section 2), there is a growing awareness about the unattainability – or even dysfunctional – nature of the visions of tight, seamless integration of large configurations of information systems. As Law (2003: 11) points out: “The argument is that entropy is chronic... Perfectionism would be dangerous”.

5. CONCLUSION

Establishing working information systems in developing countries is truly a challenge. The abundance of documented partial and complete failures within the domain of health care as well as in other domains demonstrates this beyond any reasonable doubt (cf. section 2 above). This might (implicitly) suggest that experiences, lessons and insights from information systems processes in developing countries are too specific or unique to allow for translations into a Western setting. This, we believe, is a serious misconception. The situated or ‘sticky’ nature of experiences is a general trait, identified e.g. within knowledge management and not something only applicable to developing countries (Orlikowski 2002). The exact configuration of the context for an implementation, e.g. the company, timing, history, business environment, political milieu, is always unique. Interpretative information systems research should be able to pull out, i.e. to translate and appropriate, selected aspects to make them more generally applicable. To dismiss of experiences from developing countries as not applicable to the West is politically arrogant and intellectually naïve as critiques of post-colonial reason teach us (Spivak 1999; Mignolo 2000). Moreover, the challenges we discuss related to historicity and heterogeneity are pressing problems also in Western business organizations.

Our analysis has revolved around the two core themes of historicity and heterogeneity of information systems. We argue that a generalized strategy for large, infrastructural information systems development needs to incorporate both these themes.

Firstly, the historicity of information systems development highlights the historical sediments of legacy systems, of institutionalized, even ritualized routines, of deep-seated perceptions and sentiments. This entails a stronger focus on cultivation, i.e. on evolutionary, small-step changes both in the (so-called) social and technical (Orlikowski 1996; Dahlbom and Jahnert, 1993; Aanestad, 2002). Analytically, we may here draw on theoretical studies that underscore the continuous and non-abrupt changes and how

“[it] is not an immutable but changeable object...experimenting and changing are still going on...[it] is fluid because it is variable over time” (de Laet and Mol, 2000:228).

Secondly, we want to emphasize the heterogeneity of information system, the existence of many non- or poorly integrated systems, fragmentation and the perceived ‘mess’. With respect to these challenges we in particular want to draw attention to research that underscore the un-attainability of ever reaching a state of tight, seamless integration:

“[T]here are always matters out of control. Diversity. Diverse and incomplete centres. Unstable relations. This is a chronic state of being. It is an argument about imperfection. About its unavoidability. To make perfection in one place...would be to risk much greater imperfection in other locations.” (Law 2000, pp. 10-11).

The clear, admittedly controversial, implication for large-scale information systems development is that is better to let go of the idealized visions altogether and confront and live with the mess:

“[E]ntropy is chronic... Some parts of the system will dissolve. In which case the art of management is that of accepting some failures but wisely choosing which to try to put right. For a manager accepting perfection is not a failing. It is an advantage. Indeed a necessity. Perfectionism would be dangerous” (ibid.: 11).

Integration is not the quick fix it is promoted as. The core challenge, thus, is not to strive for the (unattainable and dysfunctional) ideal of completion, perfection and seamless integration, but to live with a ‘reasonable’ level of mess.

List of abbreviations

NGO – Non-Governmental Organization

HISP – Health Information Systems Program

STD – Sexually Transmitted Diseases

FHMIS – Family Health Management Information System

BES – Boletim Epidemiológico Semanal (Weekly Epidemiological Bulletin)

TB - Tuberculosis

MTUHA - Mfumo wa Taarifa za Uendeshaji Huduma Za Afya

GIS – Geographical Information System

GNI – Gross National Index

ANT – Actor Network Theory

SIS – Sistema de Informação para a Saúde

SIMP – Sistema Integrado de Monitoria e Planificação

SPSS - Statistical Package for the Social Sciences

ERP – Enterprise Resource Planning

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8.4. APPENDIX D

LUNGO, J. H. & NHAMPOSSA, J. L. (2004). The Impacts of Legacy Information Systems in Reporting Routine Health Delivery Services: Case Studies from Mozambique and Tanzania. International ICT Workshop 2004. Dar es Salaam Tanzania. 91-113.

The Impacts of Legacy Information Systems in Reporting Routine Health Delivery Services: Case Studies from Mozambique and Tanzania

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Abstract

The awareness of the importance of effective health information systems (HIS) has increased substantially and is reflected by many ongoing efforts of HISs reform in many developing countries. However, the one mostly mentioned obstacle for health information systems reform is *Legacy Information Systems* (LIS). The impacts of LIS in the reporting of routine health delivery services were studied in a participatory action research using case study sites in Tanzania and Mozambique. LIS impacts are on the process of introducing changes (reforms) on the HIS, and on everyday functioning of the HIS. LIS were determined to cause poor quality of health data, incomplete reporting of health data, and burden to health workers. The study recommends the Ministries of Health to relinquish the LIS. A demonstration on extracting and loading of locked health data on LIS to new health information software using extraction transformation and loading (ETL) software was performed.

Keywords: Legacy information systems, extraction transformation and loading systems, installed base, health information systems reform.

1.0 Introduction: the importance of health information systems

The world health organization (WHO) has long identified health information systems as critical for achieving health for all. A report of a WHO meeting (1987) clearly links improved health management to improved health information systems as it argues that, “of the major obstacles to effective management, information support is the one most frequently cited” (WHO 1987). The rationale for addressing health information systems (HIS) is, HIS generate information in order to inform health planners and decision-makers on what is happening at health delivery facilities. In this way, health information systems improve health management and health management is a pre-requisite for good health delivery services.

Health information systems are also seen as social systems implemented in the health sector. Braa *et al.* (1999) describe health information systems as complex

systems because they tend to be deeply embedded in social work practices. Braa (1999) argues that, "working with data and information within the health sector includes filling in forms and registers, collating data into aggregated forms, statistics and reports and the reporting of these to higher levels are tasks that make up important aspects of most health workers' jobs" (Braa *et al.* 1999, p.4). Health information systems are complex systems and are social systems as they tend to be deeply embedded in social working practices. Lippeveld and Sapirie advise a successful way of designing and implementation of health information systems, by arguing that "the success of a health information systems reform depends not only on technical improvements but also on in-depth understanding of political, socio-cultural, and administrative factors" (Lippeveld and Sapirie 2000, p.249).

Despite the potential that health information systems have, in practice the collection, compilation, analysis, and reporting of health data are riddled with major problems, especially in the context of developing countries. Most health care providers in developing countries equate information systems with filling endless registers, collating, and compiling health data, conducting minimum data analysis, and sending out reports without receiving adequate feedback (Sauerborn and Lippeveld 2000). Furthermore, the data received are often not helpful for health management decision-making because they are incomplete, inaccurate, untimely, obsolete, and unrelated to priority tasks and functions of local health personnel (Braa *et al.* 2001; Sauerborn and Lippeveld 2000; WHO 1987). In other words, information systems tend to be data driven instead of action driven (Sandford *et al.* 1992). Wilson and Smith (1991 cited Wilson 2000) suggest that, "the creative use of microcomputer technology is one of the most promising means of improving the quality, timeliness, clarity, presentation, and use of relevant information for primary health care" (Wilson, 2000, p. 199). Recent experience (Braa and Hedberg 2002; Wilson 2000; Wilson *et al.* 2001) attests to the potential for using computers in health information systems.

Many bottlenecks in the development and implementation of effective IS have been identified by many researchers from different developing country contexts and includes the centralized and fragmented character of services, lack of coordination, poor quality and use of information, and the complex organizational context (Avgerou and Walsham 2000). Poor focus on the development of local expertise on the part of donor initiated projects and the tendencies of neglecting of social and organizational issues are cited as factors contributing to the problem of ineffective implementation of IS in developing countries (Lippeveld *et al.* 2000; Litlejohns *et al.* 2000). Implementation of IS in developing countries is a complex and very challenging task as the process demands not only a transfer of technology but also the introduction of the culture that go with the system. As Heeks (2002) citing Shields and Servers (1989)

points out what is transferred is not only machines, hardware, software, skill and knowledge but also the attitudes, the value systems together with the social, political, and cultural structures. While it may be relatively easy to transfer the technical artefacts, it is far more complex to “transfer” the socio-cultural context to other settings. Braa et. al. 1995 concludes that like all other technologies, IT is also context sensitive and ensuring technological learning is crucial to its successful transfer to developing countries.

2.0 Legacy Information Systems

Hanseth 2002 describes a theory which views information systems as parts of larger infrastructure, which comprise of heterogeneous components that are integrated through standard interfaces to provide shared open resources to a community of users. The emphasis of Hanseth 2002 on shared resources contrasts very much with the concept of ISs, which are normally used relatively independently and constitute private properties.

Information Infrastructure evolves over time as new infrastructures are designed as extensions and improvements of existing ones. In turn, the new or improved elements have to link with the old and what is described as the existing installed base (Hanseth 2003), which heavily influences how the new elements can be designed. As the installed base grows, its development and further growth become self-reinforcing, both enabling and constraining further development. Successful development of information infrastructure requires, first, the creation of such a self-reinforcing process, and second, managing its direction.

Many of today's computer systems, used in applications ranging from corporate accounting to air traffic control, were created decades ago, and over the years were patched and fine-tuned to perform their jobs. Sommerville (2001), argues that,

“Many computer software in large information systems remain in use for more than 10 years and are still business-critical, that is, the business relies on the services provided by the software and any failure of these services would have a serious effect on the day-to-day running of the business” (Sommerville 2001, p.582).

Sommerville describes legacy information systems as “socio-technical computer-based systems, that include software, hardware, data, and business processes” (Sommerville 2001, p.583).

Legacy information systems are typically too slow, unreliable, and inflexible for handling new, more diverse and demanding tasks. Unfortunately, the functions of these systems are very difficult to understand, and their replacement with a new and efficient designed system seems virtually impossible. Replacing a legacy information system is a risky business strategy for a number of reasons (Sommerville 2001): there is rarely a complete specification of the legacy

information system. The original specification may have been lost. Therefore, there is no straightforward way of specifying a new system, which is functionally identical to the system that is in use. Business processes and the ways in which legacy information systems operate have been designed to take advantage of the software services and to avoid its weaknesses. If the system is replaced, these processes will also have to change, with potentially unpredictable costs and consequences. Important business rules may be embedded in the software and may not be documented elsewhere. New software development is itself risky, so that there may be unexpected problems with new system. It may not be delivered on time and for the price expected.

In describing problems of running legacy information systems, Sommerville (2001, p.583) points to the following expenses in changing legacy information systems: Different teams have implemented different parts of the systems. There is, therefore, no consistent programming style across the whole system. Part or all of the system may be implemented using an obsolete programming language. It may be difficult to find staff who have knowledge of these languages and expensive outsourcing of system maintenance may be required. System documentation is often inadequate and out of date. In some cases, the only documentation is the system source code. Sometimes the source code has been lost and only the executable version of the system is available. Many years of maintenance have usually corrupted the system structure, making it increasingly difficult to understand. The data processed by the system may be maintained in different files, which have incompatible structures. There may be data duplication and the data itself may be out of date, inaccurate, and incomplete.

The research questions were,

“what are the impacts of legacy information systems in the reporting of routine health delivery services in the health sector?. We further wanted to study the nature of legacy information systems in the health sector in developing countries and to find out on how do these legacy systems impact upon: the process of introducing reform, and the everyday functioning of the health information systems”.

Thinking about taking action to leverage legacy systems, Chislenko (1995, pp. 2-3) has advised five techniques: *Parallelism and Specialization* where the increased responsibilities of a legacy information system are divided among a number of old systems. The work is substantially improved as individual systems are optimised for performing particular tasks and relieved from other duties. *Redundancy* where several systems work in parallel then the result is compared to make the output more reliable. *Wrapping* where the layers of the system that cannot be understood are left alone while the others are replaced. *External aids* technique deals with providing the legacy system with necessary resources, pre-

processing them for the input, and performing some tasks the old system is not good at. Finally, *replacement of parts* technique in those cases where the structure and function of some of the part of the system is well understood. The part can then be directly replaced with its improved equipment (Chislenko 1995, pp.2-3).

Although the above approaches by Chislenko (1995) proved useful in updating many computer systems, these have proved to be a temporary solution and sometimes magnify the problem. In his paper labelled *Reengineering work: do not automate, obliterate*, Hammer (1990) argues,

"It is time to stop paving the cow paths. Instead of embedding outdated processes in silicon and software, we should obliterate them and start over ... use the power of modern information technology to radically redesign our business processes in order to achieve dramatic improvements in their performance" (Hammer 1990, p.104).

The best option is to replace the legacy information systems with new systems. This is because it is risky to run legacy systems as outlined in the earlier discussion and because since legacy systems were developed in old technologies, as time goes, the hardware and software will fail. However, replacing the legacy systems is also a risky activity as it was presented in the earlier discussion, but this will ensure the sustainability of the organisation, as the new systems are implemented in modern technologies. While developing a new system to replace the legacy one, the most risky aspect is to loose organisation data collected for several years. The question is how the vast amounts of data locked in legacy systems can be secured and migrated to the new system.

2.1 Migrating data from legacy information systems to a new information system
Instead of adding patches to the old system as discussed in section 2.4.1, a guaranteed solution is to implement a new system and migrate all the data from the legacy system to the new system. This is common practice in building data warehouse systems as these systems aim at creating an enterprise reservoir of data, that is, integrate all operational systems and store their data in one place, the data warehouse. The process of migrating data from one system to another has a known technical terminology *Extraction, Transformation and Loading (ETL)* (Microsoft 2000).

While ETL can be done manually through "copy and paste" for a simple problem, it is impossible to migrate data from one database to another manually. The alternative is to automate the ETL processes by developing an application software system. Microsoft (2000, p.2) outlines four distinct functional elements of an ETL system: extraction, transformation, loading and meta data whereas; the ETL extraction element: is responsible for extracting data from the source system. During extraction, data may be removed from the source or a copy made and the original data retained in the source system. The ETL transformation element: is

responsible for data validation, data accuracy, data type conversion, and business rule application. It is the most complicated of the ETL elements. The ETL loading element: is responsible for loading transformed data in the target system, and the ETL meta data element: is responsible for maintaining information (meta data) about the movement and transformation of data. It also documents the data mapping used during the transformations.

Developing an ETL system seems to be the most feasible solution for leveraging legacy database because it gives users an opportunity to implement new technologies, without worrying of losing their data. In this study we have attempted to develop a software that has extracted vast amount of health data from the old computer database of the health information system of Mozambique to their new and modern computer database.

3.0 Health information systems reform

There have been many problems reported on the performance of health information systems in developing countries (see e.g. Braa et al. 2001; Lippeveld et al. 2000; McLaughlin 2001; Simwanza and Church 2001). In the 1990s, many developing countries have been engaged in restructuring their health information systems. In Tanzania for instance, the former President of the United Republic of Tanzania His Excellency Ali Hassan Mwinyi in a speech presented on 8th June 1990 was quoted as saying, “we need to improve our health information systems in order to enable individuals and the government to make sound decisions based on correct information” (MoH 1993, p. i). Similar health information systems reform efforts have been reported from South Africa, Zambia, Uganda, and Mozambique (see Braa and Hedberg 2002; Mwaluko et al. 1996; Simwanza and Church 2001). The important health information system reform in Mozambique occurred after independence in 1975. However, those efforts were deteriorated by the 16 years (1976 - 1992) civil war. Mwaluko *et al.* describe socio-economic reforms in Mozambique that, “with the peace agreement in 1992 and the democratic elections in 1994, the new government designed an economic, and social programme, emphasizing National Reconstruction and Rehabilitation of Economic and Social Infrastructures” (Mwaluko *et al.* 1996, p.4). Peace time in Mozambique has made it possible for people to re-establish effective communication with the population in areas formerly cut off by the war and to collaborate with the communities in planning and implementation of programmes intended to help them to improve their lives.

While restructuring health information systems, many countries focus on decentralising their systems to empower the lower levels in the HIS hierarchy. According to Muquingue *et al.* (2002), national health information systems are built up from the informational activity carried out in multiple, minuscule, often

hierarchically insignificant points in the geographical structure of a country; these points are generally districts. The administration structure of many developing countries includes the community (village), district, provincial and national levels. The national health information systems in many developing countries have been strongly based on Primary Health Care (PHC) and the district becomes the most appropriate level for co-ordinating top-down and bottom-up planning, for organising community involvement in planning and implementation, and for improving the co-ordination of government and private health care (WHO 1987). Being the information and physical hub between the community and the national health information system, the district consists of a large variety of interrelated elements that support the health system in a specific geographical area. A district includes the health care workers and facilities, up to and including first and second referral hospital levels (Amonoo-Lartson *et al.* 1984).

4.0 Application of IT in HIS

As many HIS reflect reform processes, the drive for the reform coincided with a revolution in information and communication technology (ICT). The computer has knocked on the doors of even the most reluctant Ministries of Health, like the computer import ban of Tanzania (Spletstoesser and Kimaro 2000). With this state of the art of technology combined with pressure from the computer industry, most HIS restructuring is featured by computerisation to a certain degree.

The computer database system of the Ministry of Health in Mozambique (known by its Portuguese acronym SISDB - Sistema de Informação de Saúde Base de Dados) was developed and deployed at the national and provincial health directorates in 1992-1994. The database was developed on "dBase III" relational database management system (DBMS). In Tanzania, the first national computer database of the Ministry of Health was developed in Mid 1990s on "dBase IV". However, due to cumbersome operations of that dBase IV database, the Ministry of Health in Tanzania decided to scrape it away and introduce a new database developed on Microsoft Access 97 (known by its Swahili acronym MTUHADB - Mfumo wa Taarifa za Uendeshaji wa Huduma za Afya Database) in the year 2000 (Lungo 2003a). MTUHADB is installed in all Regional Medical Offices in Tanzania.

In this study, the threats of LIS in the reporting of the routine health delivery services in the HISs were examined using case study sites from Tanzania and Mozambique. The authors are pioneers and active members of a broad participatory action research, Health Information Systems Project (HISP), in their respective countries of origin. HISP started in South Africa in 1996 and has spread to other countries including Mozambique, Tanzania, India, and Cuba

(Braa *et al.* 2003). In Mozambique, HISP started in 1999 where the DHIS software is piloted in three provinces, Gaza, Niassa, and Inhambane. A memorandum of understanding between the University of Oslo and university of Dar-es-Salaam in collaboration with Ministry of Health in Tanzania was signed in July 2002, which form the contractual agreement of the implementation of HISP project in Tanzania.

HISP is featured by open source software, District Health Information Software (DHIS), designed for being used at district levels as a health data analysis tool (Braa and Hedberg 2002). The argument is that districts should be empowered to be able to analyse and interpret health data. For the districts to be able to do so, HISP argues for a strong decentralisation of the health information systems to the district and sub-district levels. In addition, a computer-based database system should be implemented at the district level to facilitate better storage, analysis, and dissemination of health data. This is important because in many developing countries, Tanzania and Mozambique being examples, their respective health information systems use paper-based databases at the district levels.

5.0 Research Methodology

This study follows under the paradigm of “Action Research Paradigm”. Action research has been typified as a way to build theory, knowledge, and practical action by engagement with the world in the context of practice itself (see, e.g. Kock 1997; Whyte *et al.* 1991). Dick (2002, p.1) explains an action research as a research approach, which has the dual aims of action and research:

- action to bring about change in some community or organisation or program;
- research to increase understanding on the part of the researcher or the client, or both.

In this study, five phases of action research approach are adopted, as Baskerville and Wood-Harper (2002, p.133) argue that, “the most prevalent description of action research details a five phase, cyclical process which can be described as an ‘ideal’ exemplar of the original formulation of action research”. This ideal approach first requires the establishment of a ‘client-system infrastructure’ or research environment. Then, five identifiable phases are iterative: (1) diagnosis, (2) action planning, (3) action taking, (4) evaluating, and (5) specifying learning. The key assumptions of action research are that “social settings cannot be reduced for studying and that action brings understanding” (Baskerville 1999, p.7).

Diagnosing: Baskerville and Wood-Harper (2002, p.134) describes diagnosing phase as it “corresponds to the identification of the primary problems that are the underlying causes of the organisation’s desire for change”. Diagnosing involves self-interpretation of the complex organisational problem to develop

certain theoretical assumptions about the nature of the organisation and its problem domain.

Action Planning: After the diagnosing phase, researchers and practitioners then collaborate in the next activity, action planning. The discovery of the planned actions is guided by the theoretical framework, which indicates both some desired future state for the organisation, and the changes that would achieve such a state. The plan establishes the target for change and the approach to change.

Action Taking: This phase implements the planned action. The researchers and practitioners collaborate in the active intervention into the client organisation, causing certain changes to be made.

Evaluating: After the actions are completed, the collaborating researchers and practitioners evaluate the outcomes. Evaluation includes determining whether the theorised effects of the action were realised, and whether the effects relieved the problem. Where the change was unsuccessful, some framework for the next iteration of the action research cycle (including adjusting the hypothesis) should be established.

Specifying Learning: The knowledge gained in the action research (whether the action was successful or unsuccessful) can be directed to three audiences (Baskerville, 1999).

First, the restructuring of organisational norms to reflect the new knowledge gained by the organisation during the research, and second, where the change was unsuccessful, the additional knowledge may provide foundations for diagnosing in preparation for further action research interventions. Finally, the success or failure of the theoretical framework provides important knowledge to the scientific community for dealing with future research settings (p.14).

Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science through joint collaboration within a mutually acceptable ethical framework. The ideal domain of action research is therefore revealed in three distinct characteristics (Baskerville and Wood-Harper 2002 p.136) of the approach: The researcher is actively involved, with expected benefits for both researcher and the research client, in this case the district medical officer. The knowledge obtained could be immediately applied. The research is a cyclical process linking theory and practice.

The action research approach was important in this study because we wanted to attempt to extract health data from old systems so that health systems can migrate to new and modern computer systems with their historical health data.

6.0 The research design and methodology

The research design strategy was to perform case study in multiple sites. The study was conducted in two countries, Tanzania and Mozambique. In each country, the study involved several health units as case study sites. Three health information software were studied. The software are the national computer database system of the Ministry of Health in Mozambique (known by its Portuguese acronym SISDB - Sistema de Informação de Saúde Database), District Health Information Software (DHIS), and the computer database system of the Ministry of Health in Tanzania (known by its Swahili acronym MTUHADB - Mfumo wa Taarifa za Uendeshaji wa Huduma za Afya Database). These are described as follows:

6.1 Sistema de Informação de Saúde Database (SISDB)

SISDB is the national computer database system of the Ministry of Health in Mozambique installed at the National Health Information System (NHIS) section of the Ministry of Health and in all Provincial Health Directorates in the country. SISDB was developed and implemented at the national and provincial levels since 1994. SISDB was developed on "dBase III" database management system (DBMS).

6.2 District Health Information Software (DHIS)

DHIS is an open source software from South Africa, which was introduced in the health information system in Mozambique through the Health Information Systems Programme (HISP) since the year 2000. The DHIS has many functions such as maximum and minimum ranges, validation rules, data definitions, indicators, report generator, a number of modules ranging from PHC to hospital and TB, organisational unit infrastructure, and annual surveys. DHIS was designed to capture health data at the district level of the health information system. In Mozambique, the DHIS is currently being piloted in Niassa, Inhambane, and Gaza provinces.

6.3 Mfumo wa Taarifa za Uendeshaji wa Huduma za Afya Database (MTUHADB)

MTUHADB is the national computer database system of the Ministry of Health in Tanzania. MTUHADB was developed on Microsoft Access 97 database management system and was installed in all Regional Medical Offices in Tanzania in the year 2000.

In this study we analysed the design and implementation of the computer databases in both countries, through the use of self-administered questionnaire while conducting interviews with health workers. As it is discussed in section 7.0 (results), the health information systems in Tanzania and Mozambique were observed to be reluctant in introducing important health reforms approaches

including implementing modern computer database systems, because the current old systems they run has vast amounts of data.

To address a way of leveraging the health systems from legacy systems, we developed Extraction Transformation and Loading (ETL) software and demonstrate how the software works. Through that extraction transformation and loading (ETL) software, we managed to extract and load health data from 1999 to March 2002 in Mozambique from the SISDB to the DHIS.

6.4 The Extraction, Transformation and Loading Software

To extract data from one computer database to another, you need to know, what is exactly to be extracted from the source database system. Health facilities have a defined list of health data elements that health workers record their instances. For example, number of deliveries per month, number of out patients visited the health facility per month, etc. Thus, these data elements are constant values; the health data is the count (data entries) of occurrences of these health data elements. A complete routine services reporting record could be “February 2003, rural hospital Chicumbane, number of deliveries is 39”. This record has four main parts: period, place, data element name, and data entry value. Period is ‘February 2003’, place is ‘rural hospital Chicumbane’, data element is ‘number of deliveries’, and the data entry is ‘39’.

Data element name, health facility/organization units (place), and period are pre-defined values, thus, they exist in both databases, SISDB and DHIS. To extract health data from one database to another we need to transfer the “data entry” values from the source database to the target database. To do so, we need to map the three parameters: “place” where the data was recorded, “period” when the data was recorded, and “name” of the data element and the health facility from the source database to that of the target database. After mapping those three parameters, the next step is to copy the data entry values from the source database to the target database.

Major discrepancies between SISDB and DHIS

Date formats: SISDB database stores date into two data fields in number format while the DHIS stores date filed in one column and in the date format. For example, SISDB has “ANO (year)” column and “MES (month)” column, e.g. February 2000 is stored as follows:

ANO	MES
2000	02

While the DHIS stores the same date as follows:

Period
February 2000

Naming of data element system: SISDB uses short name of health facilities, like “cs Alto Changane”, while the DHIS uses long name like “Centro de Saúde de Alto Changane”. The SIS database uses abbreviation symbols to record the data field (data elements), while the DHIS uses full name, see Table 1.

Table 1: Names of health data elements in SISDB and DHIS

ID	SISDB Data Field	Related Paper Form	DHIS Data Field
8	CCM	B06	No Mau Crescimento 0-35 meses
9	CP1	B08	1as Consultas Pré-natais

Source: Comparative analysis of SISDB, DHIS, and SIS paper forms

Different data field values that represent the same thing: The DHIS records the name of the health unit, while SISDB records the code of the health unit. In addition, DHIS records more details of the health unit than those given in the SISDB.

Table 2: Data fields and names of health facilities in the DHIS

strDataField	strOrgUnit	dblEntry
1as Consultas 0-11 meses	Centro de Saúde de Alto Changane	247
1as Consultas 0-11 meses	Centro de Saúde de Alto Changane	290
Consultas seguintes 0-11 meses	Centro de Saúde de Alto Changane	65

Source: Analysis of the DHIS export file, April 2002

Table 3: Data fields and codes of health facilities in the SISDB

DCOD	UCOD	CP1
10	01	1248
10	02	695
10	16	583
10	08	286
10	10	159

Source: Analysis of SISDB data files, April 2002

Where, ‘DCOD’ is the district code, ‘UCOD’ is the health unit code and ‘CP1’ is the name of the health data element called “1as Consultas 0-11 meses”. The default value for SISDB is ‘zero’, while that of DHIS is ‘null’. The unit of analysis of SISDB is the provincial level, while the unit of analysis of the DHIS is at district level. The difference is that with SISDB, data are recorded by district, while in DHIS data are recorded by health facility.

The ETL software is built on homogenous architecture, as it involves only a single source system and a single target system. Data flows from the single

source of data through the ETL processes and is loaded into the target system, as shown in the Figure 1.

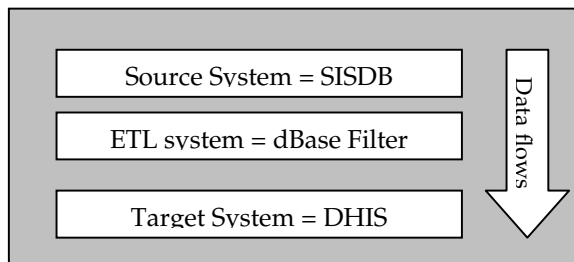


Figure 1: Database Filter system architecture

The ETL system connects the two databases using connection “bridges”, and maps from the database to the ETL system. This enables the ETL to copy the data from the source database (SISDB) to its temporary data files, and transforms the data into a format that the target database (DHIS) understands. To load the data to the DHIS, the ETL system creates texts and Microsoft Excel files. The DHIS imports the data to the DHIS database. Figure 2 presents how the ETL system integrates the DHIS and the SISDB databases.

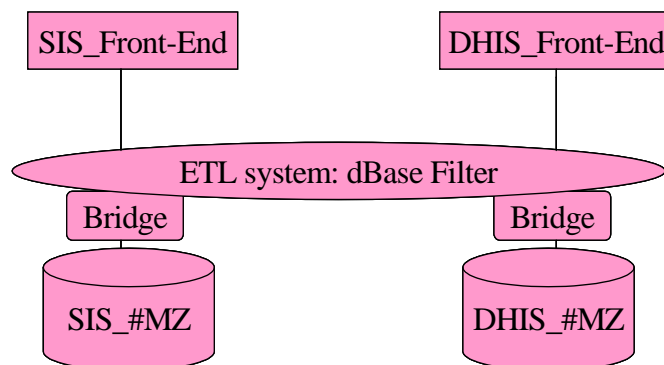


Figure 2: SISDB and DHIS integrated by Database Filter ETL system

This ETL system consists of four distinct functional elements: Extraction, Transformation, Loading, and Meta data

Extraction: The extraction element is responsible for extracting data from the source system. This ETL software connects to the SISPROG and DHIS databases at the same time, then copies the data, leaving the original data in place.

After connecting to the SIS database and the DHIS, the program presents screens that allow users to map health units and health data elements from that of SISPROG to DHIS. Figure 3 presents health data elements from SISDB and DHIS, so that users can match the two lists

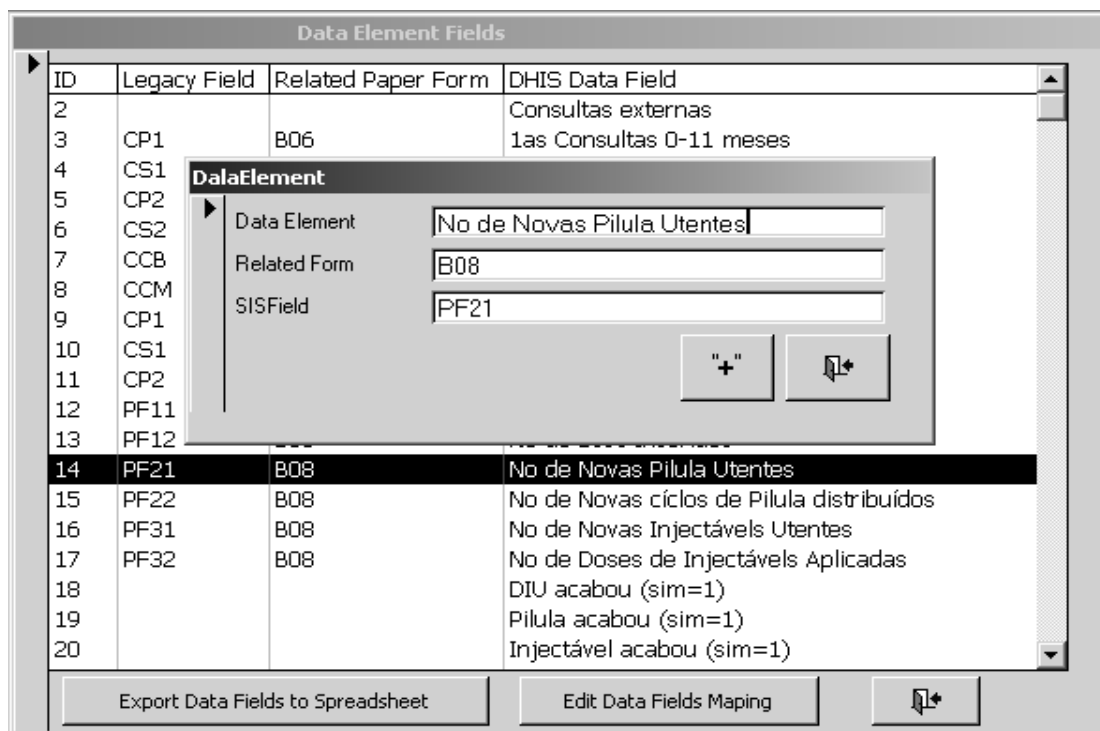


Figure 3: Mapping data elements from SISDB to DHIS

When the mapping of data elements is ready, the next step is to load the data in temporary data files using a command menu “Update Data File” (see Figure 4). The subsequent commands in Figure 4.6 have the following functions:

- Select Data Field – allow the user to select the data elements to extract data
- Create DHIS File – this command performs the transformation functional element of the ETL system.

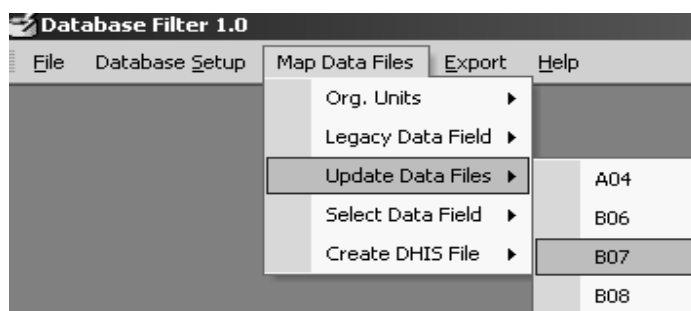


Figure 4: Extracting data modules

Transformation: The major tasks performed here are data validation, data accuracy, data-type conversion, and business rule application.

Data validation: This is important to enforce data integrity. Table 5 presents the DHIS import file headings. Since SISPROG has no data entries for every column,

default values were added to the columns that cannot receive data from the source database.

Figure 5: DHIS Import file headers

strDataField	strOrgUnit	Period	dblEntry	strComment	intMin	intMax	ysnDisplay	strUser	dtmChanged
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Data accuracy: To ensure that Boolean data fields contain appropriate values, "YES or 0" values from SIS are converted to "TRUE" and "NO or 1" values from SIS are converted to "FALSE" in the 'ysnDisplay' column of Table 5

Data type conversion: This is to ensure that all values for a specified field are stored in the same way in the target system (DHIS) regardless of how they were stored in the source system (SISPROG). Thus, the major task here is to convert the "dates" and 'names' data types used in SIS to conform to the DHIS data types. Figure 6 shows how SIS date format was converted into DHIS date format.

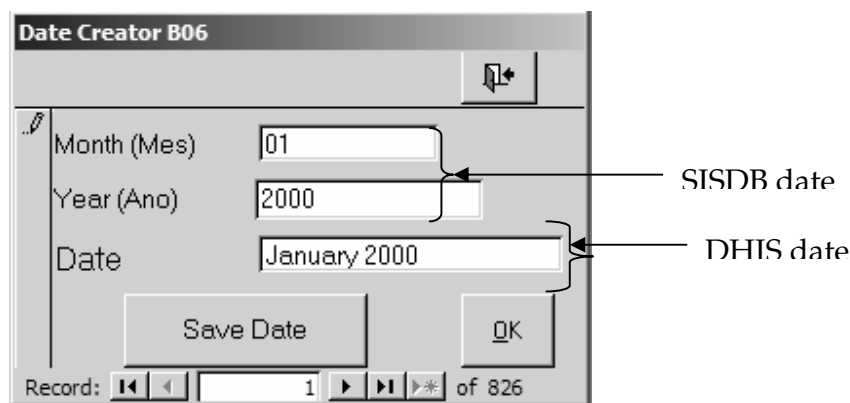


Figure 6: Date creator

Business rule application: The default values for SISDB is 'zero' while that of DHIS is 'null'. However, the business rule in HMIS is that a health unit can report 'zero' occurrence of health data element in a certain period. Since SISDB has zero as its default values. This is contradicting in that, either the health unit did not report or it has reported zero values. However, for my interest, the SISDB data will be imported as they are, that will help in assessing the quality of the data. Figure 4.8 presents extracted and transformed SISDB data in the Database Filter ETL software system.

Loading data: Extracted and transformed data is saved in a text file formatted as a DHIS import file. This resulting text file then is loaded into the DHIS using the import module of the DHIS software. The data extracted can also be exported to Microsoft Excel file, however the DHIS can only accept data formatted in 'text file'.

Meta data: The ETL system meta data functional element is responsible for maintaining information (meta data) about the transformation of data and documents the data mapping used during the transformation. This allows users to save their data elements and health units mapping, so that they can retrieve the mapping, instead of mapping it again in the future. For example, if one maps all health units from Gaza province, then Inhambane province, it should be possible to see the mapping of Gaza again.

7.0 Results

7.1 General features

The databases studied are uncompleted: The SISDB was expected to computerise 10 data collection paper forms of the Ministry of Health in Mozambique, however; only four forms were computerised fully. The MTUHADB has many uncompleted reports and data entry forms. For example, It is not possible to review the entries of data entered through the computer form F002. There is no report out of F002 available. Form F005 does not allow the data entry of drug kits for other health facilities except "Local Government owned health facilities", while MTUHA policy requires private facilities to report. In addition, in MTUHADB, there is mismatch between the paper forms data field with that of the database capture form.

The databases are without software specifications: The Ministry of Health in Tanzania did not receive the MTUHADB systems specification and the source codes. As a result, the Ministry of Health has to consult the software vendor for any changes to be made in the MTUHADB. The SISDB was developed a decade ago. At the time of this study, no system design specification and the source codes found. The consequences of lack of source codes and because of being developed long time ago, the vendor of SISDB is no where to be found and thus no one was able to reprogram further the database in order to accommodate the dynamic changes.

Date formats: The two databases store date as text and in two data fields. That is, "May 2003" would be stored as

05		2003
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. For example, In the MTUHADB form F004, dates have to be entered as a text, this implies that is not possible to sort the data according to the date and users cannot perform operations related with dates.

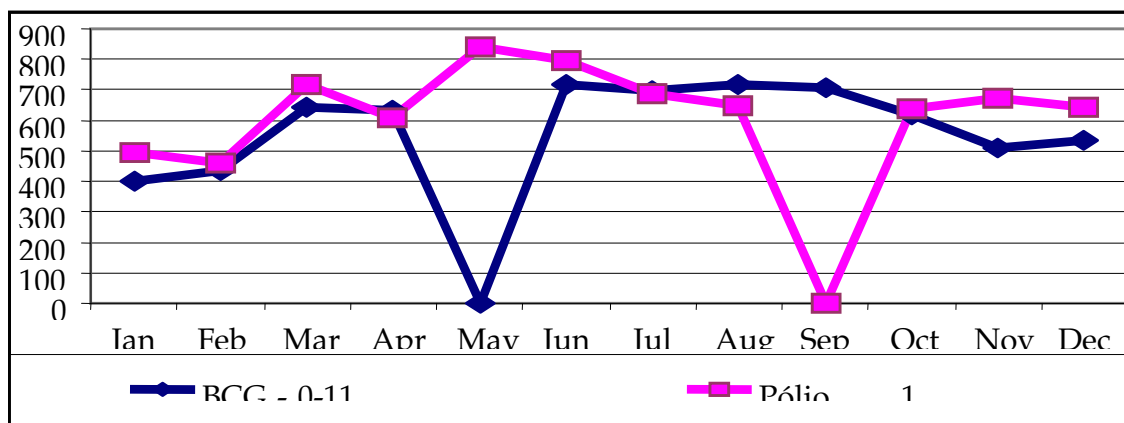
7.2 Poor design of the legacy information systems lead to incomplete reporting

This study indicates that, the newly introduced health data elements after the computer database come into operations are not incorporated in the computer databases. This is because the databases were designed in such a way that, the health data elements are "hard coded" and thus to introduce a new data

“DPT/Hep B” and “Vitamin A supplements”. Until the time of this study, the SISDB was unable to record information for “DPT/Hep B” and “Vitamin A supplements” because there was no one to reprogram the SISDB in order to introduce the new columns for the two data elements.

7.3 Poor design of the LIS degrades the quality of the health data.

This study indicates further that, poor quality of the health data is contributed by the poorly designed computer databases. The SISDB has “zero” values as default values. That means, if a health unit did not report, the database put zero automatically for the corresponding data elements. As a result, health planners are not able to tell whether there was a “zero reporting” or “non-reporting”. Figure 1 and Figure 2 show how the zero values cause different interpretations for decision-makers and health planners.



7.4 Old technologies used to develop the LIS impose burden to health workers.

The SISDB is designed in dBase III DOS version and is running on Microsoft Windows 95. The operation of the database is slow, the computers where the database is installed have very limited memory, and most are 16 MB RAM and 700 MB hard disk capacity. Despite the existence of more powerful computers, at the time of this study the Ministry of Health had no installation files for the SISDB, thus it was not possible to install SISDB onto the new computers. Figure 3 shows photos of two health offices equipped with two computers each, one for the old database (the old one), and the new one for secretarial purposes.



Figure 2: Despite the existence of new powerful computers, the legacy systems are running on the old computers.

The old computers cause burdens to the health workers for them have to take longer time to accomplish some tasks that could have been performed in short time with powerful computers. For example, it takes up to 8 minutes for the computer to start. If users want to include the health data in their reports in word processors, they have to print the data, and then re-type them on their reports because the computers are not able to copy-paste large amount of data. In addition, if they want to transfer the data to another computer (sharing data), they have to use diskettes or ZIP drives because the computers have no CD writers, however not all health offices have ZIP drives thus the common method is to use diskettes. To generate a customised graph of the health data, users used to print the data and retype them in spreadsheet software like Microsoft Excel. This is because the graph generated by the SISDB cannot be copied to word processor programs because is generated in MS DOS program.

7.5 Data locked in LIS can be migrated into new suitable information systems

In this study, we prototyped a computer database, District Health Information Software (DHIS) at the district level. The aim was to demonstrate how the DHIS can be used as a health data analysis tool at the district level. In our prototype, we decided to populate the DHIS software with real data from the field. To do this, we had two options: to key in data from the completed paper forms or to develop software in order to extract data from the SISDB to the DHIS. We decided to develop an extraction transformation and loading (ETL) software. The ETL was designed successfully and we managed to populate the DHIS with health data captured in SISDB from 1999 to April 2002.

8.0 Discussion

8.1 Reflections of the findings

Our reflections on the findings is that, the poor design of the LIS was a result of old technologies during the implementation of those computer systems, the

structure of the health information systems (vertical reporting systems), and limited computer skills of the health workers.

8.1.1 old technologies

The LIS were implemented in old computer technologies (old version of database management systems and old computers (486 family)). This reflects the reality that during those days, these technologies were the available technologies.

8.1.2 The structure of the health information systems

The health information systems were structured in such a way that, all major health data analysis and interpretations were centralised at the national levels, so the focus were to compile the data at the provincial level and send to the national level. In those days, the unit of data analysis was at the provincial level and the districts were seen to have very limited capacity in analysing data. As a result, the computer systems were installed at the provincial level and not at the district levels.

8.1.3 Limited computer skills of the health workers

The designers of the systems focused on that users have very limited skills and thus a suitable system for them is one that is fixed so no changes will be required. As a result, they designed systems that cannot accommodate the dynamic changes of the health information systems, like the introduction and deletion of different health data elements.

8.2 The need for changes

Now days there are computers that are more powerful and the computer technologies have substantially advanced. The health information systems reform focus is the districts (WHO 1987). This also implies that the districts need to be empowered in order to analyse health data. Thus, there is a need for changes.

8.3 Implementing a new computer database: lessons learned

As this study was performed under the HISP project, its main goal was to shed light on problems of the old computer databases and to pilot the new one, the DHIS. The study, focused on the progress of the HISP project in order to identify learning lessons that could be sensitively applied in other developing countries. The lessons to share in replacing the LIS and introduce new ones are that (1) the new databases need to be extensively demonstrated to health workers. In this study, we populated the new database with real health data and conduct on site and workshop trainings for health workers, and (2) deliberate political negotiations between the collaborating project and the Ministries of Health need to be in place. This is because technical solutions are not convincing enough the Ministries of Health officials.

9.0 Conclusion

In this study, we are calling the attention of the Ministries of Health to review the performance of their computer databases. This is because the old information systems are contributing to the underperformance of the health information systems. We further conclude that, in relinquishing the old information systems, a deliberate effort should be introduced to secure the health data locked in the old systems. In this study, we managed to extract data from SISDB designed in 1994. While selecting new computer database to be used in the health information systems, sustainability should be the main guiding principle. We further conclude that the DHIS is suitable software for health data analysis.

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8.5. APPENDIX E

KAASBØLL, J. J. & NHAMPOSSA (2002). Transfer of public sector information systems between developing countries: south-south cooperation. IN KRISHNA, S. & MADON, S. (Eds.) Social Implications of Computers in Developing Countries. Bangalore, India, IFIP. 507-517.

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.

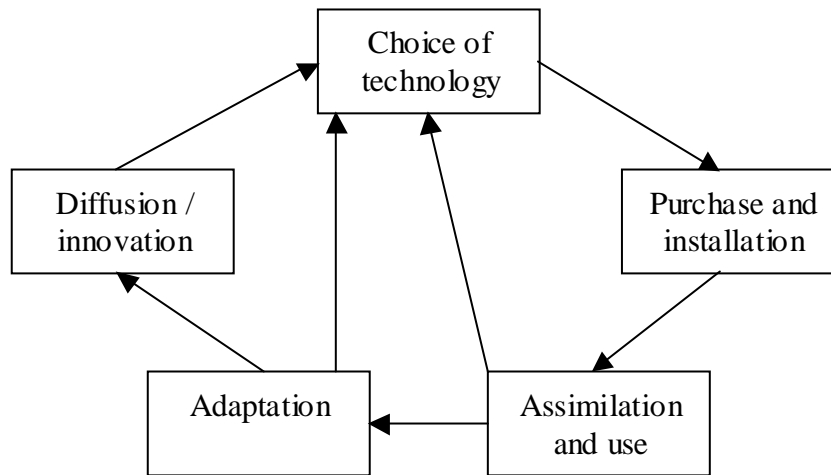


Figure 1. The information technology transfer life-cycle (Baark and Heeks, 1999, p.187)

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 health 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

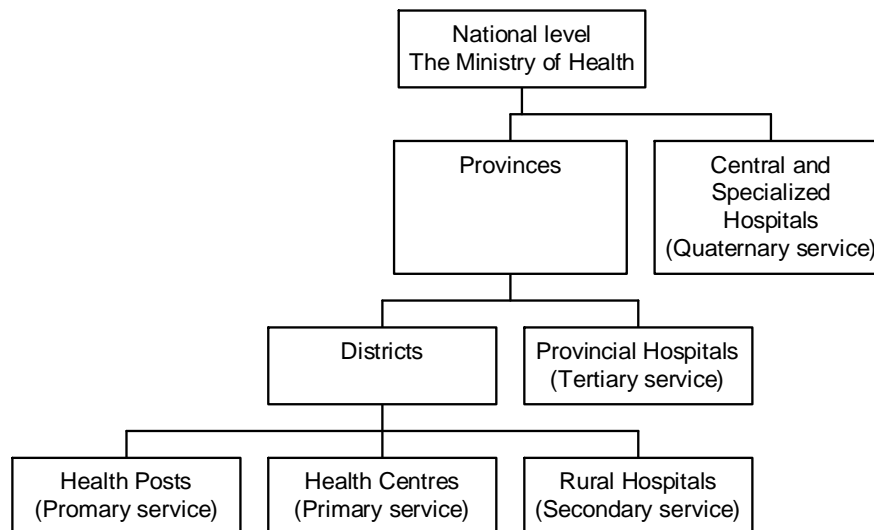


Figure 2. The health system in Mozambique.

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, health 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

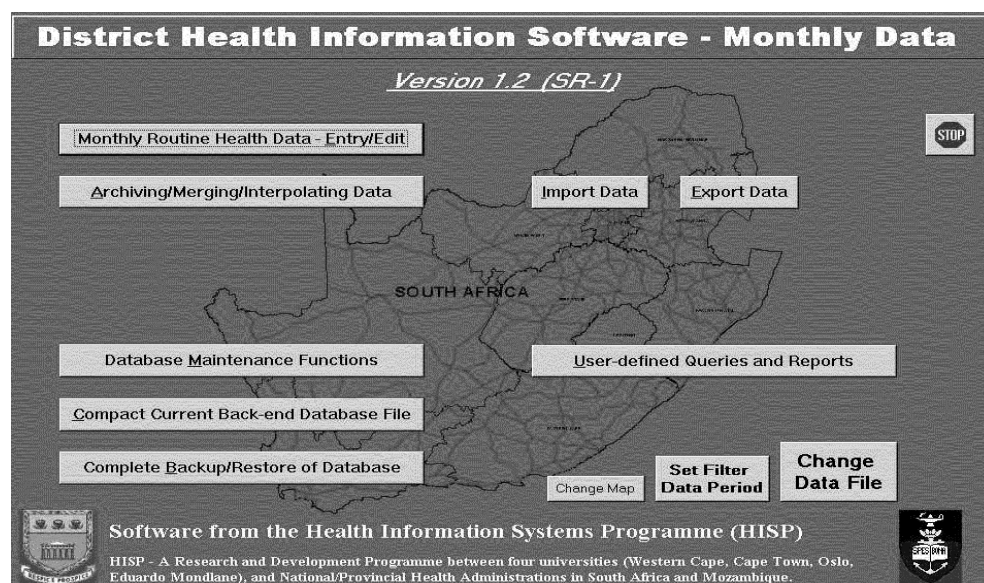


Figure 3. The main display of the South African version of the District Health Information Software.

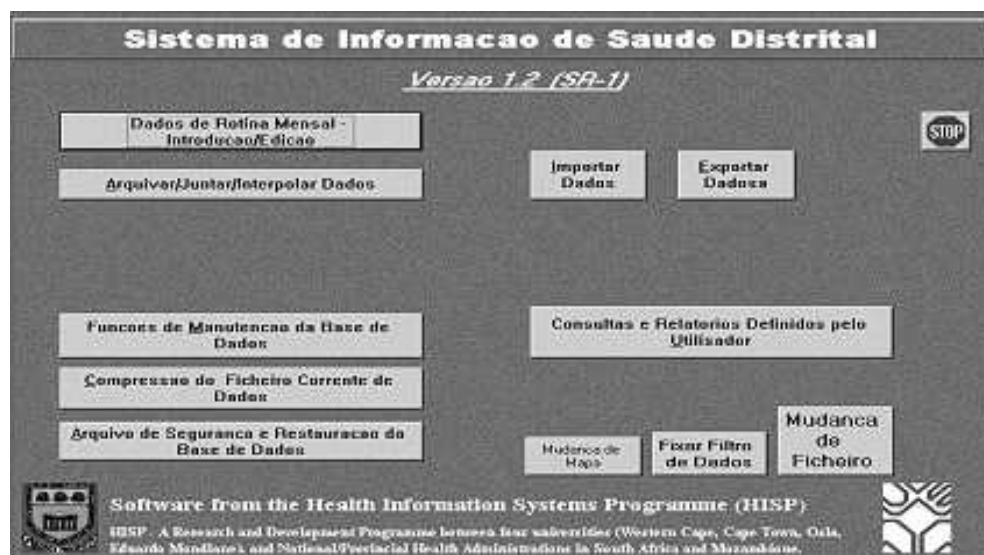


Figure 4. The Portuguese version of the District Health Information Software.

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.

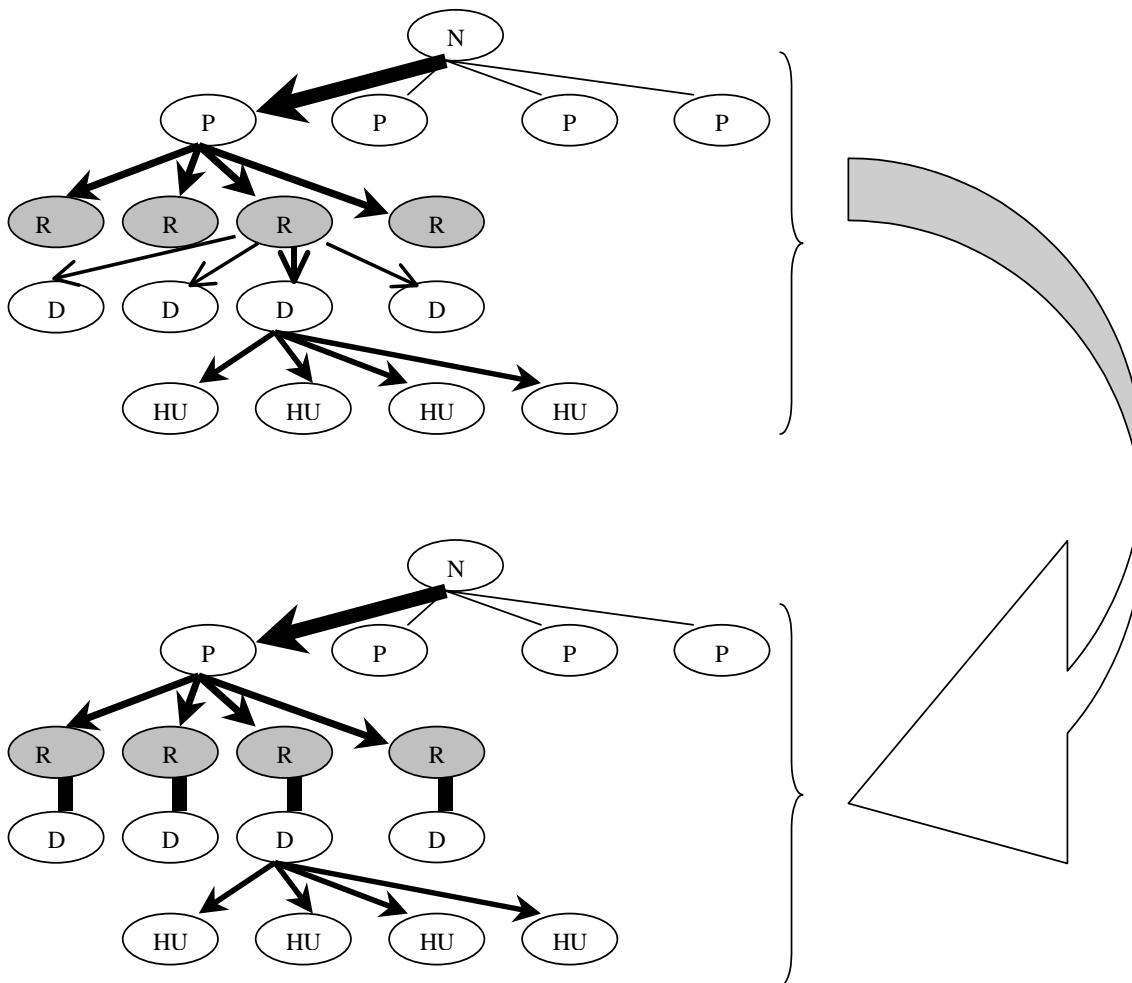


Figure 5. Inserting a dummy organizational layer in the data

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

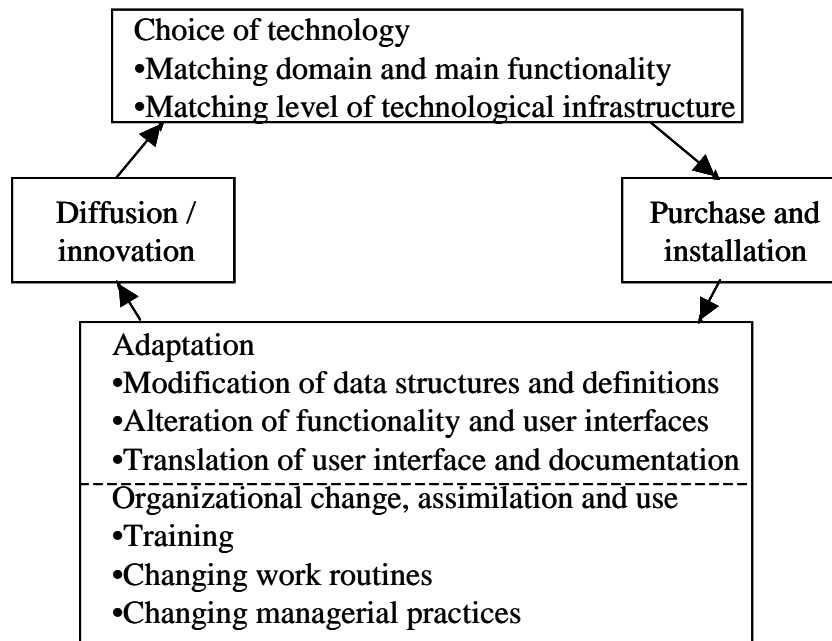


Figure 6. Model of transfer of information systems.

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.

Acknowledgement

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8.6. APPENDIX F

NHAMPOSSA, J. L. & SAHAY, S. (2005). Social construction of software customization: the case of health information systems from Mozambique and India. IN BADA, A. & ADELAKUN, O. (Eds.) Enhancing human resource development through ICT. Abuja, Nigeria, IFIP. 339-347.

Social Construction of Software Customization: the Case of Health information Systems from Mozambique and India

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ABSTRACT

Debates around the internationalization and localization of software are widespread in the current context of globalization. This paper argues the need to include in these debates, the question of the process of software customization itself, which is extremely context dependent, and can influence the content of the software itself. A social construction perspective is drawn upon to make this argument, drawing upon an empirical analysis of the customization process of the same application software within the primary health care domain set in two different countries – India and Mozambique. The analysis identified four conditions that contribute to the very different outcomes in these two settings: the health sector context; the organization of the development team; the nature of the customization process; the nature of the installed base; and the question of language.

Keywords: *Internationalization, localization, customization, software, primary health care, India, Mozambique.*

1. INTRODUCTION

In contemporary times of globalization, there are increasing pressures on developers to create internationalized software that can be used in different settings (O'Donnell 1994; Howard 1993). There are two broad approaches to this problem of internationalization. One, software is developed from the outset as one to be used in varying international settings, and internationalization is incorporated as one element of the software development cycle. In the second approach, software is developed for local settings as internationalization is not considered as a pre-defined aim, but is subsequently attempted to be adapted and customized to different national situations (Braa and Hedberg 2002). In the first approach, the development process is very resource intensive as the application needs to incorporate functionalities for different languages and cultural contexts of use. Also, since the context of use is always changing, there is continued pressure for the development agency to acquire new knowledge and incorporate it in the newer versions of their application. In the second approach, while the development process is initially not so resource intensive, there are other pressures relating to individual customization efforts in each context raising the potential danger of "reinventing the wheel." A middle ground to these approaches is what Rolland and Monteiro (2002) describe as the "pragmatic balance" where the focus is to try and distinguish between context dependent and independent components, and try to globalize the independent parts and focus on the dependent parts for local customization.

However, this pragmatic balance is very complex to attain in practice as it is influenced by many aspects including the development process itself by which the software customization takes place. In this paper, we argue that understanding the nature of this social construction process of software development, for example, related to the organization of the software team, can provide insights into how the customization process of the same software application can lead to varying outcomes in different social contexts.

Our empirical focus is in the domain of not for profit and open source software related to the primary health care in developing country contexts. Challenges, similar to those around the internationalization of commercial software, and associated debates around their globalization and localization, are also to be found in the domain of not for profit and open source software. While in the domain of commercial software, research related to internationalization has been rather limited in its focus on aspects of the user interface and how it can be internationalized by changing colours, or icons and symbols (Ott 1999; Barbour 1996), the open source related research questions take on a different focus. For example, in the open source domain, prior research has examined how the beliefs and values of developers working collaboratively but in distributed settings are manifested in software development methods, artefacts, choice of tools, and how developers in a virtual community cooperate and resolve conflicts (Elliot and Scahhi 2003).

There are at least two important contextual differences between the commercial and not for profit domains which begs different research questions. One, a majority of the research in the open source domain relates to more system related applications such as operating systems like Linux where computer experts form the development community. The development environment is much different in application specific domains (such as primary health care) where there may be a more significant proportion of "context dependent" aspects as contrasted to the system related applications. Two, the level of computing expertise in the application domain, such as primary health, is much lower than in those taking place in the traditional open source systems related domains. This difference in expertise is especially magnified within the context of developing countries.

Given this brief background, the aim of this paper is twofold. Firstly, to understand the nature of the social construction of software customization of a primary health care application in developing country contexts. Secondly, through this analysis, we seek to understand the implications of the customization process around internationalization-localization debates of open source and not for profit applications.

The rest of the paper is organized as follows. In section 2, we present some theoretical considerations arising from a social construction of technology perspective. In section 3, we present the case study concerning the customization of the same primary health care application (called DHIS) in India and Mozambique. After presenting the analysis in section 4, we present some brief implications and conclusions in section 5.

2. THEORETICAL CONSIDERATIONS

Social construction refers to the process by which social meaning becomes embedded into an object under study, be it science, technology, or other forms of knowledge (Berger and Luckmann 1967). The common-sense methods which go into the development of this meaning, and social interests which account for this process, becomes units of study for the constructivist. Technology, is not viewed as objective truth which is independent of the social world, but is seen to be shaped by social processes related to their design, implementation and use

(Pinch and Bijker 1987). Social construction of technology studies have described the importance of social alliances and control (for example, Noble 1984), social groups and their frames of meaning (Bijker 1987), the use of heuristics (Van den Belt and Rip 1987) and various organizational issues (Mackenzie 1987).

Over the years, the social construction of technology approach has been applied to the analysis of information systems, and concepts such as technological frame (Orlikowski, 1992), reinvention (Johnson and Rice 1987), relevant social groups (Blonk 2002), interpretive flexibilities (Orlikowski, 1992) and unintended consequences of technology (Zuboff 1988) have been developed and applied. Early research in this domain has contributed to subsequent developments, for example, the application of Actor Network Theory to develop theoretical concepts of information infrastructures (Hanseth and Monteiro 2004).

Despite the wide acceptability of the social construction approach to IS, we believe, the potential of this has not been applied to the domain of the process of software customization. Software customization involves people and machines; both situated and distributed, practices, methodologies and tools, all linked together in a heterogeneous network that is historically and institutionally embedded. Like any other social activity the work of customizing software is situated, taking place in particular locations and times, and being performed by people who act upon their specific contexts of knowledge, tools, tasks, social networks, and their own particular histories (Tellioglu and Wagner 1999).

The social construction of the software customization process is empirically interesting to examine when the same software is customized in different national settings, for the same application domain (primary health care in our case) by different local groups of developers. This social analysis will be useful as in the primary health care domain the dominant World Health Organization (WHO) model for information systems is applied to developing countries. There is an implicit assumption made that the same application model can unproblematically be applied to different country situations (Braa et al. 2004). Such an assumption, we argue through the empirical analysis of this paper, is incomplete as it does not take into consideration the context dependent aspects of the software, which is shaped significantly also by the very process of software customization. We draw upon this social construction perspective to analyze two cases in India and Mozambique where the same DHIS application is being customized for local needs. We now present the case studies.

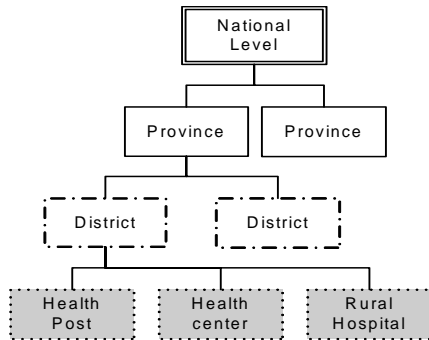
3. CASE STUDIES

3.1 Comparative context of HIS

Mozambique and India, two developing countries, are the focus on the analysis where the customization of the DHIS software under the broader Health Information Systems Programme (HISP) is currently ongoing (Braa et al. 2004). While there are similarities in the reporting structures of both countries (See Figure 1), there are important differences, for example, Mozambique has four reporting levels and India six. There are also significant differences in terms of scale with a Mozambique province having the same population level and much fewer clinics as compared to the Indian district. These contextual differences have implications on both the design and use of HIS.

There are also significant contextual differences with respect to availability of trained people (both in computers and doctors), infrastructure availability, disease prevalence and the role of donors. While India is considered as a software powerhouse in global terms (although around 90% of Indian software is for exports) with a large pool of trained people, Mozambique has barely 200 computer graduates from their local universities. In terms of infrastructure, Indian rural areas may be more stable than Mozambique, for example, related to public transport which influences the transmission of reports from one facility to the other. While both countries are dependent to a large extent on donor funds, in Mozambique where 80% of the health sector budget is comprised of external support, in India, the figure is much lower. This dependence shapes the nature of donor influence on HIS design and use.

HIS structure of Mozambique: 4 levels



HIS structure of India: 6 levels

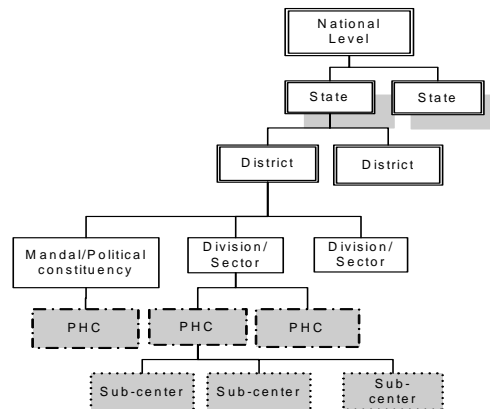


Figure1: HIS structure of Mozambique and India

After this very brief summary of some key contextual differences between the two countries, we describe their respective process of customization of DHIS from 1999 and 2000 respectively.

3.2 DHIS customization process in Mozambique

Mozambique installed a computer based HIS (called SisProg) in 1992 in all its 11 provinces and the national level. Routine health data from the districts was carried in paper forms to the province where it was entered into SisProg, aggregated and sent in electronic (floppy disks) or paper formats to the national level¹. Despite SisProg being practically irrelevant in supporting local decision making, the system has over time become deeply embedded into the practices of the Ministry making it difficult to replace. It is within this context, HISP researchers comprising of staff and students from Oslo and Mozambique started attempting to customize and implement DHIS in 1999 in selected pilot districts in three provinces (Braa and Hedberg 2002).

As part of the strategy to adapt the HISP software, a multidisciplinary team was formed, composed by academicians with training in computer sciences and medicine and health management professionals working at the Ministry of health. The team members were also subsequently enrolled for the Phd program at Oslo on the assumption drawn from action research that the project work will provide the empirical basis of the research, for example, related to questions concerning technology transfer of HIS to developing countries. However, it was not possible to always find a one-one correspondence between project and research, for example, one of the team members was working on practices related to laboratories where DHIS was not involved. This mismatch, magnified by scheduling issues of people being in Norway for their studies during different time periods, meant that the team was not always well equipped to provide field level support to district offices which are relatively difficult to access (both in terms of time and money) in Mozambique.

The customization process involved dividing the DHIS software features into two categories of global and location specific which needed to be approached differently. Global features included those which could be used across contexts without prior localization, for example related to standardized reports (like missing data), indicator generator, data mart, analysis tool, etc. Changes in global features were coordinated by the South African development team, and changes required in global features identified by the local team were communicated to South Africa for action.

Location specific features such as language, data elements, indicators, local reports, lookup tables, procedures and definitions, such as reporting frequency, needed to be adapted locally by the HISP team. The issue of language translation (from English to Portuguese) was a crucial task since the entire software and relevant

¹ See Mosse and Sahay (2003), Nhampossa (2004) and Chilundo and Anneted (2003) for an overview of the kinds of problems that exist with data quality, structures of reporting, and aspects related to non-use of data.

documentation were in English, a language not used or understood by most of the population, especially within the health sector. Since structurally, DHIS represented a front-/back-end solution in Access (Braa and Hedberg 2002), it was possible to translate and build the local database (called BACKEND) independently from the monthly data user interface (called FRONTEND). The first translation cycle involved hard coding whereby the text strings in the user interfaces were part of the code. However, since the strings were part of the code, the DHIS could not be installed in different computers, implying that the translation could only be carried out on one physical computer on which the software was initially installed. Working only on one machine meant that during a training session all the facilitators and trainees had to sit around the one portable computer that hosted the Portuguese version of the DHIS. The translation process could not be carried out on multiple machines because we were dependent on South Africa for creating the setup CD. This required that all the changes to the DHIS software were to be introduced in the same portable computer, and the physical computer along with the software was subsequently sent back to South Africa for the production of the setup CD. This was then checked by the South African team, and the validated setup CD together with the computer was sent back to Mozambique where it was further tested in the pilot districts. This cycle took place at least 8-10 times (after about a year) before the decision was taken to shift to a multi-language configuration.

The Multilanguage version of DHIS was developed in South Africa in 2001 which gave a degree of flexibility to the process of translation. Firstly, now there was no dependence on a physical computer, and translation could be carried out by the team members in parallel on multiple machines. Secondly, while the manufacturing of the installation CD was still done in South Africa (as we did not have the required tools to do so locally), on receiving the new version we did not need to delete the BACKEND as we had to do in the monolanguage system.

In general, a number of problems were faced in translating and customizing the DHIS. One of the problems being the existence of many *ambiguous data elements*. For example, the existing report formats in Sisprog included categories of “Children 0-11 months and also 0-4 years, which created an overlap. As it was not possible to change existing data items without prior approval of the Ministry, we included both and then tried to build awareness amongst the health staff about this ambiguity and how they should register data correctly. The *organizational structure* of the South African health structure, which was the starting point of the adaptation process in Mozambique, consisted of five levels, while we had four. A dummy level thus needed to be included so as to maintain the “parent-child” relationship embedded in the database structure. There were also challenges arising from the fundamental differences between English and Portuguese languages. For example, Portuguese typically needs longer words to express concepts compared to English, which had implications on the user interface design and the use of icons. Some English words, for example “backup”, do not have a literal Portuguese translation which was resolved by the creation of “hybridized” terms.

After the translation was completed, we started the process of populating the database with historical data (1997-2002) in all districts from three provinces. There were both institutional and technical challenges in this process. Institutionally, we were impeded by the fact that the Ministry did not give official orders to the field staff to use DHIS, and as a result there were both the new and old systems running in parallel. Health staff, who were already overworked, were not willing to enter the same data twice. Additional resources were not provided by the Ministry to support the pilot phase. To deal with the magnitude of the data entry task (all districts for 5 years data), we decided to automate the process by which the data from SisProg could be directly imported into DHIS. This automation process was very complex because of the nature of the “legacy systems” in terms of the outdated platforms (SisProg was built on DOS), the absence of documentation, source code, and installation disks. This meant that the work of importing data had to be done physically on the single computer of the Ministry in Maputo where the data was supposed to be stored. However, we found that the national data was very incomplete because regular updating of monthly data was not done, and we had to thus conduct this process in the Province offices where the data was more consistent and complete (See Lungo and Nhampossa 2004, Skoba 2003 and Lungo 2003 for details of this process).

The ongoing challenges of the translation process, legacy systems, and data entry meant that we put in very little effort in the automation of the routine reports that needed to be sent from the district to the province and from there to the national level. This absence of reports meant there was no visible DHIS generated information flows between the administrative levels, which made the authorities question the value of our efforts. This led to a vicious cycle where the authorities continued to be reluctant to give us official sanction for implementation and in the absence of that we could not obtain the resources and authority to “roll out.” This status quo situation is currently being taken advantage of by an EU expatriate who is trying to promote an alternative (to DHIS) “idiot proof” solution which focuses on the automation of the existing reports.

3.3 Case of Andhra Pradesh, India

The process of DHIS adaptation and localization started in Andhra Pradesh, India in December 2000. Initially, the HISP team comprised of a Project Coordinator, who is an anthropologist by training, and a systems developer. As the project developed, the team was expanded and 11 other developers were recruited, all full-time, with computer science degrees, and belonging to the native state of AP. The team has been supported continuously by two University of Oslo faculty members, including one who is of Indian origin. The customization process can be described in five phases starting from a *situation analysis*, and moving through 4 subsequent DHIS versions.

Situation analysis: (December 2000-September 2001): After gaining the necessary approvals, a situation analysis was conducted in the selected pilot district (called Chittoor) over a 8 month period. The situation analysis, in addition to helping the HISP team members develop an understanding of the working of the PHC structure including its information flows, also contributed to the process of defining a “Minimum Data Set” (MDS) which made improvements on the existing datasets. These improvements, facilitated through an intensive participatory process, were in terms of reducing the number of data items (from about 1000 to 350), and categorizing the items under two main forms (for Primary Health Center-PHC and SubCentre-SC units respectively) which was a dramatic reduction from the existing 20 odd forms which were based on different programs or diseases. Our progress was presented to the State Chief Minister who provided us with permission to pilot our system in a set of 9 PHCs in one political constituency, and led to the development of DHIS “version 0.”

DHIS “version 0”: (Sep 2001 – Aug 2002): Initially, the organization database was created by defining the parent-child relationship between the SC, PHC, Mandal (local revenue units) and the district. The MDS forms as defined in the situation analysis (but being continuously revised based on changing needs and ongoing analysis) were then implemented in the DHIS. To be compatible with the state standard, we entered the Community Needs Assessment data exactly in the same order as it appeared on the paper form, making it easier for data entry. Two aspects of our strategy are important to emphasize. One, the data entry (from January 2001 data) was conducted by the health workers themselves (and not by the HISP team) to try and develop local capacity and commitment. We focused on identifying the routine reports that needed automation on the assumption that would lead to the health workers seeing some value of the computerization process to their own everyday work (reducing time and tediousness of their data related tasks). The identification of reports requiring automation led to the development of DHIS “version 1.”

DHIS “version 1”: “AP Reports” Module (Sep 2002 – Nov 2002): DHIS software came with the inbuilt feature of certain standard reports, which however were not designed for local reporting needs. We had identified some 25-30 *routine reports* being sent monthly by the PHCs to the district, some of which could be directly printed from an Excel sheet, while others varied in formats and required special customization. In addition to the routine reports, we also developed some (health related) monitoring reports that were required by administrative officers outside the health department (for example, District Collector). We also initiated the process of developing a third category of *analysis reports* for the evaluation of facility performance and the calculation of health indicators (for example, immunization coverage). The analysis reports required the database to be also populated with semi-permanent data on population, infrastructure, and facility details. All the reports were developed using the DHIS data mart as the source file containing all processed data like indicator values and calculated data elements. Reports were developed using MS Excel using Macros and VBA as it was able to provide the flexibility in report formats and was relatively easy to be used by the health workers. Since each month, multiple reports were generated, an Excel Book was created to store all reports for a particular month, which could be easily printed or (later) emailed. To enable easy access to the Excel Book, a shortcut interface was developed using MS Access called “AP Reports.”

DHIS “version 2”: (Dec 2002 – Feb 2003): This version included revisions to “AP Reports” and the creation of a district database. Inputs to the revision came from a senior IT officer in the state while witnessing a demonstration of version 2, which concerned organizing the reports functionary wise (for Medical Officer, for District Medical Officer etc) rather than the existing service wise organization (immunization or sterilizations report for example). Also, additional monitoring reports were included (for Special Officer, Kuppam), and also analysis reports to enable comparison of facilities with each other and over time. In January 2003, the project was extended from 9 to 46 PHCs in Chittoor District, and this raised the potential to also create a district database to give the district authorities a picture of the entire state (84 PHCs). We created a district wide database and each month, a HISP team member would collect all the data (aggregated at the PHC level without SC details) coming from the PHCs in the paper forms, and enter it into the database. This database allowed us to make comparisons between the data actually entered in the PHC with that which was sent to the district office.

These comparisons were possible since we also had SC data, that was actually entered in the PHCs. Significant discrepancies were noted which were communicated to the district authorities for initiating action.

DHIS “version 3”: Adding value to the DHIS (March 2003 – ongoing): With the basic systems reasonably robust and tested, we have continued to add value to the DHIS through the following: creation of state database; creation of specialized systems for maternal and infant mortality monitoring; local language translation; integration with Geographical Information Systems; integration with Oracle. Some brief details are presented. *State Database and its web enablement:* In January 2004, we were contracted to create a state level database. The district database piloted in Chittoor was modified and implemented in each district, and populated with one year data (2003-2004). The data files were exported from the Data Mart to a text file and merged into a State level database that was created on MySQL and web enabled using DotNet. The database currently holds about 3.5 million records.

Maternal and Infant Mortality systems: To enable the monitoring of infant and maternal deaths, special systems were created, and also web enabled. Various reports have been provided to drill down the deaths to the level of names of the deceased. This system will be plugged in to the state database.

Local language translation: Using the HISP multilanguage functionality developed by South Africa, the application has been translated to Telegu, the local language in AP. Telugu language can be enabled using “Regional Language and setting”, and all text-strings appear with a \$ prefix. Each text-string was translated one by one by HISP team members (all native Telugu speakers), a complicated process given the differences in keyboard layout and number of alphabets (Telugu has 56). Reports available in Telugu can potentially help in widening the circulation of the reports (for example, to the municipal authorities who tend to be more proficient in Telugu), and to allow health workers to make more relevant interpretations.

Geographical Information Systems: A “HISP Spatial Analyst” module was developed to allow the integration of the routine data, indicators and infrastructure with village boundary maps, overlaid also with population and road maps. The application is developed in Map Object 2.0 and Maplite, and further open source tools are being identified for allowing the application to be web enabled. The use of map representations has been found especially useful for senior officials and political figures at the state level.

4. ANALYSIS

The social construction of technology perspective briefly outlined in the theoretical section helps us to analyze why the customization processes of the same software within the same application domain (primary health care) in two different countries lead to very different outcomes. While in India, the software customization has led to quite significant developments in the application (for example, creation of state database, web enabled, porting to MySQL, automation of multiple reports for different stakeholders etc), in Mozambique the struggle is still on getting the data entry modules in place and populating the district database. This is despite the fact that the customization process started earlier in Mozambique, and greater funds were earmarked to the process as compared to India. We discuss four set of socio-political-technical conditions that contribute to these varying outcomes.

The health sector context: The political, social, institutional, cultural and infrastructural context surrounding the health sector is significantly different in the two countries, which have direct influence on HIS issues. For example, because of its war torn history, the Mozambique health sector has been historically donor dependent, and aid money constitutes a much larger proportion of the health budget as compared to India. This donor dependence has then contributed to the development of a multiplicity of legacy systems, a situation not seen to the same degree in India. With respect to HIS implementation, Mozambique has the advantage of smaller size of districts and fewer numbers of clinics as compared to India, implying fewer points of facilitation required. However, the relatively poorer quality of public transport access, nullifies too a large degree this advantage.

Organization of the development team: In India, the team comprised of full time staff, all of whom had formal computer science degrees, and were native to Andhra Pradesh. The team was coordinated by an anthropologist, who was especially focused on issues of relationship building with the health department, and developing a deeper understanding of the work practices of health staff. In Mozambique, the team comprised of university faculty (informatics and medical), who were responsible for both the project work and their individual PhDs, with the challenge of trying to match the two. This challenge was not easy to resolve in practice because of various reasons including logistics (scheduling of travel to Oslo), the cost of travel to and staying in the districts. For example, in Mozambique the cost of a one night in a hotel in a district may be USD 30-40 which could be

the cost of a whole month stay in a rural area of Andhra Pradesh. These issues made it difficult to provide close and continuous field level support to the staff in Mozambique, while in India there were full time people supporting PHC-level implementation. While the training strategy in Mozambique was primarily province-based, in India the focus was providing on the job support to the staff in their respective clinics or cluster hubs.

The nature of the customization process: The customization process in the two countries evolved quite differently. In Mozambique, the starting point was the DHIS software, and the attempts were made to automate the existing formats and structures into the software. The efforts were thus geared towards replicating the existing formats and structures into the computer-based system. This process of replication was based on the strategy that changes should be minimized so as to reduce the potential of user “resistance” to the new systems, and that the training efforts could then primarily focus on teaching computer skills to run the same procedures but on the computer. In this way, the efforts were towards using the capacity of the existing installed base without making radical changes. In India, the starting point was on understanding the flows of the paper based system, and the rationalization of the existing data sets. Nearly eight months were spent on conducting a situation analysis, and through this process, the data items being collected were reduced from around 1000 to 350. In India, as contrasted to Mozambique, the manual process around the HIS itself was attempted to be redefined, before the computers were introduced nearly a year after the situation analysis.

The nature of the installed base: In Mozambique, there had been multiple (mostly donor initiated) attempts to introduce various computer-based HIS such as SisProg, and also for particular health programs (Nhampossa 2004). As a result, multiple legacy systems now constitute the National HIS, which for both technical and institutional reasons are difficult to replace with new initiatives like DHIS. For example, the MoH for reasons of history and inertia still continue to favour SiSProg which we found to be extremely inadequate to meet current reporting needs. However, technically enhancing SiSProg is difficult because of the outdated platform on which it is developed, and the absence of documentation and source code. However, in India, there were no such legacy systems operating in the sub-district level of the PHC, although there was another system at the district level which was however rather standalone and not in conflict with our existing initiative. The existing legacy systems here can be seen to exist in the form of the paper formats for data collection and reporting. These legacy systems were in most cases easy to eliminate (the staff welcomed reduction of their manual efforts spent on dealing with paper), and forms which could not be changed (for example, the CNA one), it was relatively easy (as compared to computer-based legacy systems) to adapt the computer screens to replicate these forms.

The question of language: The language translation process, as described in the Mozambique case, was a major focus of the customization efforts there for nearly the first two years of the project. There were technical issues involved (for example, the earlier mono and multi-language discussion), and also language issues related to meanings and inadequate vocabulary. In India, English was the used language for the application (as also in the paper system), and the translation to the local Telugu language was done much later in the process only after the system had been made relatively stable. Translation was done only as a “value added” feature, and not as a fundamental pre-condition to get things started as was the case in Mozambique. In the absence of needing to engage with the translation issues, the Indian project could very quickly start to develop the routine and analysis reports which were seen to be of immediate value to the health staff. In Mozambique, no similar value was at stake in the translation process for the health staff.

5. CONCLUSIONS

Our analysis, necessarily brief, identifies some of the reasons why the customization of the same software in two different contexts contributes to very different outcomes. Understanding this process of social construction helps to emphasize that debates around internationalization and localization of software needs to also consider the process of software customization itself. This process is extremely context dependent, and cannot be treated as a context independent variable that can be replicated in different settings.

Our analysis contributes directly to the theme of the conference on “Enhancing Human Resource Development through ICT”. India and Mozambique have very different levels of human resources capacity, both in terms of numbers, formal education and experiences in software project management. Given these different capacity levels, the strategy for human resource development, both for the project team and for the health staff, need to be necessarily different. In Mozambique the human resource development process has to be more long term in nature, and along with computer literacy, the training has to also cover more basic principles of health information systems and public health concepts related to for example, statistics and health indicators. In India, since the computer literacy skills are relatively more prevalent, the focus needs to be more on building a social system perspective, and also on including greater public health inputs.

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8.7. APPENDIX G

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CONTEXTUALITY OF PARTICIPATION IN IS DESIGN: A DEVELOPING COUNTRY PERSPECTIVE

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ABSTRACT

Participatory approaches to information systems design have evolved over approximately the last three decades, mainly in Scandinavia, Europe, and lately in the US. However there has been limited and peripheral research and debates over participatory design approaches and techniques in developing country settings. This paper explores three case studies in developing countries where participatory approaches have been used in the design and implementation of health information systems. The investigation reveals the politics of design, the nature of participation, and the methods, tools and techniques for carrying out design projects are shaped with respect to the diversity of the socio-economic, cultural and political situations faced in each of these settings. Though common strategies, such as capacity development, could be found that cut across the three case studies it is the importance of the contextual nature of participatory design that emerges most strongly. There is no single algorithmic best practice regarding participatory design in IS which is applicable to all situations

Categories and Subject Descriptors

PRIMARY CLASSIFICATION:

H. Information Systems

H.3 Information storage and retrieval

H.3.4 Systems and Software

Subjects: Distributed systems

ADDITIONAL CLASSIFICATION:

J. Computer Applications

J.3 Life and medical sciences

Subjects: Medical information systems; Health

K. Computing Milieux

K. Computing Milieux

K.4 Computers and society

K.4.3 Organizational Impacts

Subjects: Automation

K. Computing Milieux

K.4 COMPUTERS AND SOCIETY

K.4.3 Organizational Impacts

Subjects: Employment; Computer-supported collaborative work.

General Terms

Design, Documentation, Human Factors, Management, Theory.

Keywords

Participatory design, health information systems, developing countries, community IS.

1. INTRODUCTION

User participation in information system design (ISD) has been considered to be an important determinant of the eventual success of the system [38, 21]. The participatory approaches to ISD have evolved in the West over approximately the last three decades, mainly in Scandinavia, Europe, and lately in the US. This subject has evinced considerable research and has been a topic of keen debate in the IS literature, and more recently in other fora, for example, the biennial Participatory Design Conference (PDC). However, much of the research and debates have been confined to the Western contexts, with only limited and peripheral contact with the developing country settings. Although some evidence of the attempts to extend IS research to the third world domains has recently become discernible in the mainstream IS literature [for example, [56, 48], the issue of participatory design (PD) in these settings has lacked specific attention. An exception may be the emerging consensus in the last PDC conference (Malmo 2002), emphasizing participation should be viewed in broader contexts (outside of Western organizations), and that it should be analyzed within a larger process perspective that emphasizes its dynamic and political nature [8].

The use of information and communication technologies (ICTs) has been expanding during the last decade or so in the developing world as well. Some of the donor agencies, like the World Bank, for example, have argued for much greater penetration and use of ICTs by developing countries to usher knowledge intensive societies for ensuring their economic survival in the current era of globalization [57]. Other donors have been insisting on the use of ICTs to bring in greater transparency, and for inculcating more effective monitoring and evaluation of programs and projects aimed at poverty alleviation. The use of ICTs in these settings is also being promoted to address social exclusion of the poor [18]. The state governments are also pushing to tackle the digital divide [43], and to increasingly adopt e-governance in the rural sector also, for example through community-based networks [45]. It is thus clear

that the use of ICTs would be increasingly implicated in community development programs in the third world, for example in the health information system design sector.

By and large, in most of the western approaches, participation of intended users is seen as a precondition for good design and increases the likelihood of integrating the new system into the organization [46]. In the western context there is little discussion on the degree and type of participation or how this can be facilitated outside of organizational/corporate contexts. When related to community development programs the argument for participation is based on a more intuitive and ethical basis rather than on empirical grounds. This paper explores different approaches to participation in three different contexts – all within developing countries. The cases illustrate on a practical level the process of participation and how this was facilitated in the design and implementation of health IS. An analysis of the cases illustrates the differing types and degrees of participation which can be used with IS design and implementation. From these studies we argue that the participatory design and implementation of IS in developing countries bring in new challenges to fostering and nurturing participation, and that these represent a point of departure vis-à-vis the Western organizational scenarios foregrounded in the IS literature.

The rest of this paper is organized as follows. In section 2, a theoretical framework is developed based on major strands of participation in IS reported in the relevant literature to understand their underlying assumptions and aspirations. The next section provides the empirical basis of this paper, three case studies, one each from India, South Africa and Mozambique. These cases are analyzed in section 4 with reference to the theoretical backdrop of section 2, in particular to examine if the Western approaches to PD can be directly applied to the developing country contexts, particularly in the case of community-based IS applications in rural settings. The analysis brings out some viable, context-dependent implementation strategies, including capacity development, to meet these challenges. Section 5 concludes with remarks regarding what we mean by participation in ISD in a developing country context.

2. PARTICIPATION IN ISD

User participation in ISD has been researched and practiced in various forms since the 1970s in Scandinavia and Europe [19, 14]. These PD approaches have also influenced systems development in North America since mid-80s [25]. However, PD has followed somewhat diverse trajectories in these societies, each strand having been influenced by the local political, socio-economic and cultural factors. The evolution and adoption of somewhat different approaches to PD over time in the West has been well articulated in the IS literature [for example, see 1], and it is not intended to discuss the course of these developments at any length in this paper. Accordingly, in the following subsection 2.1, we provide a simplified roadmap of the PD trends in the West in order to understand the contemporary debates and to derive lessons for developing countries settings. In section 2.2 we look at the trends in developing countries in relation to participation and more recently to participation in IS design.

2.1 Participatory design in the West

The participatory tradition can be traced back to the rise of the Industrial Democracy program in Norway during the mid-1960s following debates around the organization of work at the micro-level of shop floors. This program provided a common framework for joint collaboration between research and labor unions, subsuming several work sites with the objective of introducing new technologies in consultation with workers, and with a strong emphasis on democratization of the workplace. The Norwegian initiative inspired similar moves in Sweden, for example the DEMOS project [20], which sought to recast the entire industrial operations and functionings through collaborative schemas jointly developed by the management and the trade unions [26]. This strand of PD sought to redress asymmetrical distribution of power in the industry, with a view to empower workers and shop supervisors by developing their managerial and technical skills to strengthen their bargaining capacity vis-à-vis the management [40].

Subsequently, these democratic underpinnings provided the basis of user participation in IS. An additional motivation was to draw upon users' knowledge of work processes into ISD to improve the end product, and also to reduce resistance to the induction of these systems in organizations. The workers, on the other hand, feared deskilling of labor, automation of decision-making in their purview, scaling down of workforce etc. as the negative outcomes of computerization [30]. The above factors led to considerable diversity in the participatory approaches to ISD. Bansler [3] identified three main schools in systems development research in Scandinavia based on the criteria of knowledge interests, notions of organization and labor force and capital/labor relations. These are: (i) system-theoretical, (ii) socio-technical, and (iii) critical. The system-theoretical school adopted a scientific basis for systems development based on engineering principles. Its main accent was on rationalization, information modeling, efficiency and control and profit maximization. The organization was treated as a cybernetic system from a system engineering perspective, and labor was viewed as 'objects' – as a system component during design. The socio-technical school advanced user participation to achieve ends of higher productivity through the means of job satisfaction, focusing on mediation of conflict between workers and management. The organization was considered in this paradigm to be consisting of two sub-systems, viz. social *and* technical functioning together and adapting to each other. The workers, considered as subjects (individuals), were fully involved in design and attempts made to harness their knowledge of work practices. In both the system-theoretical and socio-technical developments, workers and management were assumed to have a common goal of enhancing productivity through induction of new technologies, and to raise (or maintain) the workers' standard of living. In the critical tradition, the focus was on achieving industrial and workplace democracy, the organization being considered as a framework of conflicts, and the design emphasis on participation alone was seen as inadequate and more fundamental structural changes were sought.

Asaro [1] described European participatory approaches in IS to have generally been based on the socio-technical school, which led to research in Britain focusing on autonomy in workgroup organizations through power sharing, joint responsibility and multiple leadership [44]. This approach is exemplified by the

Effective Technical and Human Implementation of Computer-based Systems (ETHICS) methodology [37]. ETHICS aims at developing systems that are technically efficient while also providing greater job satisfaction to employees. This is achieved by considering various technical and social objectives separately to agree on the 'best-fit' jointly by management, design teams, and elected representatives of employees.

In the United States, the participatory design approach was adopted on a different scale governed by the socio-political conditions that are different from those obtaining in the Scandinavian countries [25]. While the legislation regulates participation is most Scandinavian and European countries, there is no similar enabling mechanism in the US. In main, participatory approaches to system design in the US were adopted by way of "engineering codevelopment" [1, p. 276], with a primary focus on customer-centeredness. The methodology used was to place working prototype systems at customer sites for obtaining feedback to 'tune' the artifact as per the customer needs. Besides seeking to involve users in design, reducing the overall product development time, and improving user satisfaction, this approach also aimed at improving the skills of designers by exposing them to novel work situations in which traditional design practices, for example life cycle methodologies, could not be applied. Another strand of participation evident in the US is the shifting focus of organizations towards business process reengineering in which the various organizational tasks and business processes around them are analyzed to eliminate redundancies to establish a tighter, functionally related process flows (ibid.). It is claimed that the employees tend to establish a closer and more direct relationship with the reengineered processes that they engage with.

The main streams of development of the participatory design tradition in the West evoked varying and diverse trajectories in different societal contexts, impinging as they do on the "questions of democracy, power and control at the workplace" [19, p. 41]. Bass and Shackleton [4] made a distinction between industrial democratic aspirations of the Scandinavian and European strands of participation in workplace settings, and the participative management approaches, for example in the US. They argued that while industrial democracy movements constituted formal, structured and often legally supported mechanisms, participative management tended to be more informal and its practice in organizations varied as per individual managerial styles and corporate ethos. The participative approaches were thus considered to be behavioral. Therefore, issues that could be addressed using these approaches tended to be different.

In summary, PD in the Western countries can be characterized by a workplace focus where it is recognized that it is ethically and morally right that workers should be involved in the development of systems which are to affect their working lives, but also the recognition of the failure of the traditional technical approaches and that participation may help overcome some of these failures [22, p. 52]. However as this brief summary illustrates there is considerable diversity in the participatory approaches to ISD. More recent critical analyses of PD suggest that while PD may be necessary, it is not sufficient in itself to ensure success of IS [6, 28], other important determinants of success being power and politics at the workplace. Also, PD theory and practice need new directions in the changing socio-

economic situations arising from globalization, visualized by Giddens [24] as 'runaway world'.

2.2 Participation and ISD in developing countries

A special issues of *The Information Society* recognizes that information systems from the "developed" world cannot be replicated in developing countries and addresses the question of how to adapt these IS in such a way to balance "... global solutions, technologies, and practices on one hand, and local requirements and institutional dynamics on the other" [48]. Braa and Hedberg [10] examined the participatory prototyping of a health IS in South Africa, the process and output of which impacted on all three case studies presented in this paper. However, there remains limited literature in mainstream journals on developing country experience in IS design, especially on the differences in eliciting participation from community based settings as compared to the Western workplaces. Braa and Korpela et al. have debated the involvement of community members in developing countries who will be served by the health system [12, 32], but the thrust of their arguments for participation is again more intuitive than being based on sound empirical rationale.

As Byrne and Sahay [15] note the issue of community participation has been dealt more comprehensively by international agencies like the World Bank and UNICEF in development projects initiated outside the IS field employing varying participatory techniques. Though the success of these participatory approaches in addressing the complex socio-historical-cultural conditions is open to debate [35], some of these methodologies (like the Participatory Rural Appraisal [16]) have been recently adapted, though in a limited way, in IS design and development projects. Given the present context where there are increasing attempts to develop e-government applications aimed at the community in developing countries, and rising concerns about the digital divide, the need to develop approaches to facilitate PD involving community-based IS is being recognized as an important need by IS researchers [42] as well as the need to rethink what we mean by participation in a social developmental context [15].

3. CASE STUDIES

In this section, we describe three case studies from South Africa, India and Mozambique relating to the use of IS in the health sector.

3.1 Research approach

Participatory action research approach to implementing, analysing and evaluating the changes in the IS was adopted by individual researchers in their respective countries. For case 1, reported from South Africa in section 3.2 below, a total of 10 interviews, 15 focus group discussions (FGD) and one meeting took place between July and September 2002 (one additional FGD with children was conducted in May 2003). The case study from India is based on participation of the researcher in the

development and use of the IS described therein during 2001-03. She has been functioning as project manager of this ongoing program since 2001. She conducted semi-structured interviews with officials from organizations involved, mainly the state, district, and sub-district level government officials, medical staff and health workers in primary health centres (PHCs). Case study 3 in section 3.3 was similarly researched in Mozambique, and is based on interviews with key informants, participant observations, group discussions, meetings, workshops, training session conducted from 2001 to 2003 at the Ministry of Health, and in Gaza, Inhambane and Niassa provinces of Mozambique. The researcher was directly involved in the efforts to institutionalize the health information system discussed in this paper.

The three cases are linked as part of a broader action-research program which aims at creating counter networks within the health sector of various developing countries. HISP (Health Information Systems Project) was initiated in South Africa in 1995, where it is now implemented nationally. It is also currently ongoing in different degrees and rhythms in various countries including in Mozambique, India, Tanzania, Ethiopia, Malawi, Mongolia, Cuba, Ethiopia, Nigeria and China [36]. HISP seeks to strengthen processes around the design, implementation and sustainability of HIS with a focus on the local level, and building the capacity of health workers to use information more effectively and operate ICTs for this purpose. The South African case study explores the extension of the district health information systems (DHIS) to include community-based child health data, whereas the cases for India and Mozambique explore the early implementation stages of the system in their respective countries. DHIS is the application software developed in South Africa in 1999, which was first used successfully in Western Cape [10]. This development took place under the HISP.

Summaries of the field observations, and interviews were individually prepared soon thereafter, and discussed with the concerned participants. Data was analyzed by individual researchers using interpretive research approach to identify key themes. An interpretive research approach was adopted for the field work reported below. Interpretive approaches in IS research proceed on the assumption that knowledge of reality is socially constructed by human actors [55] through shared meaning [31]. A primarily technical approach is limited since it does not take into account the human dimension of the eventual system use [33]. This realization of the importance and interconnected nature of the technical and social have led to an increased sensitivity to the social context of IS design [2]. Interpretive researchers take the stance that the social world is relativistic and can only be understood from the point of view of individuals who are directly involved in the activities which are to be studied. The interpretive paradigm seeks to understand the fundamental nature of the social world, as it is, at the level of subjective experience [13], how people assign meaning to those experiences [17], and the processes through which intersubjectivity is constructed.

3.2 Development of a child health community-based information system (CBIS): a case study from South Africa

This research was conducted in oKhahlamba, which is one of five municipalities in the UThukela District lying in KwaZulu-Natal on the eastern coast of South Africa. The population of oKhahlamba is mainly rural, poor and relatively under-resourced. The UThukela District Child Survival Project (TDCSP) was selected by the National Department of Health as one of three learning sites for the development of a community component to child health in 1999. The design of the child health community-based information system (CBIS) was part of this child health project.

Traditionally decisions that affect the community at large are taken collectively. Community meetings (*imbizo's*) are called and the case for and against the issue are made. Through traditional structures community members can air their opinions and concerns. Therefore it was important before embarking on any intervention to have a collective decision made regarding community support for a child health project. Once that support was given in oKhahlamba, the next step taken was the creation of a common vision for the community and the district concerning the development of their children. The key players (community health workers, parents, early childhood and crèche teachers, caretakers, social workers, health facility staff, clinic health committees, government organizations etc.) who affect the situation of children were identified and were included in the discussions on how the CBIS could best serve their needs. From the outset it was important for the roles of the researchers, project staff, community members and department of health staff to be clarified. Through meetings and discussions these was documented in the project plan at the commencement of the project.

After co-determining a vision for child health (*to achieve optimal health, growth, development and well-being of children in the uThukela Health district*) a child health monitoring and evaluation workshop was held in February 2000. At this meeting community members felt that the existing routine health IS and the periodic surveys conducted in their area did not adequately address their concerns. Community members felt that these were facility focused and they preferred an IS that provided data that they could use to monitor the situation of their children. A review of the existing district health IS (DHIS) was conducted in November 2001 and confirmed the recommendation from this workshop that a CBIS was needed.

To understand in more detail what the information needs were in relation to this vision, who should be involved in the IS and the format the information should be communicated in, a participatory action research approach to implementing, analysing and evaluating the changes in the IS was adopted. Interviews, FGDs and the meeting referred to in section 3.1 above took place within this overall context.

Discussions were facilitated by people who were familiar with the area and who also had an understanding of the norms and values of that society. Arrangements were made to enable people to participate in the design process through use of the local language and having meetings near where they lived or worked.

In the initial stages because of differentials in status and roles within the community, groups comprising, for example, mothers, councillors, facility staff, met separately to discuss what they wanted for their children. At a later stage representatives from the various groups met jointly to share the findings from the research and to discuss the way forward. To achieve some uniformity in participants' ongoing negotiations, discussions and reflections, orientation on child health issues and training on data collection methods and analysis was held.

Listening to different community members views in the field work facilitated a greater understanding around the meaning of 'well-being' and 'at risk' for a child, what factors/practices contribute to these situations, how the situations can be measured and, based on what action can be taken, who the information should go to. Additionally surveys and reports from the project [50, 51, 52, 53] provided a broader understanding, as well as giving accounts of the local knowledge and practices with respect to health, communication channels, cultural and traditional practices. Through group and individual analysis of the field work locally determined indicators (*izinkomba*), appropriate data collection tools and different information flows were incorporated into the DHIS. Some of the new indicators included were around the context the child grew up in such as communication and relationships within the household, deaths within the family, love (*'a house with warm hands'*) and being looked after by an adult (*'not leaving a child to stroll in the road'*).

The system implemented has built upon the traditions and culture in practice and therefore it is primarily a paper and oral based system. An example of this is the feedback to the community of the data collected by the community health worker. Parents, children, district health staff, councilors, teachers, clinic health committee and other interested parties are invited on a monthly basis for feedback of the data collected from their village in the previous month. Community halls or school classrooms are used as the venue. The session commences with prayer and is opened by the councilor. Through the use of song and dance the various roles of the people involved in health are explained and people are introduced. The topic for the day is then explained, for example it may be on TB, and through discussion, role play and question and answer sessions the topic is discussed. The community health facilitators and the community health worker for that village present the data using pie charts and histograms on flip chart paper. They explain the data they found, ask questions on why this is the case and discuss the possible action that can take place to improve the situation for children (this they call the triple A cycle – assess, analyze and act). Children sing songs and dance to express their views and concerns on health issues. Participants express their understanding through words sung to the tune of a familiar hymn accompanied by traditional dances. The day is very celebratory in nature and is closed by the chairperson of the clinic health committee who summarizes the days' proceedings and agreements made. The village health days strengthen a learning process approach, which encourages critical reflection and is linked with action. The learning process builds upon existing community skills and resources, their talent for song and dance, and on their knowledge and practices.

Based on the field work the CBIS was implemented in the municipality in June 2003 and agreement was reached to expand the system to the rest of the district. However as the TDCSP

project leader commented in the evaluation of the project *"This process has shifted thinking within the project from the idea of the monitoring of community interventions to the empowering approach of communities monitoring themselves and the status of their children. ... The work shows potential but is still in its infancy."*

3.3 Institutionalizing district health information Software (DHIS) – an Indian experience

Efforts to use the HISP approach and adapt DHIS in an Indian setting were initiated in 2000 in the Andhra Pradesh state of India. The health related information processing in this state, as in most other parts of the country, has traditionally been paper-based. These manual systems, typically operated and maintained by the concerned departments, carry the legacy and inefficiencies of a bureaucratized set up, with massive duplication of data, and variety of reporting formats devised over the years without much thought to their reconciliation and rationalization. The main source of primary data is the network of Primary Health Centres (PHCs) in each district. Health workers responsible for data collection from households and locations serviced by a PHC received little training for the task, and the lack of professional supervisory capacity, abetted by bureaucratic apathy, ensured that practically no data control policies or practices to ensure some level of standardization were in place. Participatory design approaches had never been adopted, the prospect of different hierarchical levels working together to achieve a common objective considered 'unimaginable.' Andhra Pradesh state was chosen for a pilot research project since the state has lately been demonstrably keen to introduce e-governance based reforms. The HISP pilot was taken up in the political constituency of the Chief Minister (CM) of the state, falling in Chittoor district, as decided by his office. The CM has been nationally as well as globally perceived as an icon of IT promotion in Andhra Pradesh [23]. HISP potentially provided an instance to demonstrate his IT vision in a much neglected social sector.

An initial survey and preliminary studies conducted by project staff in PHCs (there are 89 PHCs in Chittoor district, catering to the basic health care needs of about 3 million population) revealed a centralized, top-down and hierarchy-based work culture. Data handling was extremely compartmentalized involving multiple forms and registers maintained at various staff levels. Two main but disparate datasets comprised about 1200 data elements. This data was collected by Multi purpose Health Assistants (MPHAs) who functioned as the interface between communities and PHCs. The datasets had a high level of redundancy. Data was even being collected for programs and projects that had long been wound up since there was no culture of interaction among higher level officials and MPHAs. Consequently, MPHAs had little understanding of why data was being collected, how it would be used, and they raised no questions even when identical data was collected repeatedly to complete different input formats pertaining to different programs. Based on the data collected, about 40 reports were manually generated monthly for various desks in the hierarchical ladder. No one in the PHC knew or cared how these reports were eventually used or improved decision-making.

The HISP team took up identification of minimum dataset (MDS) adopting a participatory prototyping approach. This exercise was carried out over a year involving intense discussions to scrutinize the multiple reports being generated and the data elements collected under various programmes. The participatory prototyping for the EDS was carried out for over a year, and involved multiple discussions on data elements and forms used with the various staff. Several workshops were organized in which staff at various levels participated in discussions along with MPHAs. The MPHAs provided useful inputs based on their field experience, and as they grew in confidence, they also provided incisive and valuable critique of existing data collection approaches. Bringing together inter-program functionaries together with MPHAs also provided opportunities to discuss openly how the monthly reports were actually being used, and how these could be rationalized without subtracting from their informational value. These iterative prototyping efforts and wider consultations eventually resulted in MDS being reduced to 400 data elements, while the number of reports required (restructured for more effective presentation) was brought down to 10.

The revised MDS and the reporting system based on DHIS was implemented in 9 PHCs in 2001. Six months after the system was made operational, the HISP team made a presentation to the State Health Department. The usefulness and value of the HISP approach was acknowledged, and it was formally extended to 49 PHCs by the state government soon after the presentation. The extension of HISP/DHIS to over 1300 PHCs covering the entire state of Andhra Pradesh was recently approved in principle, an MoU having been accordingly signed between the HISP and the State Government in January 2004.

3.4 DHIS – user participation in Mozambique

The case describes the challenges encountered in the process of HISP implementation, which commenced in 1999 as collaboration between the Mozambican Ministry of Health (MoH), Eduardo Mondlane University, University of Oslo and University of Western Cape. The aim of this initiative was the provision of a tool and processes to capture data and provide routine management reports, and develop the capacity of the health staff to effectively use this tool [9]. The Mozambican health sector is extremely donor dependent with multiple donors supporting different health programs. The fragmentation that arises as a result of this multiplicity seriously impedes the introduction of new initiatives like HISP.

The MoH represents a complex institution with many actors at different hierarchical levels with different interests, educational backgrounds and agendas. The management style is highly centralised, whereby the senior staff are resistant to share power and tended to adopt rather authoritarian and hierarchical approaches, for example even small decisions need approval from the highest level. In addition to the limitation of availability of trained personnel (both medical and IT proficient) [11], the infrastructure in Mozambique is very poor and most health districts do not have electricity or proper roads and transportation facilities. Given this context, the challenge for HISP is to identify appropriate strategies for adapting and strengthening the DHIS within the existing infrastructure and technical constraints.

The HISP philosophy is based on cultivating participative approaches and creating collaborative mechanisms between MoH's top, middle and lower level managers, and field level health staff. For example, to develop a hands-on understanding of the HIS, a multidisciplinary team was established including senior information systems researchers, PhD students in computer sciences and medicine and international masters' students of information systems and public health. This team was responsible for implementing an action-oriented research to apply participatory approaches through training and education of managers, doctors and health workers. These activities aimed at (i) improving the working knowledge of computer usage in general and HIS in particular, (ii) building realistic expectations of the DHIS application, and (iii) minimizing resistance to change. This was done through organizing several seminars, workshops and training sessions in three provinces where HISP was being implemented. The HISP team played an important mediating role in facilitating interaction and communication between the MoH staff and province and district level field workers. Such interaction has historically not existed in the past and the presence of the HISP team seen as being relatively "neutral", helped to diffuse some of the historically existing gaps due to power structures.

An implementation plan called "strengthening health management information system within the context of sector-wide approach and health reform" was finalized by the MoH with active inputs from HISP and the district staff to guide the adaptation of DHIS.

The participatory process suggested that DHIS was seen by all as a prototype rather than a ready-to-use software. Through this process, the team, tried to understand the reactions of the users and how the tool met their needs. The reactions were gathered through observations, interviews, workshops and training sessions. These interactions helped to identify limitations in the prototype and implement suggestions for improvement. For example, it was suggested by the province authorities that it would be wise to develop new and locally relevant data elements, for example to register diseases that were specific to some regions that were related to local food habits, and which were typically not reflected in the national HIS. An example is the dietary cyanide exposure from exclusive consumption of insufficiently processed bitter cassava which is a major source of calories in certain regions, resulting in a condition known as konzo. Konzo is characterized by the abrupt onset of an isolated and symmetric spastic paraparesis which is permanent but non-progressive. The disease has been reported only from poor rural communities in Africa. Its name is derived from the local designation used by the Zairian population affected by the first reported outbreak, in 1936. In the Yaka language, konzo means 'tied legs', an apt description of the resulting spastic gait.

During one of the open discussion sessions, one of the participants expressed his concerns as follows:

Although Konzo is not considered to be a major public health problem [in Africa as a whole] it affects communities. Therefore, data must be collected and used to address or prevent Konzo in our region.

This suggested the need for DHIS to be flexible to allow for the extension of the datasets to include both locally relevant data in addition to that required by national authorities.

In summary, the HISP participatory approaches firstly served to mediate the relation between the senior MoH staff and province and district level health workers, an interaction that historically has been non-existent; secondly, through the close interaction with the field staff in the local language, a lot of indigenous knowledge was elicited which typically gets lost in the top-down approaches to systems development employed by foreign expatriates. This local knowledge is being attempted to be inscribed into the software. A limitation of the approach to date has been the primary focus on the province for conducting of the training programs, which to some extent excluded the districts. However, the very weak infrastructure in the districts makes it difficult to conduct training programs efficiently.

4. ANALYSIS AND DISCUSSION

In the above case studies, the underlying strategies used were of participation and capacity development. The participatory approaches used in the three cases, however, differed. The differences are discussed below in the first three subsections, whereas the last subsection explores the common strategy of capacity development to enable participation that was used in all three cases.

4.1 Participation: traditional forms of participation and communication

Two important aspects of participation in the South African case were the reliance on the tradition and culture of participation in communities as well as ensuring that the key role-players (multi-leveled and multi-sectoral) participated. If the information from the IS is to be used for action it is important that in the process and in the output of the IS traditional and cultural practices are incorporated. The approach to participation was in line with traditional and customary traditions where decisions are made collectively (based on the principle of *ubuntu* – collective personhood and collective morality). Traditional communication channels were used for data collection and feedback of information. In the village health days song, dance and poetry are all used in a collective celebration of what has been achieved, but also what needs still to be done. The case also illustrates the importance of participation of role players in the design process from the outset so that a common vision can be determined. Reaching a common understanding between the users and providers of the health services is impossible without their joint participation. For actors to participate in dialogue there is the need to recognize the structural conditions that are required for such a dialogue to take place, and to address some of the constraints to achieving this. Therefore having meetings in the local language, with people they trusted, in convenient places and times, as well as conducting multi-sectoral and multi-leveled meetings were all strategies adopted.

While involvement of all stakeholders in the Western participatory traditions has been emphasized, particularly in the socio-technical tradition, the challenges to doing so in community settings of developing countries are clearly different. Cultural

practices are deeply embedded in the ethos of the community, and the participatory paradigm in these settings is bounded by the cultural traditions and practices. Ritual and ceremonies are the events to assert unity and harmony of the community. It is through these mechanisms that social fabric of a community is constructed, value systems to nurture common good are developed and find expression [39]. Another departure from the Western settings in the context of participatory parleys is the close linkage to the ‘place,’ which underlies the cultural and moral norms of the community, and the ways in which its knowledge is constructed and expressed. Basso [5, p.31] opined “knowledge of place is [therefore] closely linked to knowledge of self, to grasping one’s position in the larger scheme of things, including one’s community ...”

4.2 Participation in hierarchical settings

The Indian case typifies efforts to foster participation in hierarchical settings. The trajectory of development programs in India, including IS endeavors involving community issues, is much dictated by a network of government institutions like the central/state government ministries, scientific institutions, and district administrative agencies. These institutions have existed historically with a strong sense of bureaucracy, with rules and resources drawn from the British colonial rule, and later reinforced by the socialist agenda of post-independent India [29, 47]. The course of health informatics in India has thus been strongly influenced by differential power relations arising from rigid hierarchical structures and strong bureaucracy.

Therefore, in starkly different historical, political and social contexts such as India, participatory processes will not arise naturally as a result of democratic aspirations or reasoned argumentation, as may be the assumption in formal workplace settings of western countries like in Scandinavia or the UK. Paradoxically, however, participatory processes often need to be initiated by government officials in-charge, rather than these emerging idealistically from grassroots as a bottom-up process. In the present case, enrolment of CM’s office resulted in the alignment of the otherwise divergent networks of HISP, state health bureaucracy, PHCs. This perspective emphasizes that local action research initiatives (like instilling IS in PHCs and creating minimum dataset need to be linked to larger networks of power to become scalable and sustainable [27]). An implication, therefore, is that to enable participation in settings that are traditionally hierarchical and non-conducive to self-initiated bottom-up processes, the initiative may need to come from the top, and then be gradually nurtured over time.

4.3 Role of mediating agencies

The Mozambican case points out to the role of mediating agencies such as university academics in fostering participatory processes. Different kinds of agencies may adopt varying strategies for mediation. In the emerging institutional structures for supporting decentralized development in most developing countries, the government departments and officials continue to be important actors. They can function as effective agents of change by translating the interests and work style of the local government departments and realigning these with the need for more transparent and decentralized governance. In the

Mozambican context, the mediating role of the academia lay in acting as a bridge between health bureaucracy on one hand, and the communities and the local health workers on the other. They also mediated between the policy formulated by national/state governments and its translation into concrete practice on the ground. The role of mediation played by the academic members of HISP was critical in creating the required environment for learning by doing. User participation means not only users participating in design but also designers participating in use. The designers should try to share practice with users. Participatory design is a learning process in which designers and users learn from each other and the users, in particular, must have a guarantee that their design efforts are taken seriously.

Non-governmental organizations (NGOs) and academia have come to play an increasing advocacy as well as intermediary role vis-à-vis government and people. These agencies are generally able to effectively communicate with government officials because of their educational background, experience, and contacts with the media, and can serve as 'gateways' between people and officials. Madon and Sahay [34], for example, describe a case study from India about developing information strategies to support the empowerment of marginalized slum dwellers in the city of Bangalore. The deficiencies in capabilities of the people, due to illiteracy in this case, were enhanced by an NGO who played the role of an intermediary, for example by developing systems in audio forms as a means of communication. The increasingly important role of local governmental and NGOs as mediators between global challenges and local concerns of exclusion and marginalization has also recently been addressed in urban contexts [7]. The mediating agency, a university in the Mozambican case, was similarly able to act as the mediator and to inspire local people to achieve their participation potential.

4.4 Capacity development

Efforts at capacity building and creating enabling environment to facilitate participation were also a main focus in the three cases discussed above. Developing capacity comprises ability to use and analyze the information once the systems are in place, as well as the ability to adapt and change the IS to suit the ever-changing context. Capacity to participate was an important consideration as the unequal nature of social relationships and positions between different actors and also institutions was recognised from the outset. Forums were established that suited the needs of the various groups, such as discussions in the home language and having the meetings near home or place of work in the South African case. Access to information was also an important requisite for capacity to act in the case studies. In the South African study, much of the data collected through the existing district health information system is valid and useful, but was not getting to the people who can act upon it. As one project leader mentioned we need to look at how information is flowing and the possibility of establishing "feedback pathways" of this data.

A notable feature of the HISP initiative in India was the focus on training of MPHAs and other staff, and efforts invested in capacity building at the level of PHCs. Besides providing on-the-job training on the use of DHIS, and data collection for the computer-based screens, long term capacity development has also been taken up by providing in-depth and intensive training to

selected staff in PHCs. Two trainers from South Africa also conducted a 2-week course on health informatics. A positive outcome of these efforts, and inculcation of participatory methods, has been the empowerment of MPHAs to an extent (most of whom are women), since they are able to communicate on more equal terms with the PHC hierarchy. Gaining an understanding of computerized work environment in itself adds to the status of an individual, particularly women, in rural settings of India. A similar training approach was adopted in the case of Mozambique.

Given this common thread it is interesting to note how very little discussion in mainstream IS software design and development literature explores the capacities or capabilities to use data and information. Through a parable (Annapurna wanting somebody to dig her garden and finding it difficult to choose one of three laborers as each would be chosen if different criteria was used – poverty, unhappiness or illness), Sen explains how decisions made depend on the informational base and indicators selected [49, pp. 54-55]. In the selection of the informational base, Sen talks about the concept of 'capabilities' as a way to measure poverty or freedom [49, p. 75]. In the CBIS and DHIS cases discussed, we explored capacities to act based on the information that the participants wanted included or excluded, as well as the format in which the data was to be collected and transmitted. The constraining factor on capability to act in our cases was largely believed to be solved through the reworking of the data items collected, information flows and the development of communication loops.

Capacity in IS design and development is also needed as the IS is not static and the people involved need to be able to change it as their needs and situation also changes. Walsham [54] underscored the context/process dynamics of IS. He explained that an IS is developed in a specific context, but, in turn, impacts the context itself, modifying or strengthening it. The changed scenario then requires modifications to the IS as well. Therefore, in the context of this paper, the design process in IS needs to be empowering, so that capacity remains at community level to introduce changes as may become necessary. In South Africa this was especially important given the recent move towards the decentralization of the health services where new role players such as local government and community health workers were taken on new positions of responsibility in relation to the delivery of health services. As such the DHIS needed to be adapted to reflect this changing context. Adaptation of DHIS to suit local procedures, working ethos, and different reporting requirements also posed strong technical challenge both in Mozambique and India as well. An added complexity in Mozambique was the need to modify input-output sub-systems to Portuguese (the original South African DHIS used English in these interfaces). Efforts are also being made to convert these features into the local language (Telugu) in Andhra Pradesh.

5. CONCLUSION

The above discussion has emphasized several important points of departure in ushering participation in non-western contexts of developing countries. Kensing and Blomberg [30] identified three main issues in participatory IS design, viz., the politics of design, the nature of participation, and the methods, tools and techniques for carrying out design projects. The case

studies bring out the topicality of their analyses to developing country situations as well. However, within developing countries, these factors impinge variously due to diversity in respective socio-economic and political situations. In the South African case, participation was fostered through respect to communities' cultural heritage; the approaches used were also in consonance with their culture. In India, technology became an important element in the political network before being accepted. Participation in this case was initiated by the top political leadership. In Mozambique, mediating agency of a university played an important catalytic role in bringing about acceptance of participatory approaches. Thus, there is no single, algorithmic best practice applicable to all situations. This perspective emerging from our analysis lends support to Bass and Shackleton's proposition [4] that participatory approaches tend to be behavioral.

The term 'participation' has different meanings for different people. "The term has been used to build local capacity and self reliance, but also to justify the extension of state control. It has been used to devolve power and decision making away from external agencies, but also to justify external decisions" [41, p. 79]. What is important in participation is who decides what data to collect, who collects it, who interprets the information and uses the finding and how participation can make decision-making a more democratic process. Participation in ISD should be a social process of bringing people together to understand different views and share decision-making so a sustainable IS is designed that is culturally and locally specific. From the literature on participation in ISD from a Western perspective (barring some exceptions, for example [7], the underlying assumptions of the democratization of the workplace, high literacy rates and a reasonable infrastructure are present. Though these assumptions can also be questioned in a Western context, it is unrealistic to assume that any of these assumptions can be made in a developing country context. An interpretive approach to participatory IS design is needed to understand the socio-economic, cultural and political context that shapes the behavior and actions of the 'users' of the system.

This paper has attempted to address a deficit found in contemporary writings on participatory design in IS literature – the absence, or very little, discussion on the how, rather than the why, of participation in IS design and development in developing countries. As our analysis of the case studies show even though the same type of system (DHIS) was being implemented in developing countries contexts and that capacity development was a viable strategy in all three cases, the approaches adopted were significantly different. If we are to learn from research conducted in the area of participation there is the need for more debate that moves beyond the theoretical and ethical arguments, and discusses in detail the *process* of participation undertaken in ISD. It is from this type of analysis that we may be able to understand what we really mean when we call from an ethical and theoretical perspective for participation in IS design.

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8.8. APPENDIX H

NHAMPOSSA, J. L., KAASBOLL, J. J. & BRA, J. (2004). Participation in the information system adaptation process in the public sector in Mozambique. IN CLEMENT, A., OOSTVEEN, A.-M., SCHULER, D. & BESSELAAR, P. V. D. (Eds.) *Artful integration: Interweaving media, materials and practices*. Toronto, Canada, Association for Computing Machinery, Inc. (ACM). 84-88.

Participation in the information system adaptation process in the public sector in Mozambique.

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1. INTRODUCTION

In the 1980s, efforts to reform health information systems (HIS) to systematically collect, analyze, and report data for improved management in developing countries were undertaken by national program managers of vertically structured programs. "This was due to foreign assistance to the health sector being typically focused on the programs rather than the entire health system" (Sauerborn and Lippeveld 2000, p.6). Many countries decided to attack the problems of HIS at its roots through integrated initiatives. Countries like Cameroon (Sauerborn 1991), Chad (Lippeveld et al. 1992), Tanzania, (Rubona 2001), Mozambique (Mwaluko et al. 1996), and Pakistan (Mujahid 2002) focused on routine HIS for primary level care facilities.

Mozambique is a country in transition with a very high level of illiteracy, shortage of manpower, and resources. In this context, the Mozambican government promotes international "North-South-South" co-operation programs to attempt reduce the economic & social discrepancies between the different communities, organizations and citizens. Historically, such co-operation lines were established at high levels, addressing mainly the top-level interests and policies in the name of national benefits. This phenomenon has to do with all sectors of the national economy and health is not exception.

While the primary health care (PHC) was the strategy selected to extend health services to most peripheral areas in the country, the dominant centralized organizational culture in the health services implies that there is limited spread of an information culture in the districts whereby the information and communication technology (ICT) infrastructure is concentrated in the capital cities. This makes it extremely difficult for the PHC strategy to work effectively in practice. There is thus an asymmetric distribution of infrastructure and access to ICT, which hinders the implementation of PHC. In Mozambique health was the first sector to install a national-wide information system (IS). At province and national levels the Mozambican HIS is supported by a computer based IS (SisProg) developed in 1992. This system was established and is working since then in all 11 provinces as well as at national level. Data from the districts are entered into SisProg and subsequently sent in an electronic format upward to the Ministry of Health (MoH), where is automatically stored in the national version of SisProg. Since its inception and installation, SiProg has been historically reported to have serious design, implementation and maintenance problems. The system was recognized to be top-down, locked to old technology, lacking flexibility to meet the organizational changes and not providing the expected data and information to support planning and decision making.

In this context the need to develop a new system which would be integrated with the present system aroused. The district health information software (DHIS¹), which was developed under health information systems Program (HISP)² principles of decentralization, open source, empowerment of local management

¹ DHIS is a not-for-profit open source software designed in South Africa for use at the district levels of the PHC care sector as a health data analysis tool, being transferred to Mozambique.

² HISP is an ongoing and integrated large-scale action collaborative research venture between the Universities of Oslo (Norway), Cape Town (South Africa), Western Cape (South Africa) and Eduardo Mondlane University (Mozambique). Partners in the Project are also the Health Administrations Institutions of Mozambique and South Africa. Is operating as a global network within the health care sector across a number of developing countries.

(Braa and Hedberg, 2002), was purchased and adopted for piloting in Mozambique in a cooperation basis.

The implementation of DHIS came with promise of changing and improving the information culture while converting the management exercise from raw data to indicator based and integrating the vertical flows at district level. The starting point of HISP is that the promise can be fulfilled by improving the routine health information processes (more than 60% of the time of health workers is spent on health information transactions, such as collection and collation of data in various forms and registers, and its subsequent transmission to upper levels of the administrative structure) and by cultivating a culture of information whereby the health staff realize the value of information to support their action. Improving these processes will then directly impact on work, and the health staff can focus more time on providing care to the community as compared to filling up endless forms that ultimately are marginal to their work of providing health care to the community.

In these terms, HISP was established in Mozambique aiming to (1) Conduct a longitudinal study on the degree of use and diffusion of ICT and the use of information at district and provincial levels in Mozambique, with special emphasis on the health sector and (2) Strengthen and further develop the health information system (HIS). The HISP started in South Africa formed the basis for the establishment of HISP in Mozambique in 1999, when a memorandum of understanding was signed for a pilot project implementation of HISP in three districts, namely Chókwe, Maxixe and Cuamba. For accomplishment of the first phase, academicians and students from Eduardo Mondlane University were involved in administrating the questionnaires in the field. The first phase of the program was finalized with a publication reporting on the actual and potential usage of ICT at district and provincial levels in Mozambique with a focus on the health sector (Braa et al., 2001).

The terms of reference of the above mentioned memorandum of understanding, included the use of participative approaches for piloting HISP philosophy and available tools. The fact that participatory approaches have become one of the mandatory principles in developing world (Rydagen, 2003) and that they were determinant factor for the HISP success in South Africa, helped the counterparts of HISP in Mozambique to adopt them to adapt DHIS to the organizational setting of the MoH.

The present work draws on the trajectory of participative and prototyping (Budde et al, 1992) strategies applied in the effort of adapting DHIS into the Mozambican setting to be used by MoH, the official institution responsible for providing public health services through specific institutions, such as health units, district or province health directorates.

2. BACKGROUND

For systems development different strategies are described in the literature. Such strategies are no longer used in individualized or uncoordinated way, but rather are embedded in an overall development strategy. They offer procedural suggestions covering all activities in the software development life cycle or prescribe specific method for use during these activities. One strategy consists in implementing standardized methodologies, based on traditional engineering disciplines. Such engineering approaches

are perceived to be more rigorous, predictable, "academic" and to not take into consideration the local needs and user priorities. Although there are no approved "silver-bullet" strategies, participative approaches show promise for improved systems development or adaptation.

For use in this paper, participative strategies are described as the adopted methodology to adapt DHIS in Mozambique, since they represent a context-sensitive development process and capture elements of user involvement (Bostrom and Heinen 1977a and 1977b; Markus, 1983; Mumford, 1983). In Scandinavia, participative approaches developed, practiced and evolved since the 1970s (Aarhus, 1975; Bjercknes et al, 1987) and this fact is linked to the traditional and well developed setting, whereby conditions for law regulated relationship between IS researchers and strong national trade unions are present and there is a positive attitude to new technology.

The starting point of the Scandinavian design approach is that every human should have the right to participate equally in decisions concerning his or her life. This is about the importance of inclusion of skilled users on the process of design and use of computer-based information systems (Bjørn-Andersen and Hedberg, 1977; Ehn, 1993). The Scandinavian approach is politically significant, interdisciplinary, and action-oriented research on resources and control in the process of design and use of computer-based information systems. It raises questions of democracy, power, and control at workplace and assumes that the participation of skilled users in the design process can contribute importantly to successful design and high quality product (Ehn and Sandberg, 1979). Therefore users are designated co-designers and systems development is an organizational, technical and human change process.

Scandinavian designers who sought to make systems design more participatory and democratic turned to prototyping, which opens the possibility of developing a model that does not normally have all the required features or provide all the functionality of the final system. Having the major advantage of being relatively inexpensive and quick to build, prototyping can help to clarify the requirements and evaluate the feasibility of a particular system design. In the IS literature one important distinction is made, concerning the Scandinavian versus North American concept of prototyping, seen as meeting very different needs in Scandinavia and in the US. While in Scandinavia prototyping is used to involve users into the design process and make them designers with decision-making role in operational planning and organizational and technological change, in US the role of users is limited to just test, ratify or tweak the work of external designers (Spinuzzi, 2002).

3. ANALYSIS AND DISCUSSION

While a foreign software can be used as a starting point (Heeks, 1999) to design, develop or strengthen local systems, as far as is adjusted to the socio-economic and technological context in question (Avgerou, 1996; Waema, 1996), the attempt to apply participative and prototyping approaches in Mozambique encountered a number of challenges. They were related to the organization (the MoH), the program (HISP) and the individuals (who were expected to use the system). The organization specific challenges of participation were the time required for adaptation of DHIS, availability of financial resources, involvement and

commitment of top management authorities and on the other hand, the individual specific challenges of participation were the willingness to participate, ability to participate and user behavior.

Time concerns and availability of financial resources.

The HISP vision is to invest energy and resources to address institutionalization, sustainability and scalability concerns, as illustrated in the sentence below:

...through training, support and capacity building, encouragement and development of district based HIS for health data management and promote electronic communication systems where appropriate.

This is a long term goal which requires for its achievement time and financial resources. The initial and subsequent project funds were provided by the Norwegian Government to support research activities (piloting, publication, field work), rather than scaling up the implementation of DHIS national-wide. The idea of HISP was to draw recommendations based on the research and piloting, on how to address the health information needs of the MoH and how the DHIS could support it. On the other hand the MoH was lacking appropriate tool to support management and informed decision making. Since DHIS was reported as a successful story, whereby the national level [authorities] endorsed HISP for national rollout in South Africa (Braa and Hedberg, 2002), the MoH along with the HISP team, decided to implement it the pilot sites. The prototyping process started, focusing only in the three pilot districts, but by recommendation of the local Provincial authorities a shift was observed from just one district to cover the all province³ (districts with proper infrastructure, e.g. electricity), but the recommendation was not accompanied by the required resources (e.g. financial, human) to support the initiative. The only human support available was the HISP team, composed by health professionals, academicians, Master and PhD students, who are involved in some other activities beside the project ones. We ended up in chicken-egg situation whereby the MoH wanted to see results of the DHIS implementation (e.g reports generated from the DHIS) in the districts and in the other hand district and provincial authorities were not using the DHIS because were waiting for a special sanction from the top level to formalize the use of the DHIS software, to avoid working using several systems at the same time. So although the MoH top managers were part of HISP team, their commitment was partial and unpredictable, since they were also involved in some other initiatives.

Cooperating with the top level.

The process of participating with the MoH shifted between periods of joint work and negotiations. During the periods of joint work, the managers from the MoH participated in the project team in the training and adaptation of the system. In between these periods, these managers defended the ministry's policies and negotiated terms with the project.

The interaction between the project and the MoH resembles that of a consultancy and its customers. Gundersen (2004) describes this interaction as a shift between a market relation and a clan, in the way that these organizational forms are defined within the

transaction cost theory (Ciborra, 1993). The relation between two actors in a market has the form of exchanges of values according to terms agreed upon. In clans, the actors cooperate towards common goals and share culture and professional competence. When a software consultancy negotiates terms with a customer, they operate under the market conditions. After the deal is closed, system developers from the consultancy establish a team with users from the customer organization, and this team is working towards a common goal of creating a system. During this period they establish a clan relation. However, when decisions concerning acceptance of solutions are to be made, the team usually takes up the roles as actors in a market again, negotiating terms from their own points of view.

Participative processes have to cater for these shifts of focus between cooperating in a clan and negotiating in the market relation. Gundersen (2004) suggests prescheduled points of decision. In this case of interaction with the health sector in Mozambique, the periods of negotiation often appeared as consequences of processes within the Ministry and therefore not according to plans that the project could set. Private companies doing consultancy work for the public sector would guard themselves against shifting policies through contracts, and academic or NGO funded projects could learn a lesson from their experience in market transactions. Since breaking up the clan at some points seems unavoidable, having a strategy for dealing with these situations would be better than regarding them as crises.

Cooperation between levels.

In addition to clans and markets, the transaction cost theory includes bureaucracy as the third way of organizing interactions. The health sector in Mozambique is an organization with a strict bureaucratic structure between the managers, the doctors, and the nurses and other clinical staff. In order to adapt the software system to the health sector, creating a minimum of common understanding of the information system at all levels required some interaction between the levels. Establishing clans including the lower level health workers and the managers from the Ministry of Health seemed impossible; the health personnel in the clinics were too afraid of their bosses. Instead, the HISP team created clan like groups including low level health staff and doctors, and other groups with doctors and the MoH people. Through these ad hoc groups, interactions between the levels took place, and some common ground was established.

In countries with strict bureaucracies, the project teams have a challenging task of creating communication across the levels. The absence of legislation concerning worker participation and culture of democracy at work puts a heavy burden on project teams, which have to create clan like conditions including people from all levels for periods of the adaptation process.

Willingness and ability to participate.

Awareness and sense of ownership creation was one strategy adopted to build the will to participate and align the MoH needs and HISP goals. This was enabled through discussions held in HISP organized meeting, seminars, workshops and training sessions with health workers, top and middle managers and doctors. The lack of basic skills (e.g. arithmetic calculations, statistics) and eSkills we believe contributed to the inability to

³ The three districts were located in three different Provinces whereby the average number of districts is 14.

participate. These sessions were organized differently in different places and levels, focusing on eSkills and management enhancement they helped to also build the ability among users to participate with constructive ideas as to identify the gaps of the current system and address them when prototyping the DHIS.

The state of being an owner is recognized to contribute positively to create the interest among the beneficiaries of whatsoever project to participate with muscle power (Rydhagen, 2003) in design process. The underlying idea is that the beneficiaries are supposed to own the project and participate in all parts of the process, from planning to evaluation (IDS, 1996). Although the initiators and the driving force of the HISP project are an academicians and software developer from Norway (educated within the Scandinavian setting), the fact that the initiative, decisions and responsibility were transferred to the locally created HISP team, ensured the sense of ownership and thus the conditions for proper DHIS adaptation.

Should engineering approaches to software development be abandoned in favour of participatory and prototyping methodologies?

For informing and illustrating the discussion towards the answer to the above question, we use the case of HISP in Mozambique, whereas both the philosophy and the DHIS application are being transferred to a new and different setting. There are enormous discrepancies between the Scandinavian and Mozambican settings. It concerns social, cultural, political and technological aspects. For instance the high educated manpower, strong commitment to democratisation at work place, positive attitude to new technology, existence of conditions for law regulated relationship between IS researchers and strong national trade unions. These issues of fundamental importance are almost absent in the Mozambican setting.

The assumption that systems built by engineering approaches can be unproblematically transferred across contexts becomes magnified in diverse contexts as in developing countries. IS cannot be understood the same way as engineered artefacts that can in a standard way solve real-world problems. In order to improve IS development it is key to develop systems that are close to those models of reality of users. And in developing countries, these models of reality are indeed very different than the kinds in the developed world from where such engineering approaches originate. However despite considerable research in software development applying participatory and prototyping methodologies, its successes have not been seen in contexts as diverse as in developing countries such as Mozambique.

4. CONCLUSION

The current case did not allow development of a system from scratch, although this was the basis of the participatory design principles. Nevertheless, the principles were followed to some extent in the process of adapting the DHIS in Mozambique. Participatory design requires that the adaptation of the software in an organization takes place in close collaboration between users and developers, and such collaboration took place at the multiple levels, national, province and district.

The focus on mutual learning process enabled bridging the gaps between the designers' and the users' understanding of the existing system and the envisagement of the new system. 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 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.

The strong bureaucracy in the public sector required three strategies in order to achieve participation. First, the communication between the top level managers and health workers normally takes place one way, top down, but interaction was enhanced by involving academicians who were seen as neutral but sensitive to the MoH management problems. Second, participation between system developers and users at the lower level required extensive skills training, due to the users' low level of education. Third, interaction between at the top level took place as an alternating process of negotiation and participatory design. Similar transitions can be expected in cooperation with the upper managers of bureaucracies due to the loyalty squeeze they may experience between the possibly shifting policies of the top leaders and their commitment to the project.

The Scandinavian version of prototyping was crucial in facilitating participatory approaches using a flexible tool (DHIS) to address the constantly changing needs of the national HIS in Mozambique. However problems were encountered in the overall process. They are related to the fact that initially the focus was on implementing HISP ideals at the district instead of multiple levels (MoH, province and district) as was expected by the top level authorities. Shifting the focus to include the MoH and province levels, time misalignment, and lack of resources (e.g. human, financial, and technical) contributed to the delays in implementing the HISP ideals and the DHIS software across the country.

5. ACKNOWLEDGMENTS

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8.9. APPENDIX I

NHAMPOSSA, J. L. (2004). The challenge of "translating" health information systems from one developing country context to another: case study from Mozambique. IN LEINO, T., SAARINEN, T. & KLEIN, S. (Eds.) Proceedings of the 12th European Conference on Information Systems. Turku, Finland, ECIS - The European IS Profession in the Global Networking Environment.

THE CHALLENGE OF “TRANSLATING” HEALTH INFORMATION SYSTEMS FROM ONE DEVELOPING COUNTRY CONTEXT TO ANOTHER: CASE STUDY FROM MOZAMBIQUE

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Abstract

What does it take for an open source, Not-for-Profit, software developed in one context to be internationalized and localized so as to be used in another context different from its origin. This question is addressed in the frame of a Health Information System application developed in and for South Africa and subsequently transferred to use in Mozambique.

Through an action research effort, five sets of key challenges to cross-country translation process have been identified: (i) language rules and lack of Portuguese equivalent terms from English, (ii) length of strings, (iii) different naming conventions, (iv) different organizational structures, and (v) inadequate knowledge. The understanding of these challenges helps us to identify the different features of translation associated with “general purpose” and “special purpose” applications. The analysis helps to address the question of how a “pragmatic balance” can be obtained between the needs for creating internationalized products on one hand, and that for providing flexibility for local adaptation on the other hand.

Keywords: Multilanguage systems, language translation, localization, internationalization, globalization, general business domain, special business domain, healthcare, Mozambique, South Africa.

1 INTRODUCTION

This paper deals with the problem of how can an open source software designed and developed for supporting Health Information Systems (HIS) in a particular developing country (South Africa) be localized and adapted for use in another developing country (Mozambique). The challenges in this localization process are multiple and complex ranging from the problem of language translation (English to Portuguese) to adapting it to the very different contexts of use in the health sector of the two countries.

Primary Health Care (PHC) in developing countries provides an interesting domain for the study of this translation process. In this paper, the term “translation” has been used more broadly than just referring to language translation but to also include adapting the software to the different contexts of use, for example related to varying health organization structures. The World Health Organization (WHO) has stipulated various standards around how HIS should be organized in various developing countries. For example, the district has been designated as the hub for all information management activities. This implies that data from the health units are sent to the district where it is aggregated and then sent to the province and national levels. Also, most countries have multiple donor-supported vertical programs operating, creating the similar need for integration of these systems to enhance effectiveness of the HISs. There is also the need for the HIS to enable the calculation of health indicators, for example of immunization coverage, some of which are standardized across countries. While this element of standardization through the WHO directives may give the impression that the HIS from one context can be easily translated to another, however, in practice this translation is very complex, given the very different socio-political-cultural contexts, which shape the HIS in distinctive ways. Having said that, however, there are certain elements in HIS which are indeed common, and can be taken from one context to another. So, while there is no need to fully “reinvent the wheel” of HIS design and development, sensitivity to the contextual differences and how they shape the HIS in different countries is essential. This need is in line with Rolland and Monteiro’s (2002) argument for the need to find the “pragmatic balance” between the pressures for building global standardized system on one hand, and to allow for flexibility to localize and expand the system on the other hand. The focus of this paper is to analyse the practical challenges of translating a HIS designed and developed for South Africa to Mozambique. An analysis of this process helps to shed light on the simultaneous processes of internationalization and localization of HIS, and the tensions that exists.

The rest of the paper is organized as follows. The key theoretical concepts are presented in the second section while the following two sections describe the methodology and the case study. The fifth section describes the challenges experienced during the empirical work of software translation. The sixth section focuses on the analysis and discussion of the findings drawing upon the relevant theoretical concepts. Finally some concluding remarks are presented in section seven.

2 THEORETICAL CONSIDERATIONS

The issue concerning the design, development and implementation of software to be used across different, national and cultural boundaries can be usefully analysed with respect to processes of internationalization, localization and globalisation. Internationalization refers to the process of isolating the culturally specific elements from the software and building a system for use in different countries (Russo, 1993; O’Donnell, 1994). Normally this process occurs in the country where the product is originally developed and is typically limited to translating text and date, time, and number formats, following specific guidelines (Russo, 1993). This processes is largely limited to language translation, or inserting some locally relevant icons and colours, but largely confined to the level of the user interface. Localization, in contrast, refers to the process of infusing a specific cultural and business context into a previously internationalized product (Taylor, 1992; O’Donnell, 1994). Like internationalization, localization is normally limited to translating text, message files, date and number

formats. Globalisation involves global corporations seeking to develop suitably standardized products and practises that can be used across the globe. These efforts at standardization are typically in tension with the need for localization and become visible in the process of translation.

Translation of software can be of two types. One dealing with software for General Business Domain Application (GBDA), and the other for Special Business Domain Application (SBDA). GBDA refers to general purpose software like spreadsheets and text processors. In this, the functionality, content and the interface is largely decided by the software vendor, and it is relatively easily used across organizations, countries, contexts and cultures. Improvements, changes and evolution of the software are driven by the vendor to maximize the time efficiencies for testing and debugging whilst expanding the market scope.

The SBDA software is more application focussed, and thus the translation process requires a greater understanding of the business domain and the context of use. Specific meanings of terms and concepts are important to understand as they are linked to particular business rules. To enable this understanding, it is important for end-users and systems developers to work collaboratively with each other. In SBDA the development process is facilitated in such an environment where the systems developers are pulled from the context of design into the context of use, and are therefore confronted with the incompleteness of current understandings of complex cultural settings (Gregory, 1995). The translation processes of SBDAs are thus more complex and require greater time and investment of end users as compared to GBDA.

In this paper, the translation process of a SBDA software related specifically to the domain of PHC in developing countries is discussed. This translation process is different from most examples described in the literature for at least two reasons. One, the software is open source and not for profit. Two, the software is designed within the context of public sector. While these differences create challenges related to the availability of resources and skilled personnel, it also helps to open up new opportunities since project maximization is not the driving motive. This study thus has potentially important contributions to make to both the understanding of open source software development, and to the design and development of HIS in developing countries.

3 METHODOLOGY

The work presented here is based on research carried out in the Health Information System Project (HISP) in Mozambique from 2000 to 2003. HISP is an ongoing international endeavour aiming to study and introduce district-based HIS in various developing countries (Braa et al., 2001; Braa et al., 2003). DHIS is an open source software meaning that not only the user has access to the all source code, but also has the ability for free redistribution and reworking of the source code (Braa and Hedberg, 2000).

The research efforts were aimed at the design, development, and implementation of the DHIS in Mozambique, and were enabled through a 6 member multidisciplinary team for translating the DHIS. The author of this paper was a member of this team comprising of medical doctors, computer scientists, and Ministry of Health (MoH) staff. Being the computer scientist, the author was overall responsible for the entire translation process. Data collection sources included discussions within the team, participating in training workshops, study of documents, and focussed interviews with other members of the team, and also with the head of the DHIS software development team in South Africa.

The process of design and development of DHIS can be described as an action research project (Susman and Evered, 1978) consisting of a set of cyclical and interleaved steps. The focus is on the interventions that the researcher takes together with the users in order to improve a phenomenon at the same time as studying it (Kalleberg, 1995). Susman and Everd present their action research approach in a diagram as depicted in the figure 1 below.

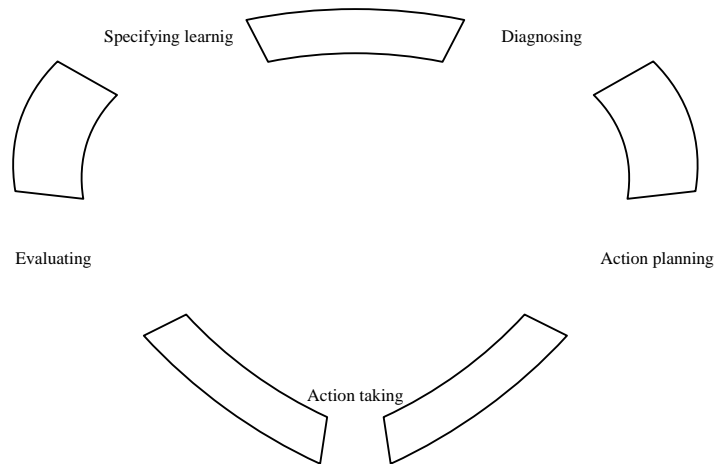


Figure 1. Susman and Evered's (1978) cyclical process of action research.

The localization and translation processes described in this paper are similar to the steps described by Susman and Evered. In the case, the diagnosing phase consisted of understanding the health information needs of the health department and how the DHIS could help support it. The action planning stage involved setting up the multidisciplinary team and establishing the strategy for DHIS localization. The action taking phase involved using the prototyping methodology for developing and using various translated versions of the software. Evaluation consisted of testing the DHIS in the pilot sites, and taking necessary correction action in “the specifying learning” phase. Through these iterative cycles there was thus learning by doing and changes emerged as a result. This approach is different from traditional software process models, like the waterfall approach that do not allow for construction until the specification phase is completed. Such approaches are problematic in conditions where specifications are unstructured, ambiguous, keeps changing, and the requirements are very user dependent rather than being system dependent. The PHC sector represents such an unstructured domain.

The starting point of the localization process was the DHIS software designed in South Africa for the needs of the South African health system. The system and all relevant documentation were in English. For example the user interface for the South African DHIS is depicted in figure 2 below.

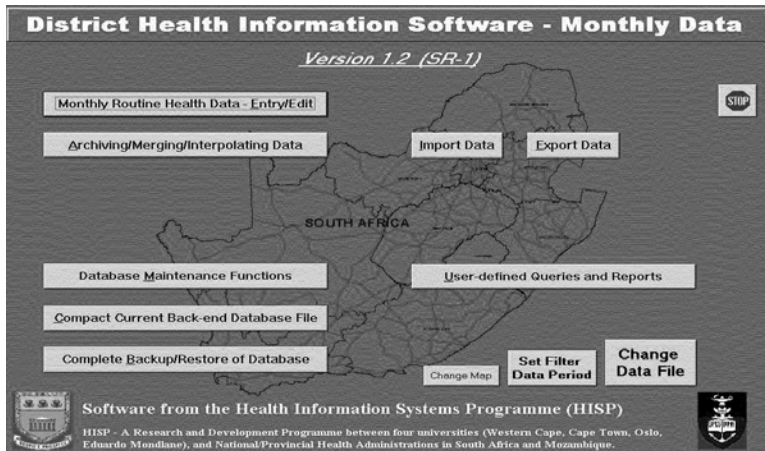


Figure 2. The original user interface of the DHIS software.

The DHIS consists of several modules and data files. The “Routine monthly data” module – allows data entry, verification and analysis of monthly data from the PHC and hospital services. The tuberculosis (TB) module enables entry of routine TB data entry, verification and analysis. The Report Generator module is used for generating and accessing reports on any of the data files. The Client Satisfaction Survey module is used to capture and analyze the client satisfaction survey data in FRONTENDS. These modules represent the different user interfaces for monthly routine health data, tuberculosis data, client satisfaction survey and data reporting.

The database files, representing the BACKEND of the DHIS stores information about data elements, data element categories, indicators, definitions, organizational unit data, and semi-permanent data for example related to population. The database files can be classified according to the organizational structure of the health system. In Mozambique, the structure consists of four levels, and the database files correspondently have four instances: National, Provincial, District and Health Unit.

For each database module there is (or can be generated) a corresponding MS-Excel spreadsheet module-pivot table that is used for data analysis. Here data can be visualized and handled in pivot tables and used to build standard or customized graphs for different purposes, for example to see the immunization coverage for different time periods.

DHIS contains tools for data quality control which allows for the checking of the quality of data entered by setting the minimum and maximum ranges for all the data elements. A validation check can be done once a facility’s data has been entered for the month.

Indicators, community data, and data dictionary are three other features of DHIS. Indicators are defined and handled according to the numerator, denominator and indicator type. These form different indicator groups (for example, district or province level indicators) that are the source for the pivot tables in the Excel spreadsheet. Community data features provide the definitions for the different semi-permanent data elements, such as population groups and targets. Population data is entered for each district catchment area according to the different population age categories. The Data Dictionary is a Web based application storing the nationally approved names and definitions for all the data elements that are in common use throughout the country.

The DHIS installation CD includes the user manual, additional support software tools including various Microsoft service releases/packs. Basically all the complementary and supplementary resources available on the DHIS setup CD are in English and for English versions of Microsoft Windows operating system and Office.

HISPML, the HISP multilanguage library, is a separate database module storing the text strings visualized in different user-interface screens of the current FRONTENDS. This module makes it

possible to translate DHIS to all MS WINDOWS 2000/XP supported languages, whereby by selecting the locale, the text strings are automatically visualized in the different screens. The text strings are basically stored in three categories of sources: GLOBAL DICTIONARY (1), BACKENDS (1 or more) and MS-ACCESS FORMS (192 or more).

The entire development of the DHIS is being conducted by a development team based in South Africa. Along with producing new versions of the DHIS as they are continuously developed, the team is also responsible for providing technical support to the team engaged in localization in different countries, as in Mozambique.

After this brief description of the technical features of the DHIS, and how the development is organized, the case study concerning its localization process to the Mozambique context is now described.

4 THE CASE: TRANSLATION AND ADAPTATION OF DHIS

There was consensus among the HISP team in Mozambique to initially implement for testing purposes only the Routine Monthly Data module of the DHIS. This module was seen to be critical as it provides the set of data collection and reporting procedures to handle monthly routine health data. So the initial use of DHIS was to computerize the existing paper system and basic procedures from the current National Health Information System, called SIS. In doing the translation, skills and expertise was required from the domain of computer science, medicine, and public health. Although none of the HISP team members were native English speakers, and neither did they possess any prior experience in language translation in general and of software in particular, the first prototype was primarily an output of the combined effort of this team, supported by officials from the Ministry of Health.

The adaptation process was conceptualized in two parallel tasks: Language translation and development of the Mozambican BACKEND. A CD with the first monolanguage version of the DHIS software was installed on a portable computer. Translating the software interface was the starting point of the DHIS so as to provide the users with a greater sense of familiarity and with it more ownership of the system.

The fact that the strings were part of the code made it difficult if not impossible to install the Portuguese version of DHIS on other computers, meaning the translation process was restricted only to the hosting computer where the piloting process was being carried out. During a training session, for example, all the facilitators and available participants had to sit around the one portable computer that hosted the Portuguese version of the DHIS.

Basically all the changes to DHIS software were introduced in the same portable computer, which was then needed to be sent back to the South African development team for the production of the setup CD. The new DHIS was then sent back to Mozambique, making it possible to distribute it among different people, and install on other computers for use and further testing.

The number of language problems reported magnified as the number of users increased. The strings inscribed in DHIS software were generated in South Africa and were not context free. The translation in a different context is naturally complex, requiring greater face-to-face interaction between Mozambique and South Africa. However, this was difficult to achieve, due to geographical distance and limited resources. Therefore the interaction with the South African team was limited to electronic mail and some limited telephone calls.

As an example of the kind of electronic communication exchanged, is provided below this excerpt of an interaction between Mozambique and South Africa.

Communication facilitated through e-mail, between the head of DHIS software development team in SOUTH AFRICA and myself:	
Mozambican side	South African side
<ul style="list-style-type: none"> • Thanks for sending me the updated version of the standard hardware/software for HMIS document. • I find it a very useful document indeed. Do you mind if we translate part of the doc and use it to update the MoH policy document regarding this issue? If yes we aim to distribute it to all provinces and district health authorities. 	<ul style="list-style-type: none"> • Feel free to translate, use, or re-distribute it as you see fit. When translating it into Portuguese, I would also suggest you adapt it to fit Mozambique (replace some SA-specific comments, use local prices etc). • In particular, I would insert a few extra paragraphs: Emphasise the need for Portuguese keyboards. I see you are using XP, and that the message is "failure to create registry key". It's too late for me to test it on my XP disk now, but check two things: <ol style="list-style-type: none"> 1. Verify that the decimal separator is set to. (ot) and the thousand separator to a comma. 2. Verify that you have logged into windows XP as a user with admin privileges (or at least have authority to make modifications to the registry).

Table 1. Electronic communication between development and localization teams

The new version received from South Africa in Portuguese was not compatible with the existing local Mozambican database/BACKEND that contained the data elements, indicators, organizational unit data, definitions, etc. So using the new version required the database to be built from scratch. One more language translation cycle took place, and the required changes were introduced in the portable computer and, to produce the setup CD the computer was sent again to South Africa. The implementation of every single change was synonymous to totally deleting the previous work since the new versions were not compatible with the local backend. These repeated cycles of changes, transfers to South Africa and not optimal design significantly impeded the progress of the project. These problems led to feedback to the head of development team in South Africa to separate the text strings from the software and associate them with a particular language module. In parallel, a checklist with a set of DHIS problems or bugs and proposals for improvement was developed in Mozambique and submitted to the South Africa development team. This formed the starting point for the birth of the idea of shifting DHIS from mono to a multilanguage platform.

A multilanguage version of DHIS was subsequently developed in South Africa which was capable of supporting several languages including Portuguese, Norwegian, Russian, and Spanish. In the multilingual DHIS, the caption strings, data definitions, and indicator strings could be translated and used with new coming versions. This new version of the DHIS was obtained from South Africa and installed in various personal computers in Mozambique. The HISP team verified to what extent had the problems listed in the checklist been fixed in the multilanguage version of DHIS. It was seen that the organizational schema of the strings suffered from great alterations, creating the need to correspondingly change the translation approach along with the adaptation. The strings in the FRONTEND – representing the visible part of the DHIS - and the ones in the BACKEND – representing the invisible part of the DHIS were approached differently when translating. The strings in the HISPML library were divided among the team members and translated to Portuguese, while the BACKEND was translated or rebuilt in parallel. To refine the translation, and make sure inputs from everyone involved in the localization process was taken into account, several stakeholder meetings were organized to discuss in detail, string-by-string and line-by-line the meanings and appropriateness of the strings or sub-strings used. It included sometimes starting up the computer and the DHIS software and clicking on the strings corresponding buttons to see the linkage to the functions and concepts behind the visualized text in the screen.

5 CHALLENGES EXPERIENCED DURING THE TRANSLATION PROCESS

As the DHIS was translated into Portuguese, it was tested in the pilot sites for the first time. Feedback on problems were reported to the HISP Mozambique (HISPMZ) team by the users during the piloting exercises and training sessions organized at various sites. Five sets of key challenges were experienced:

- Language rules and lack of Portuguese equivalent (see Griffiths et al., 1994) terms from English,
- Length of Strings,
- Different naming conventions,
- Different organizational structures, and
- Inadequate knowledge.

These challenges are now described separately.

5.1 Language rules and lack of Portuguese equivalent terms from English

The present English language computer vocabulary was invented when the need arose when the item or concept was created (Barbour, 1996). Terms like backup, zoom, and data mart do not have direct translation in Portuguese. In this case, the team was forced to perform a partial or intermediate translation, mixing English and Portuguese text. This hybridization of terms often created problems of interpretation for the users.

The dictionary (as a starting point) can be a good input for the translation if aligned with knowledge about concepts, meaning, language rules (which are specific to languages) and contexts of use. These meanings can be effectively provided only by people who are conversant with the language rules, cultural, context and business rules. The dictionary or the machine can only provide for translation of the standard concepts but not of the culturally specific meanings. The dictionary thus can help in the translation of simple strings but not of strings of strings. Since the meanings of strings are linked to broader cultural and business understandings, the dictionary provided with the installation CD was inadequate.

For example, consider the command: `printf("%s %s", string1,string2);`

The machine will access the corresponding text for strings 1 and 2 in the string tables and translate automatically. But if the text order has to be changed there will be a problem.

If string1 is for “yellow” and string2 is for “house” the translation for Portuguese could result in “amarela casa” instead of “casa amarela,” as is the rule in Portuguese.

The lack of Portuguese equivalent terms is also illustrated in the following excerpt related to what I call “partial” or “intermediate” translation.

DHIS users of non-English versions of Windows and Office should download the correct Service Releases/Packs from the relevant Microsoft web-site.

This quote is from the DHIS user manual. The decision whether or not to use the English or Portuguese version of MS Access is needed to be taken locally based upon the ease to download the correct service releases/packs from the internet. Accessing the releases/packs from the internet requires (i) availability of internet connection and a (ii) reasonably fast link. Such a downloading exercise could last for hours or even days in Mozambique. Therefore, in practical terms, we decided to install the translated Portuguese DHIS version using the English MS Access, as visualized in the Figure 3 below. This intermediate or partial translation again created confusion and ambiguity for the users.

When prompted, the user had to click on the Tools menu, Database Utilities and Compact and Repair Database buttons. The translated Portuguese version appeared as follow: *Clicar no Tools, Ferramentas*

de base de dados, Compactar base de dados. So the user is confronted with a situation where she or he is prompted to click buttons which are not visible on the screen. In this case, the translation is adding more confusion instead of facilitating the dialog between the user and the system. This situation remains the same even in the English version of MS Access because of the absence of specific technical terms in languages other than the original, in this case English. This ambiguity is reflected in one of the questions asked to the HISP team about the possibility of using the Portuguese version of WINDOWS and OFFICE. The answer was:

Ideally yes, but because of possible bugs on the Portuguese versions of MS Access, no.

The DHIS functions in the Microsoft Access environment. It would be thus advisable to use the Microsoft Access in Portuguese in Mozambique, and other countries where Portuguese is the official language to avoid the appearance of English and Portuguese strings in the same screen.

In addition to the complexity of translating Portuguese terms, similar challenges were experienced in finding the “right” equivalent for English-based terminology used in health, medicine or epidemiology.

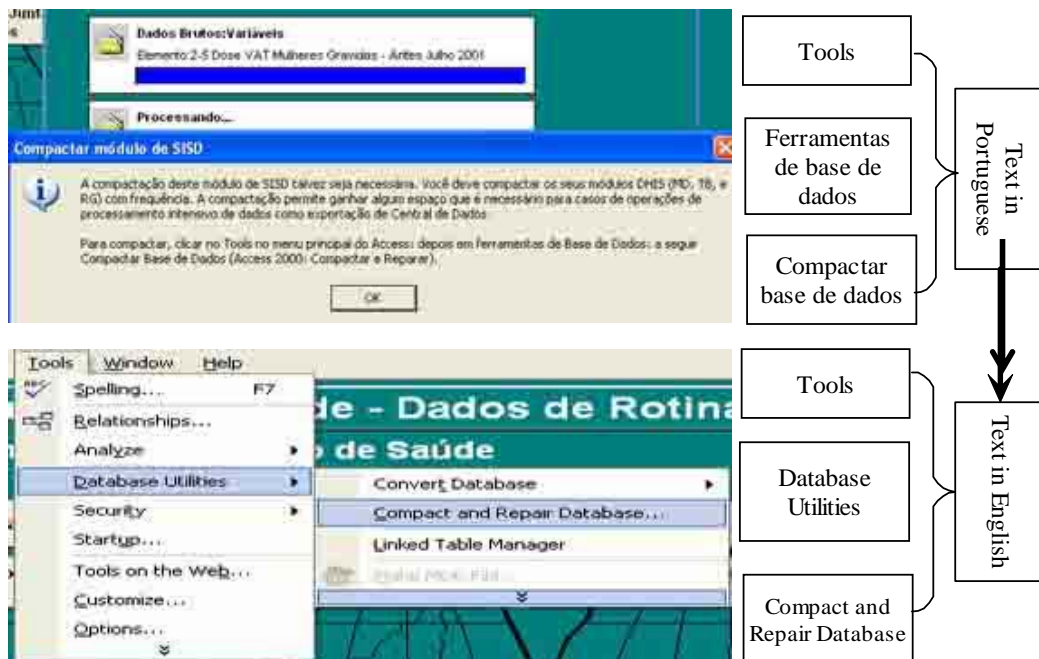


Figure 3. English version of MS Access interface development environment versus Portuguese version of DHIS leading to intermediate or partial translation: Mix of English and Portuguese text.

5.2 Length of Strings

The translation raised issues related to the length of strings as Portuguese equivalent were much longer than those used in English. This issue of length had implications for the user interfaces, the description and distribution or location of the different buttons, the layout of the screens and quality of the video adapters. Consequently, in order to keep the “correct” translation, the buttons for example had to be enlarged and located in different positions. Or the long strings had to be simplified in order to keep a reasonable layout and distributions of the buttons. For example the translation of “backup” will be *Cópia de segurança*, which did not fit in the original user interface button. In this case, the button had to be expanded with knock down implications on the design of the Menu.

5.3 Different naming conventions

The Mozambique health system suffers from the problem of different and inconsistent naming conventions of the different organizational units even though located in different provinces. For example, it is possible for a health unit in Maputo and Niassa to both have the same name of Eduardo Modlane. The naming convention thus needed to be changed, based on consultations with health authorities.

5.4 Different organizational structures

The hierarchical organizational structure of the health system in Mozambique is different from South Africa. In South Africa, there are five levels including National, Province, Region, District and the Facility. In comparison, Mozambique has one less level as there are no health regions. This implied adding a dummy organizational layer to the Mozambican organizational structure to allow for the compatibility of levels (Kaasboll and Nhampossa, 2002).

5.5 Inadequate domain knowledge

Translation required computer skills, understanding of medical terminology, knowledge of application domain and experience on translating software. The translation took place under extreme time pressure as the project needed to show quick results generated from a usable DHIS prototype to the MoH officials. For reasons of expedience, the translation of the monolanguage DHIS was therefore performed focusing more on the technical terminology and aspects from the computer point of view, rather than on developing the “correct” meanings of technical health terminology. As the English strings were hard coded, the translation took place in a traditional way, using the tools available in the MS-Access editor (cut, copy, replace, paste). However, this technical focus led to improper meanings of terms that caused problems for the users.

Language problems were the most critical due to lack of understanding of the terms visualized on the user interface and linked to specific functions of the DHIS. For example, the string data element was translated *as elemento de dados*, but on testing we found that the meaning was distorted by the pure text translation performed by people lacking expertise in technical health terminology. *Variável* for variable is in this case the correct translation according to health workers. It was possible to translate back the expression but this implied stopping the DHIS program and switching to design view, making the required changes, saving and restarting. In general this could happen several times during a training session leading to interruption of the training session.

6 ANALYSIS AND DISCUSSION

The fact that initially the DHIS strings were hard-coded significantly contributed to the challenges in translation. This is because the DHIS was not originally designed with features and code to accept international conventions, foreign data, and format processing. Miller (1994) argues that building internationalization into a [software] minimizes or eliminates the need for engineering revisions [as happened with DHIS monolanguage], and greatly simplifies the localization process and reduces the time lags inherent in localizing software for other contexts. For example, it was assumed and expected that the translation would be trustworthy if it was carried through in a team spirit and the result would be a product of conjugation of computer science, medical and health management expertise. Unfortunately the materialization of the idea was hindered by the inadequate design for DHIS which did not have the prior aim of internationalization.

The DHIS described earlier is composed by a set of modules, each with specific functionality. Viewed from the perspective of a SBDA, the DHIS gives space for specific countries or organizations to

decide, according to their needs and priorities, what do adopt and localize first. For example in Mozambique it was agreed to focus first on the localization and translation of the monthly data module (FRONTEND), which still allowed us to use the software. Similarly we had the option to translate or not the documentation of DHIS. However, given the relatively advanced nature of the DHIS implementation process in South Africa, we found the user manual provided with the software was developed for users with high computer skills, which was definitively not the case in Mozambique, especially in the rural areas.

In contrast, localizing a GBDA implies taking care of primarily all the engineering aspects before the software is released for distribution. For example, in this case the functionality present can be the base to categorize the users as beginners or advanced, according to their confidence in using the software. However, a primary focus on the technical aspects implies that the context specific meanings of use are ignored. As a result, the users can feel alienated and resist the system.

In the SBDA, the source (developers in South Africa) and the target (localization team in Mozambique) teams are expected to co-develop the software, and the source counterpart acts as a supervisor, ensuring all the desired features at the required standard are included (Uren, 1993). However, such a development model assumes the existence of local capacity, and not only about the technical features of the software, but also of domain (medical) and context of use (public health). This assumption, while initially incorrect, however has positive implications in the long run. As through the practical experience of the translation, local capacity gets enhanced, the potential for longer term sustainability of the system is incremental (Korpela, 1998).

Our analysis helps to identify the points of differences in translating software for GBDA and SBDA systems.

	GBDA	SBDA
What should be translated	<ul style="list-style-type: none"> • Translate interface • Keep functionality 	<ul style="list-style-type: none"> • Translate interface, documentation • Localize/translate functionality
Competence needed	<ul style="list-style-type: none"> • Computer skills • Technical expertise relating to formats, standards • Professional language and software translation 	<ul style="list-style-type: none"> • Computer skills • Application domain experience & knowledge • Contextual language & software translation
How	<ul style="list-style-type: none"> • Long-term iterative process of translation according to INTERNATIONAL market requirements • Separate in time and space interface translation from functionality 	<ul style="list-style-type: none"> • Short-term iterative process of translation according to LOCAL requirements • Not separate in time and space interface translation from functionality
Localization	<ul style="list-style-type: none"> • Technically enable the software to support foreign languages and basic formatting required • Vendor or corporate-driven • Provide tools and utilities for local customization of interface 	<ul style="list-style-type: none"> • Technically enable the software to support foreign languages, the required formatting and the meanings, e.g. symbols, colours • Require more time and effort for understanding the

	<ul style="list-style-type: none"> • Through localizers 	<ul style="list-style-type: none"> • culture, meanings • In-house, contextual process of development • Multidisciplinary team representing different knowledge domain • Full involvement of potential users • Provide tools and utilities for local customization of interface and functionality
Internationalization	<ul style="list-style-type: none"> • Semantic factors most important • The commercial restriction does not allow for providing the source code • Through internationalizers 	<ul style="list-style-type: none"> • Context factors most important • Internationalization as first step • Provide the application and source code
Globalization	<ul style="list-style-type: none"> • Applicable • Same standard across countries and cultures • Through globalizers 	<ul style="list-style-type: none"> • Not applicable

Table 2. Summary of semantic and context matters

Barbour (1996) argues that separating the functionality from the interface will help accelerate the internationalization of software. However, as this case emphasizes, translating the DHIS and creating the backend are not two separable exercises, and are linked to the functionality of the software. As a result, they need to be performed simultaneously, involving people knowledgeable about the application domain, public health and of the context in which the system is intended to be used. Translation is not merely a technical exercise (Barbour *at el.*, 1996), but involves mastering the domain of system use, the content of the application, new (technical) terms, use of shortcuts in menus, names of objects (trash can, dustbin, period – US, full-stop - UK), leaving space for text expansion, and maintaining consistency in terminology and documentation.

In developing application specific software to be used across countries it is not enough to cover only technical issues (Barbour *at el.*, 1996), but requires strategies to separating the user interface from the functionality of the application software. This provides space for individual user interface development and translation using the experience of local teams. In providing these insights based on the practical experience of translation, it has been attempted to answer the challenge posed by Rolland and Monteiro (2002) on how to find the “pragmatic balance”.

7 CONCLUDING REMARKS AND RECOMMENDATIONS

In this study, the primary concern was about understanding the processes involved in translating HIS in the context of developing countries. Specifically, the focus of the paper was to analyse the practical challenges of translating a HIS designed and developed in South Africa to be subsequently used in Mozambique.

Two application domain perspectives were distinguished, GBDA and SBDA, and the differences in their internationalization and localization processes were identified.

The evident tensions between the needs for internationalization and localization models were highlighted and five specific challenges were identified. These challenges need to be considered for purposes of both the language translation and adapting the HIS in varying contexts of use.

However, there are certain elements in HIS which are indeed common, and can be taken from one context to another as starting point, so as to avoid re-inventing the wheel. So, while there is no need to fully “reinvent the wheel” sensitiveness to contextual differences must be taken into account when designing, developing or implementing systems. As the HISP initiative is underway in different developing countries, lessons from this translation experience can be useful to guide localization exercises in other contexts, for example to Swahili in Tanzania and to Telugu in Andhra Pradesh, India.

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8.10. APPENDIX J

NIELSEN, P. & NHAMPOSSA, J. L. (2005). Internationalization of Information Infrastructures and control: Cases from Mozambique and Norway. IN BADA, A. & ADELAKUN, O. (Eds.) Enhancing human resource development through ICT. Abuja, Nigeria. 220-230.

Internationalization of Information Infrastructures and Control: Cases from Mozambique and Norway

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ABSTRACT

Based on the growing interest in internationalization in the information systems (IS) domain, this paper examines two attempts of internationalization. The first relates to a health information system for developing countries and the second concerns a telecommunication platform for premium rated SMS services. Discussing the experiences from these cases we use concepts from information infrastructure (II) as our theoretical and analytical lens. This analysis leads us to the articulation of an extended framework for theorizing and understanding the processes of internationalization. Our discussion engages with the inherent challenges of internationalizing IS, in particular the tensions related to control. Throughout the paper we will show that internationalization processes are highly contingent upon the IIs it is growing out from and into. The discussion will in particular concern the nature of standards and relations between the global and the local as well as the choice of a process or a product approach towards internationalization.

Keywords: *Internationalization, information infrastructure, control, flexibility, context sensitivity, standardisation, Mozambique, Norway*

1. Introduction

In this paper we discuss internationalization of information systems (IS) as a process with the aim to support the reuse of technical and human resources and building and sharing of knowledge across national borders. Accordingly, internationalization is pursued with the aim to reduce the costs of developing as well as implementing an IS as compared with starting from scratch in a new national context. Very much in line with current globalization processes, system development organizations are working to get and support the access to larger and possibly global markets. At the same time, new constellations of organizations such as multi-nationals are increasingly seeking to pursue international synergies on their disparate, scattered and disintegrated IS investments (Buss 1982). Internationalization is however a challenging endeavor, not only when linking developing and developed countries (for example Odedra-Straub 1992), but also within these different worlds.

The software design discipline has for decades discussed and appropriated the need for flexibility and compatibility. Decomposition and modularization, or loose coupling and close cohesion (e.g. Yourdon and Constantine 1979) have been identified as approaches to cope with the complex software systems. Based on these insights, researchers have engaged in providing adequate support for internationalization of software systems (for example Coronado and Livermore 2001; O'Donnell 1994; Russo and Boor 1993). Internationalization is understood as developing software systems to support localization, and ensuring their smooth adaptation in a specific national locale, for example to its different language, standards, legal requirements and cultural norms.

Management and development of international information systems (IIS) as a product have been discussed by organizational sciences as challenging for multinational corporations and their executives. Research in the IS field has addressed the variety of challenges related to standardization of inter- and intra-organizational IS in the strive towards universality and in particular to strengthen centralized control in global organizations (for example Ciborra et al. 2000; Ives and Jarvenpaa 1991; Rolland and Monteiro 2002). Drawing upon the lessons from software design, these studies have in particular illustrated how control over large scale systems can be challenged by lack of modularization and in particular local variations in system implementations and work practices. Applying a socio-technical perspective, these studies have illustrated that control is in tension with flexibility, and that managing this balance is also related to issues such as diffusion of standards (Hanseth et al. 1996) and the inevitability of situated work practices (Ellingsen and Monteiro 2003). However, little attention has been given to internationalization as a process as well as to the unique contextual issues such as existing and available technologies, human resources and work practices where the IIS is to be localized and implemented.

The research reported here is based on two case studies of internationalization initiatives. The first case is related to a health information system, the District Health Information System (DHIS), developed in South Africa and its process of internationalization and implementation in Mozambique. The second case concerns a telecommunication platform for premium rated SMS services, the Content Provider Access (CPA) platform, developed in Norway and its process of internationalization and implementation in countries such as Denmark, Malaysia, Hungary, Ukraine, Thailand and Bangladesh. These cases are dissimilar in context, conditions, content and results. However, both cases represent initiatives with the same aim of internationalizing ISs, and thus allow us to get some relevant insights in the related processes and approaches. While we relate our discussions to the referred studies concerning standardization in the IS field, the ISs discussed here are by nature nationally fragmented and independent and the challenges of control are thus not related to attaining and sustaining organization-wide and centralized control. We primarily discuss control as the challenge of on the one hand implementing and preserving global standards and on the other implementing standards locally in a context sensitive manner.

The primary aim of this paper is to contribute with new conceptual insights in the challenges of internationalization processes and specially related to issues of control. Our primary research question is how internationalization relates to the context which it is growing out from and into. We will more particular focus on how approaches vary between internationalization of products and processes as well as how control in internationalization is pursued through standards and relations. Focusing on the balance between the local and global challenges related to universal solutions (Bowker and Star 1999; Rolland and Monteiro 2002), we engage in the discussion of the different facets of control.

The rest of this paper is organized as follows. In the following section we briefly discuss the theoretical basis followed by the introduction of the two case studies in section 3. Section 4 provides an analysis and discussion of the cases based on the theoretical perspective. Finally, in section 5 we conclude by drawing some theoretical as well as practical implications.

2. THEORETICAL BASIS: information Infrastructures

In this paper, we discuss internationalization with an II perspective, understanding the ISs as intrinsically composed of, interdependent and interconnected with collections of socio-technical components (e.g. Hanseth 2000; Hanseth and Monteiro 1997; Hanseth et al. 1996; Star and Ruhleder 1996). IIs are thus not relatively simple, standalone and self-contained systems, but rather represent large and open socio-technical networks of heterogeneous actors. These actors have different perspectives on and only partially control over the II (Neumann and Star 1996; Star and Ruhleder 1996). This perspective provides us with the means to study internationalization as a process framed within socio-technical networks. As we move beyond issues of centralized management and technical software engineering, this perspective help us recognize internationalization processes as necessarily both related to product and process and means of control spanning from standards to relations.

As internationalization necessarily involves several of these networks, i.e. the network where the IIS was initially developed and grows out from and the various local networks which it is growing into, internationalization processes are intrinsically complex as any centralized efforts of control only effects parts of the networks. It is thus highly challenging, yet essential to overcome the tensions with past infrastructures, procedures and practices (Timmermans and Berg 1997) by not being “installed base hostile” (Hanseth et al.

1996). Internationalization is therefore a process of cultivating the installed bases of the involved IIs. At the same time, the nature of these installed bases is highly influential in shaping the possibilities of control in internationalization processes on the global as well as the local level.

Standardization serves both as a mechanism for control and also introduces tension between the global and the local (for example Hanseth and Braa 2000; Rolland and Monteiro 2002). In internationalization, lack of standardization in local implementations will render impossible scalable control and further sustainable reuse. At the same time, the simplicity and efficiency of an internationally uniform solution from a global perspective can easily become suboptimal locally (Damsgaard and Truex 2000). However, control can also be attained and maintained through formal or informal relations between the global and the local actors. Based on the available means of control, this choice between global and locally optimal solutions in the relationship between IIS and its local implementations (LocalIS) must in any case be balanced, what Rolland and Monteiro describe as the “pragmatic balance”.

3. Case descriptions

The empirical materials we draw upon here originate from two independent case studies conducted by the authors respectively. The first case is based on an in-depth study of the development and the current operation of a platform for premium rated SMS services for mobile phones (the CPA platform) in Norway and related internationalization attempts. During 2003 and 2004, 39 semi-structured interviews were conducted with a variety of actors related to the CPA platform. While some interviews were conducted among Norwegian actors only involved with the implementation of the platform in Norway, other interviews concerned employees occupied with the internationalization process pursued by MobiNor, as well as those working with the implementation of the CPA platform in the affiliates of MobiNor in Denmark, Malaysia, Hungary, Ukraine, Thailand and Bangladesh. The second case study was conducted from 2000 to 2003 as part of an action research effort in a global research and development program known as Health Information System Project (HISP) (Braa et al. 2001). The fieldwork included working within a multidisciplinary team in Mozambique and making two visits to South Africa to interact with the software development team as well as attending a locally organized summer school.

3.1. Internationalizing a platform for premium rated SMS services

In 1999, the mobile phone network operators in Norway launched their CPA platform, enabling premium rated SMS services. The technical CPA platform builds on a business model which enables content providers to sell content directly to mobile phone subscribers through the mobile phone network, by the network operators allowing for premium rated SMS messages, i.e. enabling content providers to charge subscribers for more than the cost of regular peer-to-peer SMS services. Based on the two different network operators coordinating common short codes, price classes as well as a common service level, ease of access as well as a transparent market for the content was created. The operators did thus not choose to compete on differentiation with services exclusive provided in one of the networks, but on the contrary pursued an “open garden” approach. Branded and advertised by the content providers, the content becomes easy to use as any subscriber can order the content from the same short code for the same price. The typical content sold through the CPA platform comprises mobile phone ringtones and screensavers, jokes, Java games, news information, traffic information, weather information and phone directory services.

Content acquisition by subscribers is simply based on mobile phone subscribers requesting content by sending an SMS (Short Message Service) (figure 1) message. The SMS is processed by the SMS-centre (SMSC) of the network operator and forwarded to the content provider by the CPA platform. Upon request, the content provider returns the content by the CPA platform, and accordingly the cost which the subscriber is to be billed is specified with a rating class. Based on this, a billing request is sent by CPA to the billing system of the operator. The revenue generated is shared between the network operator and the content provider as per an agreed revenue-sharing model.

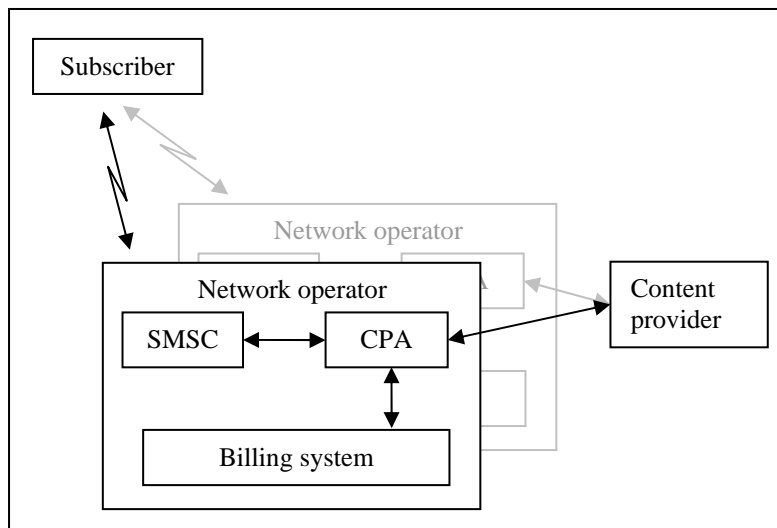


Figure 1 The basic components of the CPA platforms

The technical implementation of the CPA platform by one of the network operators, MobiNor, was based on a bottom-up initiative taken by a few key employees and drew upon relatively few resources. Only these employees really believed then in the underlying idea. Since MobiNor did not allow for an “open garden” approach, the implementation did not only lack management support but also violated the business and competitive strategies. However, coordination with employees from the other network operator as well as potential content providers quickly led to a successful platform and market for premium rated SMS services. The key challenge during this period was to create and maintain coordination between these actors as well as to develop a common appreciation of the platform. The platform implemented by MobiNor was technically an extension of an already existing facility for providing content services which was integrated with the billing system and the SMSC. The old platform, however, did not provide open access for content providers as well as a business model only providing exclusive content for MobiNor subscribers.

As the result of the continuous process of identifying interesting concepts for internationalization, CPA was in 2001 identified by the international division of MobiNor as an appealing platform for implementation in its various globally dispersed affiliates. This was only one project among others dealt with by this synergy area, and close related to the process of turning from a financial investor to an industrial investor towards the affiliates. Representatives of MobiNor traveled the affiliates’ locations to introduce the platform and a related business case, as well as to provide consultancy services where required. This process was not based on internationalizing CPA as a software platform, at least partly as a result of recent failed attempts of internationalizing similar platforms. On the contrary, a “sharing of best practices” approach was adopted. Following this approach, personnel from Norway interacted with affiliates based on their knowledge of the platform’s operations in the Norwegian context. This best practice has since been formalized as “12 guidelines for best practice”, describing the need for an “open garden” approach, a symbiotic relationship between network operators and content providers as well as the ease of its use.

Affiliates situated in Bangladesh, Denmark, Hungary, Malaysia, Russia, Sweden, Thailand and Ukraine had implemented the platform by 2004. These affiliates have their own history and have adopted locally suitable approaches to provide premium rated SMS services while taking into account the national contexts, such as the maturity of the telecommunication market, the relationship among network operators and between network operators and content providers as well as the concerned regulatory regimes. These locally inspired (and, therefore different) implementations of CPA, reflects varying degrees of success. These differences are exemplified in the following examples.

Most affiliates offer mobile originating billing (MT-billing), i.e. billing the subscriber on the receipt of the content as shown in figure 1. Some of the network operators do, however, consider it more appropriate to base their billing on the subscribers’ request of content (MO-billing). Technically, the former enables different models of billing, such as subscriptions to daily weather forecasts or receiving alerts when stock prices cross a certain threshold. MO-billing, on the other hand, renders it impossible to rate requests sent to the same number differently. This limits the flexibility available to content providers and adversely impacts ease of acquisition, thereby attenuating the potential for CPA’s success envisioned in the guidelines.

Some sort of proactiveness from the network operators towards the content providers and an entrepreneurship-spirited approach by the latter are required to create a prosperous CPA market. Companies based in countries where content providers were not flourishing suffered from lack of content services and a weak market, such as in Thailand and Hungary. This was in sharp contrast to the situation prevailing in other markets, where a range of small entrepreneur spirited content providers were active in the market, both before and after the CPA business model was introduced, e.g. in Malaysia.

The maturity of the telecommunication market related to CPA is in particular dependent on the relationship between the network operators. In some of the markets where the network operators have had a long and fruitful history of cooperation (as in the case of Norway), while in some others, a “walled gardens” approach has been further exacerbated by strong mistrust among them. In one affiliate, cooperation among network operators was spurred by the content providers in context of the CPA, but no agreements to create a permanent open standard could be reached. In addition, the absence of informal interaction between the network operators thwarts coordination efforts.

The local implementations of CPA appear differently and have shown a highly varying degree of success. With an approach to internationalize on the level of best practices, and understanding CPA as closely linked to the variety of local IIs, this do not come as a surprise. The key aspects of the internationalization process are summarized in table 1.

Table 1 Key aspects of the CPA internationalization process

Platform based on bottom-up initiative, coordination among network operators and between network operators and content providers. MobiNor not in control in Norway, and affiliates not in control locally
No-standardized product, only visiting consultants from MobiNor. Non-standardized process in different in local contexts, and guidelines only describing “best practice” in Norway
The local implementations (as well as the original CPA platform) are thus highly dependent on the installed base of e.g. cooperation among operators and their proactiveness towards content providers as well as the existing billing systems and SMSCs.

3.2. Internationalizing a district health information system for developing countries

Initiated under the Health Information System Project (HISP), the district level computer-based health information system (DHIS) for processing of data received from Primary Health Units (PHU) was accepted as a national standard in South Africa in 1997. Together with an underlying open source philosophy driven by the overall goal to achieve equity in health, a participatory and bottom-up approach was seen as essential in its development (Braa and Hedberg 2000). Over the years, the DHIS has been regularly updated and its functionalities improved as per emerging management/community needs. Later versions have also taken advantage of the ongoing developments in hardware and software technologies, for example by way of designing more effective visual interfaces, incorporation of query-based reporting etc.

The DHIS combines both routine data from the health services and semi-permanent data on the health facilities like number of beds, equipment, staff, budget, population, etc. These types of data (also called denominator data) are linked to the indicators engine which allows defining and calculating indicators on any combination of data elements using the numerator/denominator framework. An important activity in the implementation of DHIS in South Africa was to identify the essential dataset (EDS) to provide an effective template for data collection by PHUs. The composition of EDS was finalized through a participatory process of consultations involving policy makers, health workers, computer system designers and communities. Acceptance of EDS by these stakeholders eliminated earlier redundancies in data collection, pinned down responsibility for collection and update of data elements, while also providing an unambiguous framework to generate various reports at frequencies and formats desired by managers and other users.

In 1999, the HISP initiative was taken up in Mozambique. Based on its successful implementation in South Africa, as well as its emphasis on decentralization and participatory design, its strategies, processes and tools such as DHIS was transferred. Even if based on a success story from South Africa, the need for a deep understanding of the context including the health structures and information processes was identified. Priority was given to

creating local teams and enrolling researchers and practitioners to undertake the localization process with central support from South Africa. The responsibility of the HISP team in South Africa is thus both to serve the local implementations of DHIS as well as to support a broader network. Since DHIS is based on open source, the users had full access to the source code, and could introduce changes according to their needs and local conditions. They were also allowed to freely revise the source code as well as redistribute it (Braa and Hedberg 2000; Braa and Hedberg 2002).

DHIS was initially not internationalized before its transfer to and piloting in Mozambique, simply because it was not originally meant to be used in contexts other than South Africa. The initial releases were thus designed and implemented to meet the language, format, culture and regulation requirements of South Africa. The change of strategy to also include internationalization suggested that the piloting now should involve support for localization, including changes related to e.g. creating a modularized and three tier architecture of user interface, functionality and database as well as adding new modules or other features. Several localization challenges were experienced, for example, the structure of the database reflecting the five levels of units in the South African health systems had to be changed to accommodate for the four levels in Mozambique. Other aspects related to language (Portuguese), naming conventions, hierarchical structure and levels also needed to be defined as starting point, at the level of the database, the user interface and the reports.

The adaptation of DHIS in Mozambique does not follow a remove-replace but rather an add-on strategy whereby e.g. new language support was added without modifying the original software. Since technical support was absent in Mozambique, all changes to the software were sent to South Africa for the manufacture of a setup CD. New CDs from South Africa acted as a new release with newly added features and bugs fixed. The testing of the new release was conducted in the piloting sites, and further changes required were sent back to the main hub in South Africa, where the setup CD was again manufactured and subsequently sent back to Mozambique for testing and use.

The multiple adapted release cycles of the DHIS software suggested an endless process of interaction (with South Africa), whereby the integration of the new releases implied starting more or less from scratch. The new initiatives and features locally implemented in Mozambique are at the same time not necessarily relevant and even compatible to the new releases generated for internal use in South Africa. At the same time, however, the initiatives taken up have contributed to the global DHIS software. Although at a conceptual level the continuous release cycles with South Africa could be discarded in the favor of an autonomous approach, in practical terms such procedure was not feasible in Mozambique. The nature of interaction between Mozambique and South Africa, emphasizing collaboration and sharing of experiences have up until now developed a stable and mutually beneficial long term relation.

The key aspects of the DHIS internationalization process are summarized in table 3.

Table 2 Key aspects of the DHIS internationalization process

Standardized and centrally controlled DHIS software by South Africa, but also bottom-up, participatory and open source implementation approach locally
Software not internationalized initially but over time. Bottom-up and user centered development leads to no standardization on process
The implementations of DHIS highly dependent on the installed base of e.g. technical and human resources available in Mozambique as well as the specificities of language, the health care system and the local practices

4. ANALYSIS AND DISCUSSION

Different in context, conditions, content and results, the CPA and DHIS cases point to a variety of challenges related to the process of internationalization. While following different models and based on different standards and relations between the global and the local, these cases in particular illustrate internationalization processes as being continuously struggling with its interrelated IIs and its related tensions of control.

4.1. Control through standards and relations

Even if a process of internationalization have been pursued in both the CPA and the DHIS case, the nature of the local implementation are not simply controlled and determined globally by Norway and South Africa respectively. While MobiNor have pursued an approach without any technical standards resulting in little if any centralized control, South Africa has controlled the development of DHIS to a larger extent by centrally producing standardized software.

Since the content of internationalization has been kept at the level of providing guidelines in the case of CPA, the benefits accruing from this process are lesser as compared to the software development scenario in the case of HISP. The reasons why MobiNor have not followed a more rewarding internationalization process in terms of synergies can on the one hand be attributed to the history of the relationship between MobiNor and its affiliates, which has primarily been based on financial investments. On the other hand, this approach can also be attributed to the close technical relationship between CPA and the local implementation of the SMSC and the billing system. A technically standardized CPA platform would not only impact these platforms, but also require other actors in the local markets to adhere to the standard. While agreements have been made over time between these actors in the local markets, none of the affiliates of MobiNor have been able to impose one standard in their local context. Control is thus not only a local-global issue, but is diffused over a network including the affiliates and their control in the local context. The important roles of the installed base (in particular technology and human resources) also applies to the HISP case, where the global team (in South Africa) has little power when it comes to the actual implementation and use of the software out in the field.

Where standards as a means of control are not applicable, however, control can also be exercised by the relations between the global and the local actors. These relations are shaped by aspects such as resources available locally, history of cooperation, and distance between the actors. For example, in Mozambique, the key people related to the development and implementation of DHIS is not permanent field staff but primarily PhD students working part-time for the HISP project. Thus, Mozambique has been dependent upon the support from South Africa even if local resources slowly develop over time. On the contrary, the relations in the case of CPA have been weak and the initiative from MobiNor has been continuously challenged not by the lack, but rather by the presence of resources and local initiatives originating from the affiliates. Some affiliates have also been reluctant to seek support from MobiNor, but rather from other sources such as successful Norwegian content providers. Based on experiences with earlier attempts of internationalization, the risk of disfranchising the local technology and initiatives have been one important factor deciding the soft approach pursued by MobiNor.

The choice of approach of internationalization, e.g. through standards or relations and their inter linkage, is strongly related to the history as well as the means of control. The local installed bases of components, such as technology, human resources as well as the relationship between the local actors are strong determinants when it comes to creating feasible approaches. Where the installed base is weak, as in the case of Mozambique, control can be easier to achieve through standards than in the case of CPA where the installed base is complex.

4.2. The tension between flexibility and standardization

In the case of HISP, a key issue is how to centrally incorporate and locally align software and processes introducing participatory design and creating flexible software solutions based on an open-source philosophy. This was not easy to achieve as the three-tier architecture implemented in the DHIS software suggests that data storage, user interface and functionality are separate entities. This flexibility does, however, allow Mozambique to introduce changes to any of the three levels. The question thus raised is which aspects should be under local and which should be under global control? Further, this points out how using a standardized process, i.e. participatory design, results in a non-standardized product. This complexity related to internationalization is further illustrated by the case of CPA where the guidelines for best practice only describe the principles adopted for its success in Norway. The guidelines do, however, not describe how to build the network of actors from bottom-up, pursue management to engage in an “open garden” approach and settle the relationships among the network operators.

The flexible approach in the CPA case can be argued as being appropriate for different contexts, by reflecting sensitivity to the rather heterogeneous contexts of implementation. However, such an approach has lead to unstructured situation in which some of the LocalIS do violate the very rules of the best practice. In particular, due to reluctance of the network operators to adopt an “open garden” approach, the suggested coordination to develop the platform has failed. Facing the challenges of linking the various affiliates together to create synergies, MobiNor is currently in the process of planning to standardize other technologies and platforms, such as the SMSC and billing systems, both closely linked to the CPA platforms. Even if the managerial focus is

currently not on the CPA, future progress on standardizing other platforms may lead to a need for a global CPA standard. However, taking into account the various existing IIs, we should also understand each implementation of CPA as framed within and sensitively adjusted to a local network of already existing components. The affiliates' local struggle with controlling this network can be equally or even more challenging than the globally initiated internationalization process as well as other standardization initiatives.

Standardized implementation processes may lead to non-standardized products. When approaches focused on being context sensitive, e.g. bottom-up and participatory, are applied, flexibility will be pursued at the cost of standardization and global control. In such cases, however, the relations between the global and the local can play an important role in coordinating the internationalization process towards a standardized outcome.

4.3. Internationalizing Information infrastructures

In our discussion, we have extended a relatively simple model of software transfer and pointed out various facets of control in the relationship between IIS and LocalIS. The distinction between the process of internationalizing and local implementations tend to become less clear, and their relationship also stretches back to the legacy of the initial IS as well as forward to local adaptations. As II develops over time as an intricate and heterogeneous network of actors, internationalization initiatives can be highly complex and further limited in their achievements. For example, in the case of CPA, the nature of the platform is very much dependent on the nature of the billing system and the SMSC of MobiNor, as well as of the other network operators in Norway. In addition, the informal relationships amongst the network operators and between them and the content providers have been decisive for its implementations. These relationships are impossible to internationalize. In parallel, DHIS has to struggle with the local specificities of language and the hierarchical structure of the health sector, suggesting the need for DHIS to be conservatively designed to allow for these local adaptations.

The implementation of DHIS is highly dependent on the installed base of e.g. technical and human resources available in Mozambique as well as the specificities of the health care system and the local practices, while the local implementations of CPA are largely dependent on the cooperation among operators and their proactiveness towards content providers as well as the existing billing systems and SMSCs. At the same time, however, attempts to implement LocalIS will not automatically succeed if all resources, actors and components are present as the coordination between them will develop and shape over time. Thus, the challenges of control related to internationalization is not only related to a global perspective but also, and probably more important, to the local.

5. Implications

Applying an II perspective has helped to lift the discussion of internationalization from a technical perspective to a socio-technical perspective situated in a context defined by both local and global influences and relations. Our implications in the form of two models (figure 2) abstract different approaches to internationalization. Model 1 illustrates how IIS not necessarily are developed from scratch, but spawned by an already existing IS and it's surrounding and interrelated IIs as we have pointed out in the case of DHIS. Model 2 illustrates how localization can also take place directly from an IS, and thus with less flexibility and support for reuse as in the cases of CPA and DHIS initially. Model 2 is thus highly contingent upon the presence and continuity of locally available human resources and competencies.

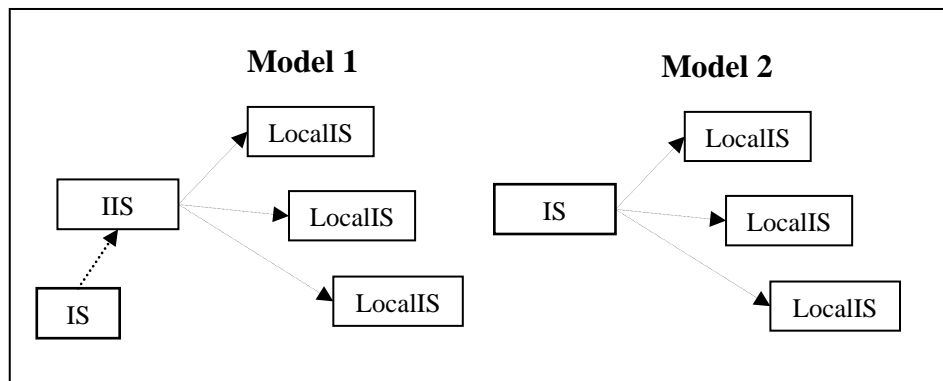


Figure 2 Extended models of internationalization

While these models are very different related to the interaction between the IIS and its various local implementations, internationalization processes can over time change from one model to the other. In the case of HISP, initial attempts of internationalization directly from an IS in Mozambique, as in model 2, over time brought out the necessity for an IIS and the process was changed to model 1. While CPA have followed model 2, a further internationalization of platforms such as the SMSCs and billing systems could lead to the revival of model 1.

In this paper we have shown that internationalization of ISs is a highly complex endeavor involving not only technology, but also human resource capacity, relations and IIs. This process is close related to controlling the relationship between the global and the local. At the same time we have illustrated how local implementations of internationalized products and processes cannot escape local IIs. These local socio-technical networks play an important role on the means, the freedom and the needs for internationalization and more particular control at the global and local level.

Internationalization and localization should neither be understood nor treated as different and subsequent processes. Such a distinction does not take into account the interrelatedness of internationalization processes and can easily mislead us to interpret internationalization success or failure as solely determined by centralized efforts of internationalization and control. Even if the very end of an internationalized IS is not meant to be one centralized system, we should also understand each local implementation as a part of a larger network. In particular to capture internationalization as being a process, the universality (if any) of the network cannot be developed by introducing one standardized solution. Our discussion suggests that the global - local relationship and the tension between the control (through standardization and relations) and flexibility must be balanced reciprocally and pragmatically between the local and the global over time. To practically approach internationalization, we suggest to exercise control through a blend of standards and relations. At the same time, and most challenging, this process of blending will not solely rest with one, central actor, but will be distributed across the socio-technical network.

Internationalization aims to support the reuse of technical and human resources. However, the consequences of internationalization for local human resource development are uncertain, in particular depending on whether internationalization is pursued by process or product strategies. A standardized product strategy will not necessarily aid local human resource development because it will require less of such local competencies. Where internationalization is pursued with a more flexible and open process strategy, local competencies will necessarily have to be in place, engaged and developed in the process of localization. We argue that while choosing between process and product strategies, in particular related to the degree of standardization, the consequences for human resource development must be taken into consideration.

While internationalization will have consequences for human resource development, it will also be shaped by the existing human resource capacities. The adversary conditions of developing country contexts call for strengthening human and technical resources, while at the same time this “void” can enable the ISs to be built from scratch. One should however be cautious to interpret a “void” of technical infrastructure as a “void” of social networks and practices. At the same time, presence of technology and knowledge is not necessarily the optimal condition for successful internationalization since changing socio-technical networks are maybe more challenging than creating them.

While standards and networks of relations in internationalization can transport products and processes, the stability of the standard and network itself will be highly dependent upon which support is provided by those

promoting and supporting internationalization. While our perspective does not give one recipe for how to blend control in internationalization processes, it directs us towards understanding ISs as parts of larger global and local IIs with their own history, content and trajectory.

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8.11. APPENDIX K

KIMARO, H. C. & NHAMPOSSA, J. L. (2004). The challenges of sustainability of health information systems in developing countries: comparative case studies of Mozambique and Tanzania. IN LEINO, T., SAARINEN, T. & KLEIN, S. (Eds.) Proceedings of the 12th European Conference on Information Systems. Turku, Finland, ECIS - The European IS Profession in the Global Networking Environment.

THE CHALLENGES OF SUSTAINABILITY OF HEALTH INFORMATION SYSTEMS IN DEVELOPING COUNTRIES: COMPARATIVE CASE STUDIES OF MOZAMBIQUE AND TANZANIA

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Abstract

The introduction of Information Technology (IT) typically comes with the promise of helping to manage scarce resources, increase efficiencies, reduce workload, and increase work productivity. In the context of developing countries, the lure of these promises is magnified given the existing conditions and inefficiencies. International donors for example the World Bank, or the World Health Organization play an important role in shaping this promise because developing countries are dependent on them for both technical and financial aspects.

Given that IT projects may take a long time to be fully institutionalized, sufficient resources are required to build the local capacity to support and sustain the project after the withdrawal of donors. Inadequate donor support often contributes to weakening rather than strengthening human resource capacity and effective system design, since it emphasizes the technology itself in the expense of the needs of the users. These factors contribute to the design and implementation of unsustainable health information systems (HIS) in developing countries.

Through a comparative case analysis of the HIS in Mozambique and Tanzania, we have identified three sets of relationships as crucial in shaping the sustainability of HIS. The relationships between the Ministry of Health (MoH) and the software development agency, between the MoH and the donors, and between the donors and the software development agency. The reasons for the lack of alignment between the relationships, although possibly different in the two cases, are identified and some specific recommendations are made to support their alignment, and with it, we argue, the sustainability of the system.

Keywords: Sustainability, institutionalization, HIS, Mozambique, Tanzania, human resources development, international donors, systems design.

¹ Both authors have contributed equally to the development of the paper. Both have conducted case studies in their respective countries, Mozambique and Tanzania.

1 INTRODUCTION

The introduction of Information Technology (IT) typically comes with the promise of helping to manage scarce resources, increase efficiencies, reduce workload, and increase work productivity. In the context of developing countries, the lure of these promises is magnified given the existing conditions and inefficiencies. International donors for example the World Bank and the World Health Organization play an important role in shaping this promise because developing countries are dependent on them for both technical and financial resources.

The domain of health care in developing countries is one such example of donor dependence. For example, in Mozambique 80% of the budget for the health sector is based on international aid (Beattie and Kraushaar, 2000). Developing countries are reported to have a large amount of unreliable health data, poor human resources, and poor IT infrastructure (Sahay 2001; Walsham et al., 1988). Effective Health Information Systems (HIS) are therefore needed to improve the processes of data handling in order to extract useful information for health planning, decision making, and resource allocation. In order to achieve these objectives, many attempts by governments and donors have been reported concerning the design, development and implementation of computer based HIS in different developing countries including Mozambique and Tanzania (Rubona, 2001; Lungo, 2003; Mwaluko et al., 1996). However, many of these efforts have been unsustainable due to political, socio-economic, and technological factors (Mursu *et al.* 2000). Donor policies (such as short term funding, top down approaches and focus on technology) also significantly contribute to the problem of unsustainable HIS (Heeks *et al.* 1999).

Historically, the introduction of IT in developing countries through donors' initiatives follows a top-down approach where people at the bottom levels are systematically excluded in negotiation and decision making processes (Walsham, 1992). This approach creates an environment whereby the ownership and control of the project rests with the top level managers and donors, leading to a situation where the users rarely gain control over the technology they ultimately are expected to use. Moreover, donor support for health projects is relatively short term in nature. Given that HIS projects may take a long time to be fully institutionalized, sufficient resources are required to build local capacity (technical, managerial and financial) to support and sustain such projects after the withdrawal of donors. This inadequate support contributes to a lack of human resource capacity, ineffective system design, and a dominant focus on technology rather than on the needs of the users. This contributes to the design and implementation of unsustainable HIS.

Sustainability of HIS is not possible without adequate resources being allocated according to the needs of users and the organization over a reasonable period of time so as to build institutional capacity and decrease the dependence on donors. However, we argue that collaboration between the local organization and donors plays an important role to sustain the changes achieved in the long run. Thus, the focus of this paper is on how such networks can be created to ensure long term sustainability of HIS. More specifically the paper focuses on two research questions.

What factors contribute to unsustainable HIS in developing countries? And what can be done to make HIS more sustainable? These questions are analyzed based on a comparative case analysis for Mozambique and Tanzania.

The paper explores challenges involved in developing sustainable IT based HIS in the context of developing countries where most such systems are developed with initiatives of donors. The paper also draws some recommendations on how to deal with the challenges. Through a comparative case analysis of the HIS in Mozambique and Tanzania, we have identified three sets of relationships as crucial in shaping the sustainability of HIS. The paper aims to contribute to the IS community literature and to guide IS Project managers and donors in understanding the challenges behind the practical development and implementation of sustainable HIS.

The rest of the paper is organized as follows. In the second and next section, we describe the key theoretical concepts informing the paper. The subsequent section, presents the methodology adopted for the study and the data collection. In the fourth and fifth sections the case studies carried out in Tanzania and Mozambique are described. Section six gives the summary of the case studies. Following that, we provide the analysis, discussion and recommendations in the analysis and discussion section. Finally, some concluding remarks are presented in the eight section.

2 THEORETICAL BACKGROUND

The problem of unsustainability plagues IS projects in developing countries including HIS. Sustainability refers to the tendency of the system to endure over time and space and is directly concerned with the system to become institutionalized in the workings of the health department. Institutionalization can thus be described as the process by which HIS can be sustained over time.

2.1 Sustainability

The term sustainability was emphasized within the environmental domain in the Rio conference in 1992, where the concept of ‘sustainable development’ was placed on the international agenda. The meaning of sustainability within the environmental perspective described in the Bruntland report (1987)² was defined as follows:

Meeting the needs of the present generation without compromising the ability of future generations to meet their needs.

Sustainability implies maintaining something that already exists over time and is often equated with being ‘self-sustaining’ or ‘self-sufficient’, implying that no outside support is needed to continue its existence (Reynolds and Stinson 1993). With regard to IT, ‘sustainability’ implies the ability to identify and manage risks threatening the long-term viability of IT (Korpela *et al.* 1998). Misund and Høiberg (2003) define sustainable IT as “technology that is capable of being maintained over a long span of time independent of shifts in both hardware and software”.

Donors are a key vehicle through which ITs are introduced in developing countries (Wood-Harper and Bell, 1990), creating a dependency of governments on them, for technical and managerial expertise. Because the context is characterized by poor infrastructure, lack of skilled and experienced human resources and, a weak information and computer use culture (Walsham *et al.* 1988) donor support is required but paradoxically also creates a situation of unsustainability. The risk of failure of donor supported IS projects is very high making sustainability a challenging task (Mursu *et al.* 2000).

Sustainability can be seen as a process, starting from the inception of the system, to the various processes around design, development, support and implementation. Sustainability concerns the longevity of these processes and how they co-exist over time, especially once external support is withdrawn (Braa *et al.* 2003). The challenge concerns how the system continues or does not continue to live on within an organization. Some characteristics of a sustainable IT are summarized below in table 1.

Characteristics	Description
Long term	IT must be able to survive over time
Demand	The degree to which IT is needed and output it produces
Simplicity	IT is easy to use with clear functionalities
Quality	IT must be supplied with quality data
Responsiveness	IT satisfies users needs and user participation in the development process
Scalability	IT must be capable of handling and addressing work loads

² The Bruntland Report, *Our Common Future*, is the report made by the World Commission on Environment and Development in 1987. It is often called the Bruntland report after the chairperson of the commission, then Prime Minister of Norway, Gro Harlem Bruntland.

Adaptability	IT allows for easy adaptation of technological innovations and improvements
Stability	IT should be operated by all key actors in the context
Robustness	IT should be fault tolerant in that it may fail without bringing the system down

Table 1. Characteristics of sustainable IT (adapted from Misund and Høiberg, 2003)

2.2 Managing sustainability

An analysis of sustainability concerns identifying the key factors that are likely to affect (negatively or positively) the likelihood of achieving sustainable benefits. Young & Hampshire (2000) argue that sustainability is related to risks as they may impede achieving sustainable benefits. While sustainability refers to long term outcomes beyond the direct influence of the project, risk analysis typically concerns the threats to the achievement of objectives within the project time frame. A sustainability strategy defines the specific approaches to ensure that the benefits are sustained and specifies how key constraints to sustainability are addressed in the implementation (Young and Hampshire 2000).

A key factor influencing sustainability is donor policies that typically follow a top down approach to the design and implementation of the system (Walsham, 1992). As a result, the IS does not reflect actual work practices at the lower levels of the organization where the system is to be used. The sustainability of IT is highly dependent on the system being able to provide reliable and useful information, and the capability of users at all levels to effectively use the system. The absence of the participation, capability and motivation of users, coupled with an inflexible system design, makes it difficult for the system to evolve over time and for institutional changes to be incrementally adapted (Bisbal et al., 1999).

ITs are typically introduced in developing countries through a technical approach to facilitate their rapid installation and utilization (Oyomno, 1996), not very dissimilar to the approach used to transfer manufacturing technologies. However, sustainability issues are not only technical (Bjørn-Andersen et al. 1990) but also concern the ownership and management of human and financial capabilities which rely on people and their needs and actions. These are influenced by the organizational, political as well as technological constraints (Walsham, 1988).

Typically donor funding is short term in nature and involves the use of foreign expatriates who return to their home country as soon as the aid period ends. Given the primarily technical focus adapted, after the withdrawal of the donors, projects are often left in the hands of local organizations without the necessary technical and managerial capabilities to sustain the system over time. (Heeks and Baark, 1998; Braa et al., 2003). Such projects cannot become fully institutionalized as they do not become part of the organizations work routines. Typically, there is no clear and explicit sustainability strategy (Young and Hampshire, 2000) left in place to ensure that the benefits, if any, are sustained and can be further strengthened over time (Heeks and Baark, 1998). Sustainability strategies require planning to transcend the project phase in which the donor is involved, and to examine ways to continue with the system and growth after donor funding is withdrawn.

Oyomno (1996) argues that the sustainability of IT is dependent upon the degree of its demand, appropriateness to the user organization, and the availability of local capacity to sustain benefits achieved over time. The demand is linked to the extent to which that technology is needed within an organization and the output it produces. Appropriateness refers to the quality of information obtained and the financial and human resources capacity available to incorporate changes and institutionalize the technology. Sustainability then depends on both the technical features of the technology including its operational simplicity, flexibility, maintainability, robustness and also the availability and capability of technical, managerial, institutional, intellectual, socio-political, cultural, and physical infrastructure (Kiggundu, 1989). An absence of a socio-technical focus in favour of a technical approach typically causes IS to be unsustainable in developing countries.

Strong donor dependence makes it difficult for planners in developing countries to cope with rapid changes of IT and the capacity to maintain them. In order to achieve appropriate IT design, collective efforts and resources are needed involving various actors (Korpela *et al.* 1998) including donors, planners, developers and users.

2.3 Institutionalization

Institutionalization can be seen as the process by which Information Systems (IS) can be made sustainable over time (Braa *et al.*, 2003). Avgerou (2000) defines institutionalization as “the process through which a social order or pattern becomes accepted as a social ‘fact’” [p.236]. IT becomes accepted through socio-technical processes as a social fact and is maintained because of its legitimacy regardless of the evidence of its technical value. A socio-technical aspect leads to the stability of IT since it is absorbed and integrated within organizational structures and routine activities (Avgerou, 2003).

Through institutionalization, IT processes are carried out and sustained within organizations without dependence upon the initiative of a special group, for example, donors. Institutions are historically produced social systems whose formal structures and processes are sustained by systems of shared meaning (Powell and Dimaggio, 1991). Thus, new processes demand adaptations that modify institutional, group and individual formal structures and behaviour, since the imported IT is subject to local social, cultural, and political processes. Institutionalization is thus about making steady and gradual changes in people’s belief, understanding and acceptance of the new technology. The basic approach is to build incrementally upon partial achievements and make them part of the routine organisational activities. However, changes in the way of doing things takes time to be understood, accepted, and routinely applied although they are expected to change the way institutions operate and how decisions are made.

Moreover, the impacts of changes made through institutionalisation take time to be recognized, due to the relatively longer time required for institutional adjustments and adaptations (Avgerou 2003). Therefore, the fact that donor funded IT projects are of short term in nature, and follow a top down approach implies that such systems are neither embedded nor fully institutionalized into the actual work processes of organizations.

3 METHODOLOGY

A longitudinal study of HIS in the Ministries of Health of Mozambique and Tanzania forms the basis for this paper. Tanzania and Mozambique are both developing countries located in the Eastern and Southern Africa, bordering the Indian Ocean. Both depend on the international agencies such as the World Bank, the International Monetary Fund, and bilateral donors for the provision of funds to rehabilitate economic infrastructure, alleviate poverty and support the public health systems. Tanzania has a total area of about 945,087 km² with a population of about 34.4 million (2002 census) whereas Mozambique has a population of 17.3 million (2003 est.) with an area of 801,590 km² (The World FactBook, 2003).

In Mozambique, the study was conducted from 2000 to 2002 and in Tanzania from 2002 to 2003. The study was part of an action research effort (Blum 1955; Susman and Evered 1978; Baskerville and Wood-Harper 1996, 1998) in a global research and development project called the Health Information System Project (HISP)³. The HISP project aims to create local capacity for data handling and processing in order to support informed decision processes at the national, intermediate and peripheral levels (Williamson *et al.* 2001; Braa *et al.*, 2001; Braa *et al.*, 2003).

In Mozambique, the study was based in the Ministry of Health (MoH) and in the Gaza province, one of the HISP research sites. The field work included several visits to and from the MoH headquarter in Maputo to the health districts and provincial health directorate of Gaza.

³ Researchers from Norway, University of Western Cape and Cape Town initiated HISP in 1994. HISP implementation initiatives have been extended to neighbouring countries including Mozambique (1999) and Tanzania (2002). See www.hisp.org

Continued interactions within HISP, helped to gain more understanding about the strategy applied to develop the current HIS, its design assumptions, objectives and issues related to sustainability. In Tanzania a similar study was carried out in the HISP research sites in the Bagamoyo and Kibaha districts, the Coast region and the MoH headquarter in Dar Es Salaam.

The data collection methods applied in both cases included group discussions, analysis of documents, interviews (mostly unstructured), (participant) observations and workshops with health managers and health workers linked to the MoH. A questionnaire was also used to guide the interviews with health workers in order to explore their views about the health system in general and its sustainability. These various techniques helped to discover not only what people said but also what they actually did in practice. The action research approach in both cases involved being engaged in interventions such as conducting training programs, participating in the design of a new HIS through HISP, and making presentations to the ministries of health. Document analysis enabled us to determine information about donor's policies and developer's strategies and their relationships with the MoH. The issues surrounding the design of the HIS approach were also analyzed mainly through document assessments and exploration of the HIS software in both countries.

A comparative case study of the HIS in two developing countries helps to understand issues of sustainability relevant to the individual cases and, examine patterns of similarity and dissimilarity between them.

4 THE CASE OF TANZANIA

Tanzania's health information system structure is divided into four levels, including the national, regional, district and health unit levels. Districts are the main operational unit for implementing Primary Health Care (PHC), and also serve as the hub for the flow of health data from the community to the national level.

Prior to 1989, the existing paper based HIS was evaluated as being fragmented providing limited useful feedback and unreliable data (MoH, 1993). To bring in improvements with the existing HIS, the Health Management Information System (HMIS) as a paper based system was designed as the routine reporting system for data and health indicators covering all public, private and Non Governmental Organisation (NGO) health facilities. The goal of the new HMIS was to address the problems of the previous HIS through integration of the parallel systems, ensuring a regular flow of reliable information within and between different levels (MoH, 1993), and to support the agenda of reform through decentralization.

The development of the HMIS started in 1989 with the first version in English converted into Swahili in April 1991. This process involved top level health management professionals assisted by external consultants with financial support coming from various donors (Rubona 2001; MoH 1993). The idea was that the local government would take full responsibility for financing the HMIS after the completion of the initial implementation phase, estimated to cost 1.7 million USD not including personnel and consultancy expenses (MoH, 1993).

The HMIS manual system was tested for the first time in the Mbeya health district in 1991 for a period of six months and then subsequently modified. After modification, the HMIS was regarded as a practical and useful manual system and spread across the Mbeya region by 1993 and nationwide by 1997 (Rubona, 2001).

4.1 Process of development of IT based HIS

Based on the current HIS, the MoH, assisted by an external consultant developed a Dbase IV database system in 1992. In 1997, this database was evaluated and due to its technical, design and operational problems, it was decided that it should be replaced with a different computer system in order to comply with the new demands of MoH.

For materialization of the decision, the MoH contracted the services of a local software vendor, whereby development and implementation costs were covered by donors. In negotiations with

top level managers at the MoH, the vendor developed the HMIS software using Microsoft Access 97 and delivered it for immediate rollout in all 20 regions of Tanzania in 2000. The HMIS is now computerized at the national and regional levels, remaining paper-based at the district and health unit levels. Although all districts were provided with computers in 2002, the data handling is still manual at the district level.

A key problem in the development process was that the donor's funds were not given to the MoH, but instead were directly given to the software vendor (Lungo 2003: 118) apparently due to the donor's lack of trust in the MoH. Moreover, in the absence of any formal agreement between the MoH and the vendor on how to verify the completeness of the system before its delivery and its future maintenance, various defects related to functionality, reporting and system operation were subsequently reported (Boehning 2002).

The vendor did not solve even a single bug of all errors/bugs reported in June 2001... because the MoH had no money to fix the bugs (Boehning, 2002; Lungo, 2003:119).

Since solving errors/bugs was not contracted, the MoH needed to secure additional funds for maintenance. In addition, because the software vendor had control of the source code, the MoH could not make changes without support from the vendor. The MoH faced a situation whereby further development of the HMIS depended on the vendor while the financial support process depended on the donors. The relationship between the MoH, vendors, and donors was thus fundamentally misaligned.

Currently, the HMIS software is being used regardless of its limitations. However, the MoH had not been able to pay the vendor to resolve the identified problems and address the changing user requirements. A technical review team recommended to:

Contract out the review of the current HMIS software in the light of alternative packages available, with a view to recommending the best option for the national [health] system (MoH, 2002: 16).

This recommendation implies that the collaboration between the vendor and the MoH is not likely to happen in the development of the new software. The recommendation to replace the HMIS comes only two years after the system has been in operation, implying a significant waste of resources.

In addition to the misaligned relationship between the donors, the MoH and the vendor, the issues contributing to the system being unsustainable include the lack of human resource capacity and ineffective system design.

4.2 Lack of human resource capacity

The HMIS unit of the MoH was given responsibility for the overall coordination of all activities relating to the HMIS, including the training of health workers, and monitoring and evaluation of the nation-wide implementation. However, the unit historically had a severe shortage of skilled manpower and had no any contingency plan to deal with the additional responsibilities. The HMIS unit has thus never been able to accomplish its increased responsibilities (MoH, 2000). The report stated:

The head of department [at the MoH] responsible for HMIS activities is currently undertaking a second MSc. course overseas. [His] sudden departure... did not allow sufficient time to prepare [acting staff to take over his responsibilities]. [Among seven staff in the HMIS department] three are undertaking studies. One of the remaining staff has additional responsibilities [which are not part of his terms of reference] (MoH, 2000: 7).

While assessing the skills of the staff working at the HMIS unit at the national level, we found that most (if not all) had a background in statistics and epidemiology and had basic computer skills but not to the level required to deal with hardware and software issues of the HMIS. For such knowledge, the MoH had to hire external IT consultancy expertise, which was extremely

expensive and short term. Our survey emphasized the need expressed by staff to strengthen IT training, in the absence of which they found it difficult to effectively use the computer.

4.3 Ineffective system design

The HMIS is a set of data elements, data collection and compilation tools and procedures to help health workers perform their activities. Thus the design of HMIS implied computerization of all selected data elements reported to the regional and national levels, concerning all health services. After the HMIS was implemented in all 20 regions and at the national level, it was evaluated to have a number of problems (MoH, 2000; Boehning, 2002; MoH, 2002):

- The HMIS was not completely developed as initially intended.
- Inability to perform some operations, such as adding or editing data elements, implying that the data elements were hard coded.
- Absence of functionality to perform basic operations such as sorting, validating or querying data.
- The HMIS generated a number of random bugs, for example some reports were malfunctioning.

In summary, criticisms of the HMIS software are related to lack of flexibility, user-friendliness, organizational control over the source code and systematic support of users from the developer's side. Due to the MoH's lack of capability to deal with the HMIS software constraints, the reported bugs were being collected and historically archived at the national level without any prompt correction action. In this case additional funding was required to deal with HMIS bugs, whereby the vendor awaited for money from the MoH or donors to fix the system bugs or to improve the design, seeing them as extra requirements.

The subsequent evaluation report in 2002 recommended that the HMIS software be replaced with another system that is more flexible whose operation demonstrates to comply with the needs of the MoH (MoH, 2002:16). However the question still remains on how the users' needs will be addressed.

5 THE CASE OF MOZAMBIQUE

The MISAU⁴ is the national authority responsible for the management and administration of health services in Mozambique. There is one level of Primary Health Care (PHC) provision (health unit) and three management levels (district, province and national). The data collection, compilation, validation and reporting are basic activities done at the health unit level with summaries sent to the management levels in an aggregated manner. Health services include curative and preventive activities which are hampered by scarce resources, such as human, drugs, transport and others. This creates the need for improved planning and deployment of scarce resources to the areas where the needs are most pressing. The need for improving the HIS has been promoted within this context.

Since independence in 1975, the MISAU has given high priority to developing a HIS, including several revisions of the SIS⁵ and its computerization in 1992 at the provincial and national levels. SIS by definition represents the main storage of data, required for management purposes. Like the HMIS in Tanzania, SIS was expected to support the process of health reform through decentralization.

The issues that have contributed to the unsustainability of SIS include design and development, human resource development and donors' policies.

⁴ MISAU: Ministério de Saúde – Ministry of Health in Mozambique.

⁵ Sistema de informação de saúde, Portuguese for Health Information System.

5.1 The design and development of SIS

SIS is a set of tools, procedures and activities aimed at providing information to decision making (MISAU, 1994), and consists of a number of registry books and paper forms designed to handle various data. The data handling tools are classified according to the unit or level of use. So basically a data collection form at each level has the same structure and data elements, differentiated only by a separate code for health unit, district or province. The lower levels are seldom given any feedback by the provincial and district levels, and therefore the system is essentially a top-down system designed for fulfilling the needs of higher levels.

Mozambique is described to have a relatively good data reporting system from health units to the national level in comparison to some other neighbouring countries (MISAU, 2003) like Tanzania. However, the content and quality of what is reported is inconsistent with what is expected (Braa *et al.* 2001). In addition, the reports merely summarize activities which cannot be usefully applied for planning purposes or to make vertical or horizontal comparisons.

The SIS software was developed in-house by a foreign expert (who is long gone) with the goal of integrating data from different health programs such as immunization, mother and child health, drugs and infrastructure. See figure 1 below which describes the various reporting programs that SIS was expected to incorporate. However, in practice the SIS software only managed to integrate two health data programs, Immunization and Mother and Child Health. As a result, the remaining health programs set up individual projects supported by different donors to develop and use their own software and computer technology for handling their data. In the absence of overall coordination and control by the MISAU, the systems developed were not capable of sharing information among themselves or with the SIS.

In 2002, the Minister of Health described this fragmented structure in the following way:

[MISAU] was a 'ministry of projects' rather than a Ministry of Health. This led to confusion. Officials lacked clear direction. They dealt with different donors and owed their loyalty to the donor, competing with each other to keep certain teams of individuals around certain projects, receiving differential and unknown top-ups from different donors (even now). The demands are on the few qualified staff to serve particular donors, to follow their routines, to ensure that the donors' money goes to what the donor requires (Minister of Health Songani, 11 June, 2002 quoted in Batley, 2002).

He went on to say:

Consequently, clients or citizens are themselves unclear about who is responsible for what. Even now in the provinces it is common to hear people say 'this is a Country X project, while this is Country Y's. This is an issue of symbolic importance, undermining the sense of nationhood and weakening the sense that issues are a matter for government. Government is frequently seen as the problem while donors are the solution (Minister of Health Songani, 11 June, 2002 quoted in Batley, 2002).

In order to address this lack of integration, another foreign expert with a background in epidemiology, employed at MISAU, developed an integrating spreadsheet system called SIMP⁶ that was subsequently implemented at all provinces and at the national levels in 2002 (MISAU, 2003). SIMP integrates data from finance, public servants information system (SIP), office of cooperation and international projects (GACOPI), infrastructure, epidemiological surveillance data, and also SIS through a series of standardized reports that enable cross correlation of major indicators. Different technical evaluation teams criticize the integration of SIMP and SIS because it does not handle the validation of data generated from SIS. Since SIS is reported to have many bugs, SIMP tends to automate these existing inefficiencies.

⁶ Sistema Integrado de Monitorização e Planificação, Portuguese for Integrated System of Monitoring and Planning.

5.2 Human resource development

MISAU has the responsibility for human capacity building through focused and continuous training. The nationwide implementation of SIS was carried out along with training of the potential users in statistics, use of computers and use of SIS for data entry and generation of reports. Since 1992, when training was carried out along with the implementation of SIS, there has been no further training. As a result, there are inadequate skills and human capacity to support SIS functions. Furthermore, most health workers at health units have only a basic primary or secondary education whereas health workers at the provincial or district levels have a slightly higher education level. For example, we discovered that the head of HIS statistics at the province level was qualified as the standard XII level. In addition, to their involvements in clinical work, health staff are also engaged in SIS administration tasks related to data. In summary, the lack of adequate basic education, poor training and heavy workload contribute to the inadequate human resource capacity to support the computer based HIS at all levels of the health structure.

5.3 Donors and MISAU policies

Different aid agencies have individual projects in different departments and this leads to fragmentation in the absence of overall control and coordination (Chilundo and Aanestad 2003). This situation leads to a duplication of effort where donors may redirect their support to the same health or management problems leaving others unsolved. The problem created by parallel donor supported systems is described by Batley as follows:

The [donors] have operational policies and procedural requirements that guide their engagement with partner countries [like Mozambique]. A major problem is that even where [donors] have similar objectives, their specific requirements can be different. As a result, donors and partner countries alike face administrative complexities that reduce development effectiveness. This is a particularly crucial issue for poorer and smaller partner countries. More importantly, the multitude of complex administrative requirements makes it extremely difficult for partner countries to exercise ownership (Batley, 2002: 1).

6 ANALYSIS AND DISCUSSION

In the two cases, different issues were discussed highlighting key factors which contributed to the development of an unsustainable HIS. These issues are now discussed in the framework of three key sets of relationships; relationships between the MoH and the software development agency, between the MoH and the donors, and between the donors and the software development agency. These sets of relationships are analyzed within the context of the two cases of Mozambique and Tanzania.

6.1 Relationship between MoH and the software development agency

In Tanzania, the software development was entirely delegated to the vendor's control, thus resulting in a system which did not suit the users' needs. The focus was on creating a ready-to-use software with no long term support plans for the users. The Tanzanian MoH was bypassed in this process, and thus its interests, requirements, knowledge, and experience about the needed system was excluded. For example, the HMIS bugs, including malfunctions, identified at the regional levels by the users, could only be communicated to the MoH. However, the MoH did not have the technical capacity, source code, or financial resources to address those problems. There was thus a fundamental mismatch between the users, their needs, the existing problems and how they could be addressed.

Contrary to the Tanzanian case, MISAU in Mozambique had substantial control, at least in the initial stages, over the development of the system while the developer was still working for the MISAU. However, when his contract expired and he left for his home country, the system

became unsustainable, since there were no technically skilled individuals at the MISAU to take over the vacant position. And since the foreign expert did not involve any local people in the development process, no one had the required knowledge to conduct further development or maintenance of the system. Therefore, the system was not capable of evolving with the changing needs and priorities of the different MISAU departments over time. Also, because of the top down approach to development used by the SIS developer, the users were excluded which has led to continued resistance by the users to use SIS.

In both cases the top-down development approach and a dysfunctional relationship between the MoH and the development agency contributed to the creation of an unsustainable system. The reasons for dysfunctionality were, however, different in the two cases. In Tanzania it was because the donor directly gave funds to the vendor bypassing the MoH. In Mozambique, the responsibility of the vendor expired after the system was developed and he left the country.

6.2 Relationship between MoH and donors

In Tanzania donors provided financial assistance for the development and initial implementation phase of HMIS. However this funding was basically short term without any strategy to support the post-implementation phase, such as local capacity development, training, maintenance or system enhancement.

Contrary to the Tanzanian case, MISAU obtained money from several donors for systems development. But since donors had their own funds and agendas and operated independently from each other, this led to the creation of multiple systems to support different departments and programs. This problem was magnified because there was no strategy for coordination of these multiple systems by MISAU. This led to the Minister of Health calling MISAU as ‘the Ministry of projects’. Another problem in Mozambique, as in Tanzania, was the short term nature of funding leading to systems remaining unsupported in the post-implementation phase.

6.3 Relationship between donors and the software development agency

In Tanzania, the developer, a private software firm, received money for the development of HMIS directly from the donor. This led to the developer working for the donor and thus focused on the donor’s interests, rather than meeting the long term needs of the MoH. The relationship between the vendor and the donor jeopardized the relationship with the MoH, leading to a lack of ownership and responsibility of the MoH over the HMIS.

In Mozambique the relationship between the donors and developers was facilitated through MISAU, who had a direct channel of communication with the developers. But the control was of short term nature as the donors funds dried up, and the expatriate left. This left MISAU with no technical or financial capacity to sustain the system (Heeks and Baark, 1998).

6.4 Recommendations towards development of a sustainable HIS

Our recommendations are presented with respect to how the three sets of relationships discussed earlier can be strengthened.

Donors have funds and expert knowledge while normally the user organizations in developing countries have a shortage of manpower, skills and are confronted with constantly changing needs. In these terms donors could play a long-term role to assist user organizations to cope with changing demands and needs in an appropriate way. The alignment of resources, interests and responsibilities is crucial to avoid duplication of effort in addressing the health and management problems. For example, in Mozambique there are a number of donor funded projects which contribute to an improper distribution of resources and manpower, and to low performance and outcomes of the overall HIS.

The actors involved in one way or another with the HIS have roles to play either technically, financially or operationally and their joint actions can be reflected in the sustainable development of an IT system. Moreover, the HIS must be ‘needs’ and ‘local people’ driven and

appropriate for sustained use (Misund and Høiberg 2003) and its evolution over time. A collaboration between the local organizations and donors plays a key role to sustain the changes achieved in the long run since donors have funds, expertise and experience. Donors should not bypass the local organizations as in the case of Tanzania. The local organization needs to have control over software development process in order to shape it to their particular needs. However, this requires donors' expertise and experience.

Based on the analysis of the two cases and the theoretical framework, we argue that for the sustainability of HIS to be achieved, the interests and resources of all involved actors must be aligned in a common network as summarized in figure 2. Actors' interests, knowledge and resources need to be aligned in a network whereby each actor in the network understands its obligations and responsibilities. Such alignment enables the actors to share common understanding about developing sustainable IT systems so that their individual and joint actions become institutionally shaped meeting the goal of the common network. IT development involves a network of actors who are immersed in the institution and not individual actors who exert influence to the institution. Developing a sustainable IT is a process whereby the involved actors succeed by translating their interests into the development and use of IT (Avgerou, 2003).

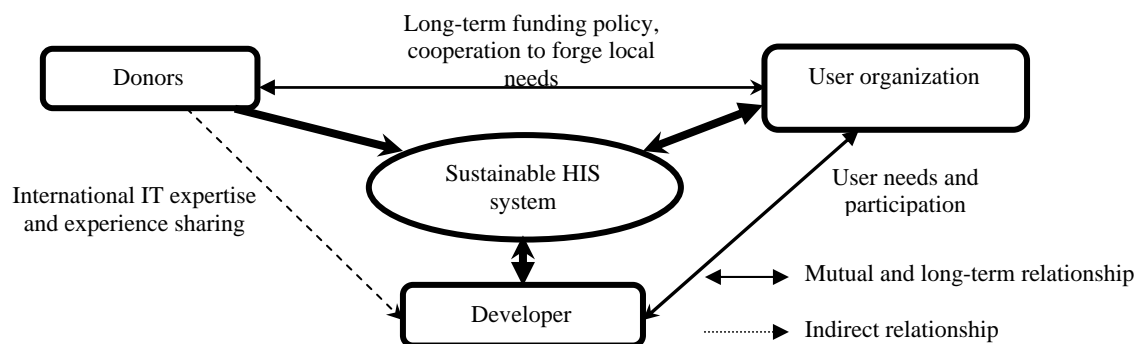


Figure 1. Network of aligned actors towards a sustainable IT

We further adapt from various authors (for example, Korpela *et al.* 1998; Misund and Høiberg 2003; Avgerou, 2003; Walsham, 1992) to outline the responsibilities of the individual actors in table 2.

User organization	
<ul style="list-style-type: none"> • Develop both strategic and operational organisational needs • Create reliable data sources and infrastructural resources • Develop IT policy and its integration within organisational framework • Cultivate a habit of information dependence and use • Plan for institutionalization of IT processes through organizational change 	<ul style="list-style-type: none"> • Build skills and local capacity to adapt to the new organisational changes • Decentralize the decision making to allow for user participation • Participate in mobilization of resources for long-term IT support • Integrate processes and needs to avoid duplication of efforts and resources • Conduct regular evaluation and assessment of IT
Donors	Developers
<ul style="list-style-type: none"> • Long-term funding policy • Long-term strategies to ensure fully institutionalization of processes • Bottom-up strategy involving top level managers • Local human capacity building through expertise, experience sharing and training 	<ul style="list-style-type: none"> • Iterative, incremental and flexible strategy for system development • Design of technology and its institutionalization involving top and bottom level users in the processes.

Table 2 Expected responsibilities of each actor

In order to ensure that systems accomplish their intended purpose, the developers, MoH and donors need to develop a sustainability analysis and strategy prior to system design and implementation. This is necessary to examine the potential individual impacts of the systems and how each actor's responsibilities can be accomplished. This implies that the system should be developed focusing on users' needs, whose evaluation and feedback should provide the basis for future improvements to the system. The developer needs to study, interact and understand users' needs through involving them in the development process.

During the requirements capturing, design and development of IT, the socio-technical consideration need to be incorporated into the process to create a balanced system that meets organisational needs. The social aspects are composed of the norms, values and assumptions of the organisation, leadership style, formal and informal relationships. Thus the technology needs to be designed to fit the desired organisational social aspects.

We argue that sustainability of an IT system depends on its integration into the organizational complexities and routine work practices through institutionalization. However the institutionalization process takes time and demands a continuous learning curve (Avgerou, 2003) and thus requires a long term flow of funds. User participation from the inception of ideas of such systems, their initiation, design, development and implementation is also required in order to develop gradual changes in user's understanding and to enable IT to become a normal way of doing things. Such changes need to be carried out incrementally, enabling users to learn from previous changes and to incorporate new changes that emerge over time. Thus, the actors need to create an environment that enables in-house and external generation and sharing of knowledge within the sustainability strategy framework.

Planning for institutionalization of new systems such as HIS, creates roles, responsibilities, and budgets to ensure that the HIS becomes part of the existing organizational routines. For example, mandating that all reports should be generated through the HIS, or creating a HIS office, or budget for stationary for printing of the HIS reports, can help to create structures that support institutionalization of the HIS. In summary, processes of sustainability and institutionalization are closely linked. These linkages are examined in the case studies.

7 CONCLUSION

This paper started with two research questions: one dealing with what contributes to unsustainability of HIS in developing countries; the second dealing with what can be done about it. The major factor that we found to contribute to development of unsustainable HIS is the misalignment of the interests, roles and responsibilities of the actors involved in the process (the donors, developers and MoH). Effective collaboration between these actors is fundamental to sustain the changes achieved in the long run.

We argue that the interests of the actors should be aligned in a common network to address the long term users' and organizational needs. The user organization, in this case the MoH, in collaboration with donors, needs to build basic, long term, sustainable skills that can survive changing times, technology, and needs. That means development of user skills should be viewed as a continuous process in order to allow use to learn from their experience and to change course when required. Managers need to upgrade their skills for better management of information flows and planning. In order to build and retain human capacity there is a need to build a conducive working environment not only for organizational but also group and individual benefits. A conducive environment implies better workers' benefits, incentives and work procedures created by the involved actors in response to performing their attached responsibilities.

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8.12. APPENDIX L

KIMARO, H. C. & NHAMPOSSA, J. L. (2005). Analyzing the problem of unsustainable health information systems in less-developed economies: Case studies from Tanzania and Mozambique. *Information Technology for Development*, 11, 273-298.

Analyzing the Problem of Unsustainable Health Information Systems in Less-Developed Economies: Case Studies From Tanzania and Mozambique

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ABSTRACT

Most of donor-supported information technology (IT)-based projects developed or implemented in less-developed economies (LDEs) end up as complete or partial failures or unsustainable. Notably, a number of intra-organizational and external factors are associated with this problem, including inadequate infrastructure and human resource capacity, fragmented donor policy, and lack of policies to manage the sustainability problem. Accordingly, IT initiatives are often donor-driven, top-down, and hijacked by top managers who (normally) do not have adequate skills, but have enormous power to enforce such initiatives across organizational hierarchies.

In analyzing the concepts from sustainability and institutionalization, key insights towards a better understanding of the problem of unsustainability are developed. It is argued that health information systems (HISs) become sustainable if they are institutionalized in the sense of being integrated into the everyday routine of the user organization. However, a sustainable HIS should also be flexible enough to allow changes as the user needs change. Moreover, introduction of a new HIS is not only a technical change, but requires the cultivation and institutionalization of a new kind of culture.

Through a comparative case analysis of the HIS development and implementation processes in Tanzania and Mozambique, we have identified two sets of relationships, between the Ministry of Health (MoH) and donor agencies and between the MoH and software development agencies as critical and contributing factors to the unsustainability of a HIS. Given this setting, we highlight three key strategies for dealing with the problem of unsustainability in LDEs: (a) integration of a HIS, (b) local shaping of new cultures, and (c) cultivation approach to systems development. © 2005 Wiley Periodicals, Inc.

Keywords: sustainability; institutionalization; health information systems; integration; international aid agencies; design; development; less-developed economies; Ministry of Health; Tanzania; Mozambique

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1. INTRODUCTION

Information technology (IT) has been described as offering a remarkable potential for improving the efficiency and effectiveness of organizations (Mackenzie, 1999; Winner, 1999). However, its adoption, adaptation, and use are quite variable depending on the context. Information technology offers less-developed economies (LDEs) an opportunity to introduce improvements in health service delivery, as well as meet broader developmental goals that have an impact on health (Chandrasekhar & Ghosh, 2001). Through the use of IT, healthcare organizations can potentially plan, monitor, and control health services and communicate more effectively across organizational hierarchies (Bhatnagar, 1992). Wilson and Smith (1991) suggest that, “the creative use of microcomputer technology is one of the most promising means of improving the quality, timeliness, clarity, presentation, and use of relevant information for primary health care” (p. 199). Recent experiences attest to the potential for using computers effectively to support health care delivery, for example, in South Africa (Braa & Hedberg, 2002). A health information system (HIS) involves manual procedures and a set of technologies to collect, analyze, present, and use data for monitoring, planning, evaluation, and management (Heywood & Rohde, 2000; Lippeveld, Sauerborn, & Bodart, 2000). The potential of an IT-based HIS for the management of health care is emphasized by the following quote from Braa and Blobel (2003).

All countries need a national HIS at least partially based on modern IT linking the various levels of the health system and addressing the information needs of policy makers, managers, health programmes, service providers, staff, and increasingly patients [...] Without reliable, relevant HIS, health care managers and providers cannot optimally allocate resources, improve the quality of health services, or address epidemics such as HIV/AIDS (pp. 177–178).

However, the literature provides a number of examples where assumptions about IT being critical for bringing about change in LDEs have been problematic (Avgerou & Walsham, 2001; Chandrasekhar & Ghosh, 2001; Silva & Figueroa, 2002). The challenges are linked to the lack of awareness of computers (among users and managers), lack of well trained IT professionals (who can bridge the gap between management and technology), inappropriate or weak infrastructure, lack of IT policies and strategic plans, and a weak culture of using computer based information (Bhatnagar, 1992; Sahay, 2001; Walsham, Symons, & Waema, 1988) in the context of LDEs.

Numerous bottlenecks related to the implementation of IT have been identified including the top-down, centralized, and fragmented character of design and services; lack of coordination and sharing of resources; poor quality and use of information, the complex organizational context (Avgerou & Walsham, 2001; Chilundo & Aanestad 2003); and limited focus on the use of information for action (Braa & Blobel, 2003). Moreover, HIS initiatives often rely on foreign experts for the implementation and regard the user organization only as consumers of the technology, and not as active participants in the design and development process. This exclusion of the users often leads to the development of unsustainable HISs.

Governments of LDEs have been placed under international pressure by donors to adopt more efficient HISs (Human Development Report [HDR], 2003; Organisation for Economic Co-operation and Development [OECD], 2003) as a basis for health care reforms, which depend on the disbursement of funds. Donor support promises great improvements in the redesign of the recording and reporting system, development of integrated databases, training of national staff locally and abroad, and the provision of computers. These expectations,

however, are not often fully realized in practice (Bhatnagar, 1992; Heeks, 2002a; Heeks, 2002b; Heeks, Mundy, & Salazar, 2000). There is typically a multiplicity of donor funding aimed at particular disease-specific programs (Chilundo & Aanestad, 2003, 2004) leading to the development of a parallel HIS. Historically, such HISs have not been sustainable due to the short-term nature of funding, inability to mobilize national support, the top-down approach (which ignores institutional issues), and the lack of focus on the development of local expertise. Thus, often well meaning initiatives end up as complete or partial failures and unsustainable HISs (Heeks, 2002a; Heeks, 2002b; Littlejohns, Wyatt, & Garvican, 2003; Lippeveld et al., 2000).

Implementation of a HIS particularly in LDEs is a complex and challenging task as the process demands not only a transfer or development of the technology itself but also the introduction of a different kind of culture that accompanies the system. As Heeks (2002b) points out, what are transferred are not only machines, hardware, software, skills, and knowledge, but also the attitude and values of the system, together with the social, political, and cultural structures. While it may be relatively easy to transfer the technical artifacts, sociocultural settings have to be cultivated and technological learning has to be ensured (Braa, Monteiro, & Reinert, 1995; Hanseth, 2002; King et al., 1994). An absence of such a sociotechnical focus in favor of a technical approach typically causes a HIS to be unsustainable in LDEs (Avgerou & Land, 1992; Doherty & King, 2001; Walsham et al., 1988).

Through this brief discussion we have tried to emphasize that sustainability of HISs in LDEs is a significant issue, and trying to address it is a matter of urgent concern for both IS researchers and practitioners. Thus, the focus of this article is (a) to theoretically develop an understanding of the problem of unsustainability of HISs, (b) to analyze the conditions that contribute to it, and (c) to try to articulate some strategies to address this problem. The empirical base for this analysis comes from ongoing studies of HIS implementations in Tanzania and Mozambique.

In line with the above research aims, in the next section, we define the problem of unsustainable HISs and identify the conditions that contribute to it. We draw upon the concepts from sustainability and institutionalization literature to analyze how HISs can be made sustainable. Following this, in section 3, we provide our conceptual understanding of institutionalization and sustainability. In section 4, the research approach and case studies from Tanzania and Mozambique are presented, followed by an analysis of the unsustainability problem and discussion of some strategies to address it in section 5. Some conclusions are presented in section 6.

2. THE PROBLEM OF UNSUSTAINABLE HEALTH INFORMATION SYSTEMS IN LESS-DEVELOPED ECONOMIES: A THEORETICAL PERSPECTIVE

In this section, we first present definitions of sustainability and institutionalization in the context of HISs in LDEs. Next, through a review of the literature, we discuss conditions that have been identified by researchers to contribute to the problem of unsustainable HISs.

2.1 Sustainability

The term *sustainability* can have different meanings, often implying maintaining something that already exists over time, and is often equated with being *self-sustaining* and *self-sufficient*, meaning that no external support is needed (Reynolds & Stinson, 1993). However,

with regard to HISs, *sustainability* implies the ability of the user organization to identify and manage risks that threaten the long-term viability of the HIS, following the withdrawal of external support (Korpela, Soriyan, Olufokunbi, & Mursu, 1998).

Sustainability is not to be considered as the final stage of HIS development (Pluye, Potvin, & Denis, 2004), but is concerned with the initiation of a HIS, its design and development, through to its implementation and implications once external support is withdrawn (Braa, Monteiro, & Sahay, 2004). A sustainable HIS is institutionalized and maintains its benefits over time (Manfred, Crittenden, Ik Cho, Engler, & Warnecke, 2001; Puska et al., 1996). Our interest is thus in systems that are both effective and institutionalized because systems are often institutionalized but not effective.

Generally, not all systems that get institutionalized can be described as useful and sustainable. The sustainability of a system is dependent upon the degree of its demand and use, its appropriateness to the organization and its users and the availability of adequate local capacity and resources to sustain benefits achieved over time (Akubue, 2000; Oyomno, 1996). Moreover, for a sustainable system to continue over the long run, it must possess the flexibility to be adapted to the changing needs of the organization over time, and the organization must have adequate local capacity and resources (Lafond, 1995; Pellegrini, 1979) to translate changing needs to system design and development efforts.

2.2 Conditions That Contribute to Unsustainable Health Information Systems

In this section we analyze four sets of conditions that have been said to contribute to the unsustainability of HISs in LDEs: inadequate infrastructure, inadequate human resource capacity, inappropriate policies and strategies to manage the sustainability problem, and fragmented donor policy.

2.2.1 Inadequate Infrastructure. The implementation of HISs not only requires the existence of a sound technical infrastructure (e.g., hardware, software, and networks), but also a reliable physical (e.g., roads, power supply, and transportation) and communication (e.g., phones, fax, and Internet connectivity) infrastructure (Kenny, 2000; Walsham, 2000). For example, computers cannot work effectively when there are frequent power supply failures or power fluctuations which may cause system failures. Furthermore, frequent equipment failures require prompt support which is often not forthcoming in the context of LDEs. An example of the need for an effective combined infrastructure is provided by Mosse and Sahay (2001) in the context of HIS implementation in Mozambique. They wrote,

Poor infrastructure leads to poor coordination and information sharing [. . .] and contributes to an absence of coherent socio economic development initiatives with benefits to the people. Akpan (2000) argues that one way to reduce these asymmetries in underdeveloped societies is by connecting them to industrial societies through modern ICTs. However, mere technical connections through ICTs are not enough.

Thus, the lack of a sound combined infrastructure creates the risk of failure of HISs leading to a situation of unsustainability.

2.2.2 Inadequate Human Resource Capacity. Less-developed economies have a tremendous shortage of skilled, experienced, and adequate human capacity in IT both

in the private and public sectors, making the process of developing, adopting, and using IT a problematic issue (Walsham et al., 1988). There is not only a shortage of technical skills but rather a lack of a mix of skills that entails management, social, organizational, and technical aspects (Bhatnagar, 1992; Waema, 2002). As a result, the majority of top managers do not have the capability and experience to deal with the complexity of the development and management of IT in their organizations. As a result, top managers are sometimes easily persuaded by foreign experts and inexperienced programmers to accept technological solutions that promise much but deliver little in practice.

Given the existing inadequate human capacity in LDEs, once donors withdraw, the HISs are often left in the hands of locals without the necessary technical, managerial, or financial capabilities to sustain the system over time (Baark & Heeks, 1999; Braa et al., 2004; Heeks & Baark, 1998). The lack of donors' strategies to expand or enhance the existing human capacity in LDEs institutions and the lack of local institutional strategies and initiatives on IT training and human resource development contribute to an inadequately skilled human resource capacity. The lack of appropriate local capacity makes it difficult to translate the changing needs of the organization to an effective HIS, thus contributing to unsustainable systems.

2.2.3 Inappropriate Policies and Strategies to Manage the Sustainability

Problem. Donor policies on funding to LDEs are typically short term in nature (Heeks, 2002b; Heeks et al., 2000) and have no clear or explicit sustainability policies or strategies in terms of funding human resource development or IT deployment (Baark & Heeks, 1999; Heeks & Baark, 1998; Lead Team, 2001). Sustainability strategies require planning to transcend the project phase in which the donor is involved, and to examine ways to continue and grow the system after donor funding is withdrawn (Young & Hampshire, 2000).

Health information system developments typically follow a top-down approach, with control resting in the hands of foreign experts and National Ministry administrators who often fail to address institutional issues (e.g., organizational politics and culture) (Okot-Uma, 1992), and systematically exclude people at the peripheral levels of the organization from the negotiation and decision-making processes (Lippeveld et al., 2000; Walsham, 1992). The ownership and control over the HIS rests with the top managers and donor's representatives, leading to a situation where the users rarely gain control over the technology they ultimately are expected to use. Health information systems often take a long time to be fully institutionalized and to develop local capacity (technical, managerial, and financial). Thus, inadequate and short-term support and a top-down approach contribute to a lack of local control and ownership leading to systems which are not sustainable.

2.2.4 Fragmented Donor Policy.

The focus of donor assistance is on development of particular disease-specific programs rather than a unified HIS, which leads to the presence of parallel and fragmented HIS. Because donors' funds are a priority, the focus on specific health programs is to a certain degree inevitable (Lippeveld et al., 2000). Often foreign experts come with ready-made software packages or develop software for a particular disease or set of diseases that may be incompatible with existing systems and procedures. Some of the software packages are targeted to solve specific research problems and are not suited to provide larger practical benefits.

The fragmentation of the HIS and services leads to overlaps, gaps, and a lack of standard definitions for data, reports, and technological solutions (see Chilundo & Aanestad, 2003; Monteiro, 2003). Moreover, the existence of a fragmented HIS increases the burden to

health care workers at the peripheral level of the health care sector who are the source of all health data. A fragmented HIS increases running costs and utilization of limited resources and limits the ability to obtain an overall picture of the health status of the community.

In summary, sustainability, which implies the capacity of the HIS to endure over time and space, is adversely affected by the four sets of conditions that we have discussed above. To address these problems, it becomes important that the systems become institutionalized, i.e., they become routinized into the everyday working of the institution, which in our case is the Ministry of Health (MoH). In the next section, we clarify our approach to understanding institutions and the institutionalization process. We also discuss how this perspective helps in analyzing the sustainability problem, and how it can be addressed.

2.3 Institutionalization

Institutions include all socially devised rules of governance (such as policies, contracts, codes of conduct) and social/cultural norms that constrain how individuals or groups act in a social context (Dovers, 2001). Thus, institutions are made up of formal constraints (e.g., rules, laws, constitutions) and informal constraints (e.g., norms of behavior, conventions, and self-imposed codes of conduct). People interact and respond to each other through formal rules or culturally shared behavior without having to negotiate ground rules (North, 1990). Institutionalization refers to a process by which a social pattern or an activity becomes accepted as a social “fact” (Avgerou, 2000, p. 236) and thus sustainable over time (Braa et al., 2004). Scott and Meyer (1994) define institutionalization as the “process by which a given set of units and a pattern of activities come to be normatively and cognitively held in place, and practically taken for granted as lawful whether as a matter of formal law, custom or knowledge” (p. 10).

The HIS is institutionalized if it is integrated into organizational routines or existing policy or if it introduces a new policy to guarantee its durability (Baum & Cooke, 1992; Ouellet, Durand, & Forget, 1994). For example, by mandating that all reports should be generated through the HIS, creating an HIS office, or creating a budget for stationary for printing the HIS reports, structures can be created that support the institutionalization of the HIS. Thus, institutionalization of new systems such as a HIS includes creating roles, responsibilities, structures, and budgets to ensure that the HIS becomes part of the existing organizational routines. Institutionalized processes become absorbed and integrated into the organizations with the ideas being accepted and acted upon to become normal and routine in the organization because of its legitimacy.

Introducing a HIS also demands the introduction of a new kind of culture (e.g., sociopolitical structures and beliefs) that go with the system, such as new ways of reporting, collecting, processing, analyzing, and using data. Thus, the institutionalization of a HIS implies designing new work activities so that they become a routine way of doing things for most people in the organization. For this to happen, however, demands a gradual, progressive institutional change as a result of learning (Clemens & Cook, 1999). Mutually understood actions of the organization or individuals (Ingram & Clay, 2000) can help to modify existing cultures (such as attitudes, institutional structures, and organizational behavior) in people’s understanding and their beliefs to accept the rules of the new changes.

Cultural change is normally carried out gradually since it is difficult to change the way people are used to doing things (Avgerou, 2002). The change is associated with a change of collective ideas, values, and meanings of people in the organization and is not done by imposing new behaviors (Alvesson, 2002; Keen, 1981). New cultural changes that emerge

are shaped and maintained through the interaction of people at all levels in the organization. North (1994) explains that cultures are difficult to change because the formal rules are only part of the institutional system.

While the rules may be changed overnight, the norms usually change only gradually. Since it is the norms that provide legitimacy to a set of rules, revolutionary change is never as revolutionary as its supporters desire, and performance will be different than anticipated. [An institution] that adopts the formal rules of another [institution] will have very different performance characteristics than the first institution because of different informal norms and enforcement. (p. 8)

Cultural changes are necessary, however, for an activity to persist over a long time. However, there are “good” and “bad” cultures. It is important to institutionalize good cultures, characterized by norms and values beneficial to the organization and its people. According to Backer (1980):

Good cultures are characterized by norms and values supportive of excellence, team work, profitability, honesty, a customer service orientation, pride in one’s work, and commitment to the organization. Most of all, they are supportive of adaptability—the capacity to thrive over the long run despite new competition, new regulations, new technological developments and the strains of growth. (p. 10)

There is no overall framework for creating or modifying a good culture apart from emphasizing the process of local cultivation in shaping desirable cultures, and deemphasizing those that are seen by concerned people as problematic.

Thus, new behaviors (such as beliefs and values) associated with a HIS need to be cultivated in the organization for people to decide to accept them (Alvesson, 2002). In the process of bringing the new ideas and values, the target people may respond differently due to cultural differences. The involved people may require a large amount of resources in negotiating various issues and changes, and making the cultural change part and parcel of their daily activities, talk, and structural arrangements (Alvesson, 2002).

In the next section, we summarize our theoretical understanding of institutions, the institutionalization process, and cultural change to analyze how a HIS can be made sustainable.

3. CONCEPTUAL UNDERSTANDING OF INSTITUTIONALIZATION AND SUSTAINABILITY

Building on the earlier theoretical perspectives, we conceptualize institutionalization and sustainability by the following key ideas:

- Systems become sustainable if they are institutionalized in the sense of being integrated into the everyday routine of the user organization. However, sustainable systems need not only to be institutionalized, but also flexible to allow for changes as the user needs change. For example, the disease and diagnosis patterns may involve the introduction of new technological changes, involvement of different actors (e.g., non-governmental organizations [NGOs], World Health Organization [WHO], etc.), and the need for new data sets.
- Introduction of a new HIS is not only a technical change, but requires the cultivation and institutionalization of a new kind of culture and way of doing things that are associated with the HIS.

- Donors influence the processes of institutionalization, and thus also the sustainability of systems significantly.

Generally, the surveyed literature have indicated that the sustainability of HISs in the context of LDEs like Tanzania and Mozambique is dependent on many factors including existing infrastructure, local capacity and culture, as well as local government and donors' policies. However, some of the negative effects of these factors are implicitly created or supported by the involved actors given their political interests and agendas.

The top managers normally have no adequate skills but in contrast have enormous power to enforce new initiatives such as HIS implementation across the organizational hierarchy. Thus, the decision about the HIS rests with the top managers despite having inadequate knowledge about IT. The top managers' interest to support the new initiatives in some cases may be a burden for capacity development. For example, some top managers fear a loss of reputation or being replaced in their jobs or positions, or subsequently lose the financial or other benefits in the project when the capacity of their staff is enhanced. However, donors in some cases tend to be loyal to the top managers as a strategy to have their initiative approved and thus undermining consideration of sustainability issues. Moreover, in most cases foreign experts arrive in LDEs with motives, interests, and agendas of making the IT work technically, but not to develop the local capacity. Because of the uniqueness of skills the foreign experts may possess, they often create a culture of being continuously needed in that particular context, thus contributing to unsustainability when they leave or their contracts expire.

4. RESEARCH APPROACH AND CASE STUDIES

In this section, we describe the case studies of HIS development and implementations in Tanzania and Mozambique. In both cases, the three sets of actors (MoH, developers, and donors) are central to the process. While the Tanzanian case emphasizes the historical relationships and misalignments between the three sets of actors, the case of Mozambique describes the current fragmentation of the HIS contributed to by the lack of coordination among the three actors and a multiplicity of donor funding.

4.1 Research Setting and Approach

Tanzania and Mozambique are LDEs located in eastern and southern Africa, respectively, both bordering the Indian Ocean. Both depend on international aid agencies such as the World Bank, the International Monetary Fund, and bilateral donors for the provision of funds to rehabilitate economic infrastructure, alleviate poverty, and support the public health systems. Tanzania has a total area of about 945,087 km² with a population of about 34.4 million (Tanzania country Web site, 2004) whereas Mozambique has a population of 17.3 million (2003 estimate) with an area of 801,590 km² (The World FactBook, 2004).

The two case studies were both part of an action research initiative within the Health Information Systems Programme (HISP);¹ Braa et al., 2001, 2004) that was first initiated

¹The Health Information Systems Programme is an ongoing international endeavor to study and introduce district-based HIS in various developing countries. Researchers from Norway, University of Western Cape, and Cape Town initiated HISP in 1994. The HISP implementation initiatives have been extended to neighboring countries including Mozambique (1999) and Tanzania (2002). See www.hisp.org.

in South Africa in 1995 and subsequently in other countries including Mozambique, India, Tanzania, Ethiopia, Malawi, and Mongolia (Mosse & Sahay, 2003). The aim of HISP more generally is to strengthen processes of design, development, and implementation of sustainable HISs with a focus on building the capacity of health care workers to effectively design, operate, and use information for action. The aim of HISP in applying action research is that it provides practitioners and researchers with the opportunity to work together, help share learning and experiences across the different research sites, and to become more aware of the options and possibilities for change (Braa et al., 2004).

Through collaborative efforts among researchers in HISP, the District Health Information Software (DHIS) was developed (Braa & Hedberg, 2002) to assist health care workers and managers in the process of analyzing and presenting routine health data in a simplified, meaningful, and useful format for making informed decisions.

The two cases are based on the authors' individual experiences as action researchers on HISP teams in their respective countries since 2000. The authors were involved in the installation and training of DHIS including studying data flows and their use in the MoH. In this process, the authors were engaged in many key discussions and events with health care managers and health care workers to understand and explore the existing HIS.

The case study of Tanzania was based on a number of interviews with informants (see Table 1), participant observations, group discussions, meetings, workshops, and training sessions, all conducted at different periods between 2002 and 2004 at the Ministry of Health headquarters, in the coast-region health office, the Bagamoyo and Kibaha districts' health office. During the interview, the respondents were asked questions related to the processes of design, development, implementation, maintenance, training, and user support of the HIS, along with how different actors were involved in these processes and the nature of developers' contracts as well as roles played by different individuals in shaping the HIS. In addition, analyses were performed of documents such as software evaluation reports. Moreover, HIS events (such as data collection, use, and management) and use of the HIS software were observed, then documented in a descriptive format, reflected upon, and analyzed.

Similar data collection methods were applied in Mozambique. The case study was carried out in multiple sites, involving top-, middle-, and lower-level managers and health workers of the HIS (at national, provincial, and district levels). Also, representatives of the donor

TABLE 1. Type and Number of Respondents Interviewed in Tanzania and Mozambique

Organizational level	Type of respondents	Number of respondents in Tanzania	Number of respondents in Mozambique	Total
National	Managers	2	2	4
	Trainers	3	3	6
	Statisticians	2	2	4
Region/Province	Information officers	2	8	10
	Managers	2	9	10
	System users	4	11	13
District	Information officers	4	8	10
	Health managers	4	10	12
Health facility	Data compilers	10	10	20
Total		33	63	96

agencies employed at the local Ministry of Health (MoH) from 2000 to 2003 were interviewed. Geographically, the study was carried out in three provincial directorates of Gaza, Inhambane, and Niassa, and at the MoH. Part of the data was also collected from Chibuto and Cidade de Xai-Xai districts in Gaza, Maxixe, and Massinga districts in Inhambane and Cuamba district in Niassa. The different subsystems of the national health information system software were also studied.

Both the authors were acquainted with the working languages of their particular research contexts (e.g., Tanzania—Swahili and English, Mozambique—Portuguese). The authors were also conversant with the local context, culture, and languages, and all the interviews, training, and workshops were conducted based on the language of that particular setting.

4.2 The Computerization Process of the Health Information System: Case Study From Tanzania

This section provides details related to initiation, design and development, and implementation of the current Microsoft Access-based version of the HIS. Details of the earlier DBase versions in the MoH are provided as a historical reconstruction only to illuminate the role of developers and donors in the process.

4.2.1 Historical Background (From 1989 to 1998). Tanzania's national routine health information system (also called *MTUHA*² in Swahili) was initially conceptualized as a paper-based system. The administrative organizational structure consists of four levels, namely national, regional, district, and health units. The district in this case represents the main operational unit for implementing primary health care (PHC), and serves as the hub for the flow of health data and information from the community to the national level. When designed from 1989 to 1991, MTUHA was meant to integrate all vertical programs, ensure a regular and reliable flow of information within and between the different levels, and support the agenda of health reforms through decentralization (MoH, 1993). Top managers assisted by an external health consultant from Nairobi, Kenya, with financial support coming from different donors (MoH, 1993; Rubona, 2001) were strategically enrolled in the development process of the paper-based MTUHA. The idea was that the local MoH would take full responsibility for further financing the MTUHA system after the completion of the initial implementation phase, estimated to cost 1.7 million USD excluding personnel and consultancy expenses (MoH, 1993).

While the piloting of the MTUHA paper-based system started in 1992, its scaling up to the rest of the country took place in 1993. The computerization process was simultaneously undertaken in 1992 by a software developer (called Developer I), recommended by a Nairobi consultant. As a result, the first version of the MTUHA software was developed in dBASE and delivered for implementation and use in 1993 by the MoH headquarters in all 20 regions of the Tanzania mainland.

During its use between 1993 and 1995, the first version of the MTUHA software was tested several times in the field and a number of bugs were identified and recorded. Developer I's services and expertise was then required for addressing the recorded bugs, but efforts made to contact him failed since he had left the country without even leaving his contact

²MTUHA: Mfumo wa Taarifa za Uendeshaji wa Huduma za Afya.

details. Consequently, and thanks to the fact that the source code was available, another software developer, here called Developer II, based in Arusha, Tanzania, was approached and improvements were carried out (e.g., making new changes and fixing bugs) which resulted in MTUHA version two.

The MTUHA paper-based system was subject to a major evaluation by the Danish International Development Agency (DANIDA) in 1997. A number of changes were made to the paper-based system; new forms were added and reporting frequency for health care facilities was changed from monthly to quarterly, implying fundamental changes to the software. When analyzing the recommendations developed by the evaluation team, which included improvements of the current version, Developer II concluded that the requests were too significant; thus, the ideal alternative was to start a new software development project instead.

Following Developer II’s recommendations and assurance of funding from the DANIDA, the MoH contacted a third software development company, here called Developer III who had been recommended by Developer II, based in Dar Es Salaam to take over the job of developing the new MTUHA software. By this time, the MoH had made contact with Developer I, who was given the responsibility of providing Developer III with the detailed software specifications as stipulated in the 1997 evaluation recommendations. Contrary to the previous MTUHA, which was based in DBase, the new system was developed over a 7-month period in 1998 using the MS-Access database management system. The decision to change the platform was undertaken by Developer III because he was not conversant with DBase. Furthermore, the MoH lacked the required skills, experience, or expertise to make an alternative recommendation and instead wanted ready-to-use software without bothering about its specification or development matters.

Figure 1 illustrates that the MTUHA system has been under development and redevelopment by three separate uncoordinated efforts involving different developers, all financed by donors. Developer II took over the MTUHA modification or extension job from Developer I and Developer III was recommended by Developer II to the MoH to develop a new MTUHA system. At the same time, Developer I was hired once again to assist in developing software specifications for system to be developed by Developer III. Generally, there were no formal procedures on the ways in which the developers were chosen. However, Developer II who proposed Developer III had contacts with DANIDA.

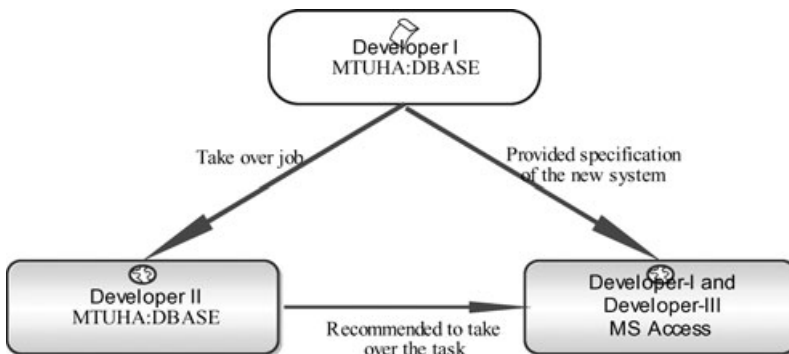


Figure 1 The relationship between the three developers (I, II, III).

4.2.2 Process of Development of the New MTUHA (From 1998 to 2004). The MS Access MTUHA had a 6-month period postdelivery guarantee where the existing bugs reported would be fixed free of charge. The main purpose was to replace the DBase MTUHA system installed at the regional and national levels, and to generate reports from data reported from the district level on a quarterly basis. After the guarantee expired, additional funding was required either from the MoH or donors to further maintain and extend the system.

The software's guarantee period has been a big constraint because bugs kept being identified, even after 6 months of delivery. This implied the need to find extra funds from donors every time it was required to improve the system further. It was only at the end of 2003 that the MoH succeeded in getting additional money from the new donor, the German Development Cooperation (GTZ) to support further development and support, which led then to an improved version of the previous MS Access version.

The new version was claimed to have fewer bugs as compared to the previous one. The testing process of the new version was done in December 2003 in Morogoro district and further bugs were reported. Despite this, the employees who were involved in the testing process recommended to replace the old version and re-install the new system in all 20 regions starting from February 2004. The new bugs were reported to have been subsequently rectified.

4.2.2.1 Design Process. During the design of the new MTUHA system, the MoH's HIS unit was the only point of contact with Developer III and the donor. The participation of top managers was mainly in the provision of necessary documentation, and endorsing the work done by the developer to the donor to guarantee funds. The end users of the system at the regional level were not involved in the design process at all, as described by one of the regional information officers:

The MoH's authorities did not involve us during the design of this system. They just informed us that they will come with a new system. At our place, only two people know how to enter data into the MTUHA system. However, we do not know how to generate reports from that data. We only know how to put data and create diskette for sending to the national level.

While the paper-based MTUHA was designed with the aim of integrating existing vertical programs (such as HIV/AIDS, tuberculosis and leprosy, Mother and Child Health [MCH], etc.), the respective program managers were not consulted in the design process. As a result these managers did not trust the MTUHA system. The lack of coordination and collaboration between the various vertical programs and also with the donor is reflected in the following quote from a regional information officer: "Even though there were HIV/AIDS, tuberculosis, MCH coordinators in the same regional or district level they could not cooperate with the MTUHA coordinator to share or compare their data."

After being developed, the system was evaluated to have a number of unsolved problems (Lungo, 2003; MoH, 2002). For example, there were missing functions (such as a help facility, function to check for errors in entered data), inability to perform some basic operations (such as adding and editing new data elements), and absence of required functionality for sorting, validation, and querying data; and many malfunctioning reports still persisted. An HIS unit manager described these problems as follows:

The experience of the Developer III was very low. It was first time for the Developer III to develop a system with such a big scope and lots of needs. Moreover, there was no feedback from the developer

to MoH in each stage of development. Therefore, the developer took it for granted to develop most of the things by himself.

4.2.2.2 Implementation and Maintenance Process. After the development of the new MTUHA software, Developer III handed over to the Ministry an executable version on diskettes and also installed it on some computers at the HIS unit. The developer then provided the initial knowledge about the software to a unit employee who was expected to train others. The HIS unit rolled out the software in all 20 regions in the country towards the end of 1998.

Each regional health officer prepared at least four health care staff to participate in the installation process. The training provided a technical overview of how to operate the MTUHA software in terms of entering and generating reports. Thereafter, no additional training was provided (Health Research for Action [HERA], 2000). Users claimed basic familiarity with dBase systems, but an inadequate understanding of how to operate the new MTUHA system, for example, on report generation. One of the users at the regional level said:

The MoH' authorities did not teach us and we do not benefit from the system actually. The authorities just assumed that we can use the new system. The system is not user friendly. Previously, we were using dBASE system but they switched us to Windows immediately. We were trained how to use dBASE system but this one we weren't! For example, with MS Access MTUHA system if you want to print, the printer prints lots of papers. I think we need some instruction on how to use the software properly. Before introducing the DBase system 5 days training was given but we did not know how to use a computer. Then they sent us to the training on how to use simple application like MS Word for 4 weeks. Then the second system they have just assumed that we can use it. But we do not know how to use Microsoft Access.

Users were supposed to report bugs in the system by mail or phone to a contact at the HIS unit who would then visit the users, or wait until the routine supervision. The problems that the HIS unit could not handle were reported to the developer and funds were sought. This led to significant delays. For example, when the author visited the HIS unit, the unit manager was waiting for an invoice from the developer before the rectification could be carried out. The district and regional levels had their own budget for solving hardware problems and used this to hire a private technical person. However, a health manager expressed frustration at the amount of money they were charged: "The MoH authorities could teach us even how to deal with computer minor repairs. You find that we pay lots of money for just simple things. Someone just comes and fixes some cables and we pay him lots of money."

Although most regions and districts had at least two computers, they were not always usable. For example, the author found five computers at the regional health office being mainly used for secretarial services only and not for processing health data. Frequent orders by the top managers to do different things, like attend meetings, were seen to disrupt further familiarization with the software and operations of HIS activities. This frustration was expressed by one of the data information officers:

Top managers call and tell you that you have to do this! They do not know that we have our own plans. When new tasks come from above you must deal with them first. Which means leaving out all our planned activities? For example, my boss at the national level just phoned me today; he wants me to accompany him in the journey to Mafia district. It just happens like this throughout the year!

Another problem expressed was the perceived irrelevance of data being collected for local needs of action. As stated by a regional health information officer:

Our work is based on the higher level needs, for example, the districts and regions write their reports based on the national-level guidelines. We are not able to write based on our own capability. We use the Ministry's guidelines as our own needs. We tell the district that we need this kind of report and then they make that report for us. That is the kind of behavior we have created in our society.

4.3 The Computerization Process of Health Information Systems: Case Study From Mozambique

The national paper-based HIS (called *SIS* in Portuguese) in Mozambique was established in 1979 to cover all the levels of the national health services. Originally, the system was composed of 60 data collection forms which were later reduced by authorities at the Ministry of Health to 12 to integrate and handle health data specific for:

- Immunization and mother and child health programs
- Surveillance data
- Health activities, such as in- and outpatient treatment
- Crucial resources including drug management, infrastructure, human, equipment and beds

These items represent part of the universe of the activities of the different health programs and departments within the MoH for which information need to be systematically captured, analyzed and used. The remaining data needs, for example, reporting for Malaria, HIV/AIDS, and tuberculosis are historically undertaken through autonomous vertical health programs. The *SIS* is partly provincial and partly centrally operated, following vertical lines of the various departments and divisions, all relying significantly on donors for support.

With a vision of developing a national conventional database to store integrated data, authorities in the MoH initiated the computerization process in 1992, without adequate coordination between various stakeholders. The aim was to automate most of the information transaction activities linked to the different health programs. The *SisProg* software was developed in-house as the first attempt towards these aims. However, in practice the *SisProg* software only managed to integrate data on the Immunization and Mother and Child Health programs, leading the managers responsible for other health programs to initiate their individual projects. This led to the creation of multiple systems, in different platforms, supported by different donors. This "spaghetti" of systems is depicted in Figure 2 below.

The Mozambican HIS, represented in Figure 2 is quite disintegrated. The health data is redundantly captured in the different computer systems; the outputs are also redundantly generated and sent through overlapping and strange information flows. For example, data on immunization once received is initially entered to *SisProg* software at the provincial level. On a monthly basis, two copies of the report are printed out and sent through two different channels, one to the provincial department of community health and the second to the department of health information (DHI) at the national level. In turn, the provincial department of community health re-enters the same data into a computer spreadsheet and subsequently sends it to the department of community health (DCH) also at the national level. Because both the DHI and DCH are located at the national level, this activity could be avoided and resources saved. Another quandary of the HIS is related to the fact that

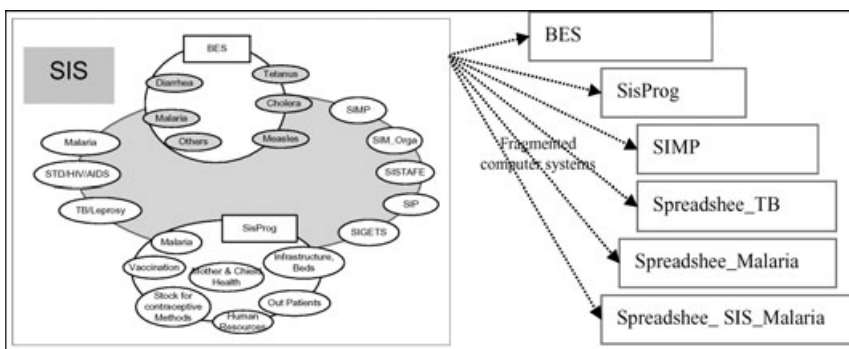


Figure 2 The SIS software and associated subsystems (see Table 2 for more details).

malaria data, for example, is processed in three different computer applications and thus not in an integrated way, namely SisProg, Malaria (vertical program), and BES, as shown in Figure 2.

The study has identified three major reasons which significantly contributed to the fragmentation of SIS: multiplicity of donor support, lack of institutional coordination, and lack of technical compatibility. These are now described.

4.3.1 Multiplicity of Donor Support. Since independence in 1975, the Mozambican health care sector has been heavily dependent on funding and technical support provided by multilateral funding agencies leading to a multiplicity of donor-supported systems. This is described by Batley (2002) as follows:

The [donors] have operational policies and procedural requirements that guide their engagement with partner countries [like Mozambique]. A major problem is that even where [donors] have similar objectives, their specific requirements can be different. As a result, donors and partner countries alike face administrative complexities that reduce development effectiveness (p. 1).

The Mozambican Minister of Health also criticized the fragmentation as follows:

MISAU³ was a “ministry of projects” rather than a Ministry of Health. This led to confusion. Officials lacked clear direction. They dealt with different donors and owed their loyalty to the donor, competing with each other to keep certain teams of individuals around certain projects, receiving differential and unknown top-ups from different donors (even now). The demands are on the few qualified staff to serve particular donors, to follow their routines, to ensure that the donors’ money goes to what the donor requires. (Minister of Health Songani, personal communication, June 11, 2002, as quoted in Batley, 2002)

The subsystems were designed without input from users and data elements were often hard coded requiring additional programming competence to make any changes. However, such competence was not available in the MoH, making it difficult to make modifications independently. The HIS department in the MoH has historically been understaffed, lacking in skills and having high work loads, making it problematic for employees to participate

³MISAU: Ministério da Saúde in Portuguese for Ministry of Health.

in the development efforts. The computer systems developed on different platforms with little attempts at integration were tailored by expatriates as technical solutions, adding to a complex and disparate installed base of the MoH. Absence of documentation and source code further magnified this state of fragmentation.

4.3.2 Lack of Technical Compatibility. The fragmentation of SIS has contributed to the absence of a national database, which, in turn, has led to the development of a number of ad hoc software solutions lacking technical compatibility (Piotti & Macome, 2004). Their lack of compatibility has also been acknowledged by the MoH, as expressed in their strategic plan:

... the importance of (1) integrating the various subsystems at central level, (2) bringing the financial management of the department at higher level, (3) strengthening the responsibility of the [various departments or health programs] to implement their [initiatives] in a coherent and integrated way, and (4) improving the coordination between all actors. (MoH, 2003)

While the value of integrating the existing subsystems has been realized by top management as an important step towards a sustainable SIS, changing the situation in practice is complex. Lack of compatibility is contributed to by systems' multiplicity of platforms (e.g., there are spreadsheets—Lotus, Excel; databases—dBASE, Clipper; and specialized software applications such as Epi-Info for statistical analysis). Applications exist without documentation, specifications, or source code or uniformity of data structures or reports generated. A lack of technical skills in the MoH means that these problems cannot be solved locally. Often the solution is to obtain donor assistance, which further contributes to delays or further fragmentation. The summary given in Table 2 below provides technical and functional details of some of the subsystems comprising SIS and the problems observed in their operation.

4.3.3 Lack of Institutional Cooperation. Individual managers heading different health programs try to guarantee their overall operations and planning and identify funding sources to keep the programs working. There is limited coordination between the different program managers on those efforts, and also between the donor agencies themselves. Each manager tends to take care of their own plan, without crosschecking the content and priorities of the other plans. The absence of an overall coordination instrument, such as an IT policy reference document, adds to the weak culture of information sharing and institutional cooperation.

Although the various subsystems were developed as departmental initiatives supported by donors and delegated to foreign experts (who could not converse properly in official or local languages to allow interaction with individuals in different levels of the MoH), their subsequent maintenance is attached to the HIS department. This department is expected to provide leadership, support, guidance, training, and assistance in the identification and solution of the emerging software and hardware problems in the MoH and in the 11 provincial health directorates where computers are installed. Some of the department's tasks include:

- Assemble acquired or donated new or old computers
- Provide advice to acquire new computers
- Install general use software such as MS-Office, Epinfo
- Install specific local health packages such as SIMP

TABLE 2. The Different Subsystems Platforms and Functions Comprising SIS

Legacy system and platform	Functional descriptions	Design problems
SisProg: dBASE/Clipper	First attempt to computerize SIS. Integrates only Mother and Child Health and Immunization programs and few data items for organizational unit infrastructure and personnel.	It fails to update infrastructure data. Does not allow the distinction between the entry '0' and unknown values '-'. Does not address the dynamic changes of the MoH: Old and locked technology.
BES: FoxPro	Weekly notification of the cases and deaths for malaria, measles, tetanus, meningitis, diarrhea, dysentery, cholera, poliomyelitis, sleep disease and rabies.	Computerized at the provincial and national levels. Does not address the dynamic changes of the MoH: Old and locked technology.
Spreadsheet for monthly notification of malaria cases for outpatients and inpatients, (SMNMOI): Excel	Malaria data is collected from all health facilities and aggregated by the district where it is compiled and sent to the province and then to the Malaria Programme at the national level.	Ad hoc solution. Tables with non-uniform data structure in the different provinces. Unique data structures, designed to support vertical flows.
SIS-based spreadsheet Excel or Lotus	Used for monthly malaria synopsis from rural hospitals. Data from inpatient wards including maternity, medicine, malaria, diarrhea.	Ad-hoc solution. Tables with nonuniform data structure in the different provinces.
Spreadsheet for tuberculosis (TB): Excel	The tuberculosis reports are sent only quarterly. The system reports the new cases, treatment failure, transfers and also the cases being submitted to a second chance of treatment.	Ad hoc solution. Unique data structures, designed to support vertical flows.
SIMP: Excel and Visual basic	Administer data from all health units on the services provided, patients attended and drugs. Deal with government budget and funds from donors.	Does not have functionality for data validation. Generates outputs mainly relevant for top managers and donors.
Epi-Info	Malaria, HIV	Not appropriate for primary health care (PHC).

Technical support interventions are request-based, whereby the unit with the problem communicates it through available channels (phone, fax, or through someone going to the capital, Maputo). The solution to the problem reported may involve travel and payment of per diems for the technical staff of the HIS department. Normally, an immediate intervention is expected, but in practice it is not the case because the provision of financial resources follows a bureaucratic, time-consuming, and inflexible procedure. Because of the centralized structure of the user support schema, the HIS department is very busy most of the time, understaffed, and incapable of addressing the multiple requests coming from various sources nationally. Furthermore, user support is not a once-and-for-all activity and ongoing problems require continuous support that is not forthcoming. In the absence of a timely response from

TABLE 3. Comparative Summary of SIS in Mozambique and MTUHA in Tanzania

Item/HIS	SIS in Mozambique	MTUHA system in Tanzania
Purpose	Handle and integrate data for all departments of the MoH.	Integration of vertical program. Increase performance of HIS.
Inception	1992	1992–1997, 1998–
Actual status of use	Most subsystems are used fairly, e.g., SisProg and SIMP. Discussions taking place to develop an NHIS.	Limited use (e.g., data entry only at the regional level) and recommended for replacement (MoH, 2002).
Approach to development	Top-down, ad hoc, and foreign experts driven. In-house development involving foreign national employed at the health department.	Top-down and donor-driven. Developer-driven design and development.
Role of MoH	Overall control and coordination of activities related to multiple solutions of HIS. Continuous support of multiple solutions.	Technical support and maintenance after initial implementation. Manpower development. User training and evaluation. Supporting and financing the MTUHA after the initial implementation (assumed).
Role of the donor	Expert knowledge and consultancy. Ad hoc funding.	Short-term financial support during the first development cycle only.
System design characteristics	Most subsystems are not flexible, thus not evolving along with changing needs of the MoH. Multiple and not completely developed subsystems. Most subsystems have no source code available due to hardware failures and unavailability of the prospective developer.	Not evolving along with changing needs of the MoH. Vertical program managers do not trust the MTUHA system. Not completely developed whereas further development continuously requires donors support. Source code retained by Developer III for financial gain.

the HIS department, the units with problems either appeal to private services (locally or in Maputo), if they have the resources to pay for this, or simply stop using the software or hardware.

4.3.4 Comparative Summary of the Two Cases. In Table 3, we present a summary of the two cases of Mozambique and Tanzania described in the previous section followed by the analysis and discussion in section 4. It summarizes the two cases, highlighting the approach used for the development of HIS and roles of the three key actors in the process.

5. ANALYSIS AND DISCUSSION

In this section, we analyze and discuss the role of the MoH as the user organization, donors as funding institutions, and developers as software development agencies and how their inter-relationships influence the sustainability of the HIS. Next, we provide some recommendations for developing sustainable HIS.

5.1 The MoH and Its Relationship With Donor Organizations

In analyzing the relationship between these two actors we have identified three sets of factors that led to unsustainability of HIS:

1. The weak institutional and technical capacity of the MoH.

While the MoH takes the technical and institutional responsibility of implementation, training, and support of HIS, technically, it does not have the capacity to do so. The implementation of the HIS once installed takes for granted the availability of skills and motivated users. In the Tanzanian case, for example, the end users at the regional level were only informed about the new system installation process and inadequate training was provided. As a result, there was a lack of ownership and the system was regarded as primarily serving the interests of the top managers and donors.

Institutionally, in the Mozambican case, most subsystems were built by different efforts of foreign developers within different departments of MoH. Lack of technical skills in the MoH coupled with the limited focus of foreign developers to promote local capacity contributed to systems failures after they left. The subsystems cannot exchange information easily and integrating them becomes a very challenging exercise that requires additional resources. The presence of a weak technical and institutional capacity implied that the MoH could not maintain the systems and accommodate dynamic changes taking place within the MoH.

2. Nature of contracts produced by the MoH to utilize donor support.

Normally, foreign experts or developers (consultants) are employed or contracted by the MoH and paid (exorbitant salaries) by donors on a short-term basis for the development of HIS. The contracts are often established not based on the expertise, experience, skills, or terms of reference, but rather on human resources that are available or recommended by the donors. This provides limited power to the MoH to exercise control over the experts once their contracts have been formalized, giving them the license to develop or impose software solutions already developed and implemented elsewhere.

For example, in the Mozambican case, the multiple individual consultants employed were foreign experts attached to the MoH on a short-term contract basis for setting up in-house HIS development within different departments. Unfortunately, there was no formal assessment of their background; thus, their experience, expertise, and skills were taken for granted.

3. The unbalanced influence exercised by donors over the MoH.

The relationship between the international agencies and the MoH represents an unbalanced relationship. While the common aim of both parties is to address HIS-related problems, the donors tend to exercise greater influence on major decisions, because they have the funds and are seen as IT experts with knowledge of the latest trends in IT. While the MoH representatives have institutional and administrative power, they are undermined by their own lack of managerial and technical skills. As a result, HIS initiation and development (as seen in both Mozambique and Tanzania) is typically driven by the donors' perspective, while the MoH plays essentially a political and symbolic role. Similarly, there are distinct asymmetries in the relation between the top levels of the MoH and the peripheral-level field workers, who do

not have a voice in the design, development, and implementation of the system. This further contributes to unsustainability.

5.2 The Relationship Between the Ministry of Health and Software Development Agencies

We have also identified three sets of factors that contribute to unsustainability of a HIS arising from the relationship between the MoH and software development agencies:

1. Lack of coordination of software development efforts.
The development of the different subsystems by different foreign experts within different departments of the MoH in Mozambique was a result of a lack of coordination leading to fragmentation. Likewise, in Tanzania, the MoH had no skills to influence the development process, apart from endorsing payment for the developers without understanding the quality of the work accomplished. The MoH only provided the HIS systems requirements and the software development agency or consultancy who delivered back a ready-to-use software. The computerization process was organized as a unidirectional communication. In this case, coordination was not foreseen and as a result, the developer retained the source code for financial gain, leaving the MoH without an alternative to control further the development process. This suggested that the MoH had to continuously depend on the same agency and look for additional funds to support and extend the system.
2. Poor and inadequate understanding of user requirements.
The development of HIS in Tanzania and Mozambique aimed to include the computerization of all useful data elements reported from the peripheral to the national level. However, the developers only analyzed partial requirements of a few top managers without including the requirements of vertical program managers and users at the peripheral level. Moreover, in the Mozambican case, the foreign experts were not familiar with local or national official languages (e.g., Portuguese in Mozambique) and conversed in English or a makeshift local language. Thus, the lack of participation of the actual users of the systems and lack of understanding of the contexts led to the development of a very incomplete understanding of local needs and problems.
The lack of capability of the MoH to the rather ad hoc manner, in which donors deputed experts in the two countries and the exclusion of users, meant that the professional skills deployed in the development of HIS were limited and top-down.
3. Rigidity in design efforts.
Systems developed in both cases reflect a lack of design flexibility with poor organizational control over the source code and systematic support of users. In Mozambique, for example, most systems were technically incompatible and hard coded, built by different experts using different technological solutions within different departments of the MoH. This design constraint means that the systems could not accommodate the dynamic changes and emerging needs of various programs. The subsystems in Mozambique were institutionalized within the individual departments and they were seen as convenient to create room for continued exercise of power and to gain multiple funding. However, these systems were not effective in terms of generating output for organizational benefits or possessing the flexibility to adapt to new changes.

5.3 Towards the Development of a Unified and Sustainable Health Information System: Some Implications

Less-developed economies such as Mozambique and Tanzania do not necessarily lack the technology, but rather the capability to support and sustain it over time. Different shortcomings contribute to this situation, and can be summarized as a general failure to institutionalize effective technology. Institutionalizing the technology is a necessary condition but not sufficient because several other questions need to be asked as to what is actually institutionalized and why. The answer to these questions is not trivial and requires a deep analysis and understanding of the organizational politics and management interests towards the technological solution in use, in addition to technical capacity to shape its effectiveness and flexibility.

Three key strategies for dealing with the problem of unsustainability are now described:

1. Integration of health information systems.

The weak institutional capacity in LDEs can be enhanced by rationalizing the use of resources through a unification of the multiple and parallel subsystems. However, a unified HIS approach cannot be achieved overnight, and requires a long-term commitment of the interested actors (local, national, and international). However, integration should not to be considered as a technical issue only (Chilundo & Aanestad, 2003, 2004) but one that requires an alignment of various political interests through negotiations (Dickson, 1974). The alignment of interests of at least three sets of actors (MoH, developers, and donors) is crucial to action the integration process.

As illustrated in the two cases, systems cannot be institutionalized to become sustainable unless key actors are involved and their needs are addressed. Thus, the development of an effective and flexible HIS calls for participation of users at various levels, clear determination of their needs, and proper grasp of the context of use. The users, having the domain knowledge, will inform the development process in terms of organizational priorities and needs over time. This suggests an iterative and incremental development approach to guarantee the required flexibility (Jacobson, Booch, & Rumbaugh, 1999).

2. Local shaping of new cultures.

The introduction of new systems is often accompanied with new forms of cultures (Heeks, 2002b; Walsham, 2001), which may collide with the local ways of doing things related to the use of local languages, presence of hierarchy, and power relations.

The introduction of new cultures involves participation of the locals in shaping their own ways of doing things while increasing feedback to their actions and linking information with actions so that the locals can realize the benefits of the new technology. For example, the “top-down” culture whereby the systems are enforced by the power of managers rather than organizational benefits is a “bad culture” and thus needs to be changed. However, the change needs to be regarded as a learning process and be adaptable to promote local control, and motivation for change (Alvesson, 2002).

Local control is not possible without the appropriate capacity necessary to extend and exploit the HIS and to engage in effective participation (Braa & Blobel, 2003). Building technical and managerial skills is as a major priority for dealing with the complexities of technology use (Oyomno, 1996). This calls for a strategy to enhance or expand the existing human resource capacity to engage in HIS development over time. The local initiatives complimented by external support need to play significant roles in

the acquisition and allocation of training resources and in the overall implementation of the human resource development strategy. Enrolling the users of the HIS in the development team (Bostrom & Heinen 1977; Mumford, 1983) ensures ownership, local control, and learning by interacting with developers to gain the knowledge necessary to sustain the HIS.

3. A cultivation approach to system development.

Systems with rigid design get institutionalized but consequently fail to evolve along with the constantly changing needs of the MoH. A cultivation approach suggests a shift from the design of systems to a cultivation of networks and infrastructures. The design of systems is associated with the assumption that systems are isolated entities and it is thus possible to specify them completely and design them to solve specific organizational needs. On the contrary, cultivation suggests that an installed base (as represented by the multiple systems in Mozambique) is not a dead artifact because it involves an existing network of users and legacy technology (Hanseth, 2002; Hanseth & Aanestad, 2003). So the shift from single-system focus to networks requires an information infrastructure perspective that takes into consideration multiple actors and the installed base—both technical and institutional.

6. CONCLUSION

In this article, we have tried to develop a theoretically informed empirical understanding of the problem of unsustainability of HIS in LDEs and how these can be addressed. Three key strategies have been discussed. Generally, we argue for development of appropriate and flexible systems, participation of the locals in shaping their own ways of doing things and proper grasp of the context of systems use, appropriate donor and institutional policies for action that will result in a better response to the organizational needs and management of scarce resources in LDEs.

The challenge faced concerned the donors' influence in shaping the technology development process and thus de-emphasizing the role of the local organization. The focus on participation and alignment of key actors into a network may create the necessary knowledge and resources to make the HIS sustainable. However, the local organization needs to drive this process with support and collaboration of other actors.

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8.13. APPENDIX M

Questionnaire on ICT capacity.

UNIVERSIDADE EDUARDO MONDLANE

TRABALHO DE PESQUISA CONJUNTA

Questionário para o Inquérito sobre o USO DE COMPUTADORES

Este questionário tem como objectivo a obtenção de uma ideia sobre O USO DO COMPUTADOR nas instituições de SAÚDE (e outras instituições) na província de GAZA e INHAMBANE. Estamos focalizando a nossa atenção nos meios de comunicação entre a Capital, as Províncias, Distritos e as Localidades. Nós estamos particularmente interessados no Sistema de Informação para a saúde. Não existem Respostas certas nem erradas: Nós pretendemos recolher as impressões existentes sobre as questões colocadas, e todas as respostas são **ESTRITAMENTE CONFIDENCIAIS**.

Número do Questionário –QUESNUM:

0. IDENTIFICAÇÃO:

- 01. Província _____
- 02. Distrito _____
- 03. Localidade _____
- 04. Sector/ Departamento _____

Código

POS. Qual é a sua posição?	
ASERV. Anos de Serviço	
NIV_ACAD. Nível académico. Assinale com um círculo a resposta.	<ul style="list-style-type: none"> 1. Nenhum 2. Nível Básico 3. Nível Médio 4. Nível Superior 5. Outro

A. O COMPUTADOR:

	1. Sim	2. Não	3. Não Sei
A.1. Você tem acesso ao computador			
A.2. Que tipos de computadores existem na instituição:			
	# de anos	# de meses	
A.2.1. Diga há quanto tempo a sua instituição possui computadores?			
A.3. Indique a modalidade de aquisição do/s computador(e)s:	<ul style="list-style-type: none"> 5. Oferta 2. Empréstimo 3. Compra 4. Aluguer 5. Outro 		
A.4. Você tem Impressora/s?	1. Sim	2. Não	3. Não Sei

B. PROBLEMAS

B.1. Que problemas tem com o equipamento?	Indicar # de Meses	1. Sim	2. Não	3. Não Sei
B.1.1. Não funciona?				
B.1.2. Trabalha parcialmente/ faltam de peças?				
B.1.3. A impressora não funciona por falta de papel/tinta?				

Assinale com X a resposta apropriada	1. Sim	2. Não	3. Não Sei
B.3. A falta de capacidade de treinamento é um problema?			
B.4. A maior parte do Software está em Inglês e isso constitui problema?			
B.5. A falta de acesso ao computador Constitui um problema?			
B.6. Tem sido um problema a reparação e manutenção do equipamento?			
B.7. Especifique outros problemas:			

C. MANUTENÇÃO E COLABORAÇÃO LOCAL

C.1. Existem na Província Empresas que providenciam os serviços de Manutenção?	1. Sim	2. Não	3. Não Sei
C.2. Você colabora/ tem tido assistências numa empresa de computadores da Província?			
C.3. Onde você normalmente recebe apoio, para a superação dos problemas relacionados computador?	1. Sim	2. Não	3. Não Sei
C.3.1. Duma empresa de informática da Província?			
C.3.2. De amigos da Província?			
C.3.3. Da capital do País?			
C.3.4. Duma empresa da capital provincial			
C.3.5. Outras facilidades:			

C.4. Quanto tempo demora para obter peças sobressalentes	# Dias	# Semanas	# Meses

C.5. Onde você toma conhecimento sobre novos programas ou obtém cópias do software adicional, tais como programas de Antivírus?	1. Sim	2. Não	3. Não Sei
C.5.1. Através numa empresa de computadores do distrito?			
C.5.2. Através doutros utilizadores de computadores no Distrito?			
C.5.3. Através de amigos no Distrito?			
C.5.4. Através da Capital ?			
C.5.5. Através de empresas de computadores da capital?			

C.5.6. Outras fontes: (especifique):

C.6. Quantos utilizadores de computadores existem nesta instituição? Indicar o número

C.7. Até que ponto tem colaborado com outras instituições/ Individualidades?	1. Sim	2. Não	3. Não sei
C.7.1. Aprendem um do outro?			
C.7.2. Permutam novo software?			
C.7.3. Solucionam problemas típicos de software e/ou hardware?			
C.7.4. Outros (especifique):			

Em cada um dos casos escolhe a resposta apropriada indicando com um X:	1. Sim	2. Não	3. Não sei
C.9. É muito popular aqui trabalhar com o computador?			
C.10. Considera trabalhar com o computador um meio de elevar o nível da carreira profissional?			
C.11. Considera que o uso de computador é visto como uma função de baixo nível?			
C.12. Considera que o uso de computador é Visto como função de prestígio?			

D. O USO DO COMPUTADOR

D.1. Com que intensidade você usa o computador? (escolhe a resposta indicando com um círculo)

1. mais do que 3 vezes / semana	2. Todas as semanas	Todos os dias	3. Todos os meses	4. Duma forma irregular	5. Nunca
------------------------------------	---------------------	---------------	-------------------	-------------------------	----------

D.2. Indique para quais dos seguintes fins você usa o Computador:	1. Sim	2. Não	3. Não Sei
D.2.1. Para Introdução de Dados?			
D.2.2. Para Análise de dados?			
D.2.3. Para Geração de relatórios?			
D.2.4. Para Produção de gráficos?			
D.2.5. Para Processamento textos?			
D.2.6. Para Produção programas financeiros?			
D.2.7. Outros:			

D.3. Você usa a informação processada e produzida pelo computador?	1. Sim	2. Não	3. Não Sei

D.4. Que tipo de informação(especifique)? _____

—
D.5. Para que Propósitos? (especifique): _____
—

D.5. Quem mais usa a informação obtido do computador?		
D.5.1 Quem/ Posição?	D.5.2. Que informação	D.5.3. Para que propósito?

E. TREINAMENTO/ FORMAÇÃO

E.1. Como é que você aprendeu a usar o computador?	1. Aprendi num curso 2. Aprendi através de colegas 3. Através de Livros e Revistas 4. Sozinho
--	--

E.2.. Você precisa de treinamento?	1. Sim	2. Não	3. Não Sei
E.2.1. Especifique as suas necessidades em treinamento:			

E.3.. Existem necessidades em treinamento na sua instituição?	1. Sim	2. Não	3. Não Sei
E.3.1 Especifique essas necessidades em treinamento:			

E.4. Existe algum plano de treinamento na sua instituição?	1. Sim	2. Não	3. Não Sei
E.4.1. Especifique em que consiste o plano:			

E.5. Foi alguma vez organizado um treinamento em computadores na s/ instituição?	1. Sim	2. Não	3. Não Sei
E.5.1. Quantas pessoas participaram no curso?			
E.5.2. Especifique o tipo de curso/s:			

F. PROGRAMAS DO UTILIZADOR

F.1. Que programas você usa na sua instituição?

- 1.
- 2.
- 3.
- 4.
- 5.

F.2. Existem Manuais de utilizador?	1. Sim	2. Não	3. Não Sei
F.3. Para a exploração do software			
F.3.1. Para a exploração do hardware?			
F.3.2. Os manuais são acessíveis?			
F.3.3. Tem precisado de formação?			
F.3.4. Tem recebido ajuda/ apoio e suporte?			
F.3.5. Sido necessário fazer ajustamentos para as necessidades locais?			

G. COMUNICAÇÕES

G.1. Que meios de comunicação você usa no seu trabalho?	1. Sim	2. Não	3. Não Sei
G.1.1. Telefone?			
G.1.2. Fax?			
G.1.3. Cartas pelo correio?			
G.1.4. Cartas entregues a pessoas que vão para o mesmo caminho?			
G.1.5. Estafetas			
G.1.6. E-mail ?			
G.1.7. Outros meios (especifique):			

G.2. Você tem problemas de comunicação com o centro?	1. Sim	2. Não	3. Não Sei
G.2.1. Telefone é fiável?			
G.2.2. Fax é viável?			
G.2.3. Falta transporte?			
G.2.4. Correio é fiável?			
G.2.5. Cartas do correio são caras?			
G.2.6. Outros problemas:			

G.3. Como se comunica com as Províncias? (Ou com o nível abaixo)?	1. Sim	2. Não	3. Não Sei
G.3.1. Por Telefone?			
G.3.2. Cartas do correio?			
G.3.3. Cartas entregues à pessoas que vão para o mesmo destino?			
G.3.4. Estafetas?			
G.3.5. Outros (especifique):			

G.4. Você tem tido problemas de comunicação com os Distritos (ou um nível abaixo)?	1. Sim	2. Não	3. Não Sei
G.4.1. Telefone não é fiável?			
G.4.2. Falta de transporte?			
G.4.3. Correio não é fiável?			
G.4.4. Via Rádio não é fiável?			
G.4.5. Correio é caro?			
G.4.6. Outros:			

K. PROGRAMAS DE USOS LOCAL E FUTURAS NECESSIDADES

K.1. Você produziu algum programa para uso local?	1. Sim	2. Não	3. não Sei
K.1.1. Indique o propósito e o tipo? Especifique:			
K.1.2. Que software? Spreadsheet/ Programa de base de dados/ outros Especifique:			
K.1.3. Que faz o programa?			
K.2. Você precisa de programas de uso local?	1. Sim	2. Não	3. Não sei
K.3. Necessidades Futuras - Para que propósitos você gostaria usar o computador?			

K.4. Você precisa de programador/res?	1. Sim	2. Não	3. Não Sei
K.5. Você precisa de mais software?			
K.6. Você tem recebido solicitações de informações ou análises Especiais?			
K.6.1. De Quem?	1. Do Centro	2. Do nível superior	
K.6.2. Qual a informação solicitada? Especifique:			
K.6.2.1. Com que frequência essa informação é solicitada?	1. Constantemente 2. Mensalmente 3. Todos os dias 4. Duma forma irregular		

L. SUGESTÕES:

L.1. Como é que o uso de computadores pode ser mais efectivo? (ex. Melhor acesso, mais formação, bons programas, etc.). Especifique.

NOME DO ENTREVISTADOR: _____

DATA DA ENTREVISTA: ____/____/____

MUITO OBRIGADO

8.14. APPENDIX N

Questionnaire on use of Information.

UNIVERSIDADE EDUARDO MONDLANE
Questionário para o Inquérito sobre o Sistema de Gestão de Informação para a Saúde

Este questionário tem como objectivo a obtenção de uma ideia sobre que tipo de dados a instituição coleciona e com que fim (o que é feito com eles). Não existem Respostas certas nem erradas: Nós pretendemos recolher as impressões existentes sobre o que está acontecendo com os dados, e todas as respostas são **ESTRITAMENTE CONFIDENCIAIS**.

Questionário Número-QESNUM:

6. IDENTIFICAÇÃO

01. Província _____	Código
02. Distrito _____	
03. Localidade _____	
04. Sector/ Departamento _____	

POS. Qual é a sua posição?	
ASERV. Anos de Serviço	
NIV_ACAD. Nível académico	7. Nenhum 8. Ensino Básico 9. Ensino Médio 10. Ensino Superior 11. Outro

A. TEMPO DE USO (estimativas aproximadas)

A1. Para as perguntas seguintes diga QUANTO TEMPO , você leva para colher os dados, fazer o registo e elaborar o relatório.	1. Sim	2. Não
A.1.1. Todos os dias?		
A.1.2. No fim de cada semana?		
A.1.3. No fim de cada mês?		
A.1.4. Princípios de cada mês?		
A.1.5. Trimestralmente?		
A.1.6. Anualmente?		

A.2. Quanto Dias são gastos na análise dos dados / cálculo dos indicadores, etc?	1. Sim	2. Não
A.2.1. Todos os dias		
A.2.2. No fim de cada semana		
A.2.3. No fim de cada mês		

B. A POPULAÇÃO ALVO

B.1.1. Você tem uma área de saúde definida? Indique com um X	1. Sim	2. Não	3. Não sei
B.1.2. Qual é o NÚMERO TOTAL de pessoas que você serve?			
B.1.3. Donde vem esse número? Indique, marcando com um círculo, a fonte mais comum.	1. É uma estimativa somente 2. Atravéz de inquéritos 3. Atravéz de registos periódicos 4. Censo populacional/ Administração		

B.2. Você conhece o número de pessoas nos seguintes grupos?	1.Sim	2. Não	Indicar o # aproximado
B.2.1. Crianças de 0 a 1 ano de idade?			
B.2.2. Crianças de 1 a 5 anos de idade?			
B.2.3. Mulheres Grávidas?			
B.2.4. Número de Partos?			
B.2.5. Número de Mulheres com Idade Fértil?			
B.2.6. Número de crianças em idade Escolar?			
B.2.7. Número de crianças VACINADAS ?			
B.2.8. Número de casos de TUBERCULOSE ?			
B.2.9. Outros			

C: SISTEMAS DE INFORMAÇÃO

Marque com X o lugar apropriado	1. Sim	2. Não	3. Não sei
C.1.1 Você mantém/ Recebe informação sobre as seguintes actividades?			
C.1.2. Doentes em ambulatórios/ consultas?			
C.1.3. Doentes internados?			
C.1.4. Consultas Pré-Natal?			
C.1.5. Imunizações?			
C.1.6. Busca activa de doentes que abandonaram o tratamento?			
C.1.7. Actividades da saúde comunitária/ Actividades móveis, Matronas, Activistas,			
C.1.8. Morbilidade de crianças entre 0-1 ano			
C.1.9. Morbilidade de crianças entre 1-5 anos			
C.1.10. Doenças de Notificação Obrigatória?			
C.1.11. Outra (especifique):			

C.2. Asinale com um X o lugar apropriado, nas seguintes questões:	1. Sim	2. Não	3. Não sei
C.2.1. Você faz análise dos dados para o uso ao seu nível?			
C.2.2. Tabelas			
C.2.3. Gráficos ou eixos (gráficos circulares, etc)			
C.2.4. Indicadores de saúde?			
C.2.5. Análise usada em relatórios?			
C.2.6. Outros (especifique):			

C.2.7. Você considera que a informação é:	1. Sim	2. Não	3. Não sei
C.2.8. Facilmente disponível?			
C.2.9. Correcta?			
C.2.10. Completa?			
C.2.11. Forma uma discrepância entre os dados?			

C.3. Indique com X no lugar apropriado	1. Sim	2. Não	3. Não sei
C.3.1. Você usa essa informação no seu próprio trabalho?			
C.3.2. Como (explique):			

D. COMPUTADOR

D.1. Marque com X a resposta apropriada	1. Sim	2. Não	3. Não sei
D.1.1. A sua instituição tem computador(es)?			
D.1.2. Os dados que recolhem são introduzidos e guardados no computador na sua instituição?			
D.1.3. São introduzidos a nível Superior?			
D.1.4. Se sim, você tem algum benefício com isso?			
D.1.5. Como?			

D.1.6. Como o computador poderia auxiliar mais a sua instituição?			
D.1.7. A sua instituição necessita de computador(res)?			
D.1.8. Se sim, para que objectivos?			

E. FLUXO DE INFORMAÇÃO

E.1. O quê que você faz depois de preencher os formulários?	1. Sim	2. Não	3. No sei
E.1.1. Analisam localmente			
E.1.2. Preenchem e enviam			
E.1.3. Outros (especifique):			

E.1.4. Para onde você envia os formulários preenchidos? _____

E.2. O que você pensa que o nível Superior Faz:	1.Sim	2.Não
E.2.1. Analisa os formulários?		
E.2.2. Usa para a planificação?		
E.2.3. Usa para o relatório anual?		
E.2.4. Não usa para nada?		
E.2.5. Usa para outros fins?		

E.3. Como você recebe a informação Estatística Mensal do nível superior a tempo?	1. Sim	2. Não
E.3.1. Através de estafetas?		
E.3.2. Via rádio?		
E.3.3. Telefone?		
E.3.4. Através de pessoas que vêm para o mesmo caminho?		
E.3.5. Por E-mail?		
E.3.6. Outros meios (especifique):		

E.4. Como envia a informação estatística mensal para o seu nível hierarquicamente superior?	1. Sim	2. Não
E.4.1. Através de estafetas		
E.4.2. Via rádio		
E.4.3. Telefone		
E.4.4. Através de pessoas que vão para o mesmo destino		
E.4.5. Por correio electrónico (E-mail)		
E.4.6. Outros meios (especifique)		
E.5. Você consegue enviar as estatísticas mensais a tempo?		
E.6. Você tem tido problemas em apresentar relatórios/ enviar informação para o nível superior?		
Se sim indique quais são as causas assinalando com X:	1. Sim	2. Não
E.6.1. Estafetas não são fiáveis?		
E.6.2. Via rádio não é fiável		
E.6.3. Telefone não é fiável		
E.6.4. Através de pessoas que vão para o mesmo caminho não é fiável?		
E.6.5. O Correio é muito caro?		
E.6.6. O correio não é fiável?		

F. RETROINFORMAÇÃO

F1. Você tem recebido FEEDBACK dos resultados que você envia para os seus superiores?	1. Sim	2. Não	3. Não sei
F2. Com que frequência? (marque com	1. Mensalmente		

um CÍRCULO a resposta apropriada)	2. Trimestralmente
	3. Semestralmente
	4. Anualmente

G. ESTADO DE SAÚDE

Assinale com X o lugar apropriado	1. Sim	2. Não	Indique o valor aproximado
G.1. Você conhece o estado de saúde da sua população Alvo?			
G.2. Taxa de mortalidade infantil de 0 a 1 ano?			
G.3. Taxa de mortalidade infantil de 1 a 5 anos?			
G.4. Taxa de mortalidade materna?			
G.5. Taxa de fertilidade?			
G.6. Taxa de desemprego?			
G.7. Outros (especifique):			
G8. Onde vem essa informação?			

I. PROBLEMAS PRIORITÁRIOS

I. Quais são os maiores problemas de saúde da população da sua área de saúde ? (marque com X a/s resposta/s apropriada/s)	1. Sim	2. Não	3. Não sei
I1. Aumento do número de crianças com baixo peso?			
I2. Doenças respiratórias?			
I3. Alta Taxa de Mortalidade Materna?			
I4. Alta Taxa de Mortalidade Infantil?			
I5. Alta taxa de famílias pobres?			
I6. Falta de água potável?			
I7. Falta de serviços de transporte?			
I8. Malária			
I9. Outros? (especifique)			
I10. Como obteve essa informação?			

J. METAS E INDICADORES

J.1.1. Você tem alguma Meta que pretende atingir?	1. Sim	2. Não	3. Não sei	
J.1.2. Você conhece outras Metas da Instituição/ Programa?				
J.1.2.1. Se SIM Especifique:				
J.1.3. Você ou a instituição está a usar os dados ou informação para o cálculo de Indicadores , na tentativa de atingir as METAS ?	1. Sim	2. Não	3. Não sei	
J.1.4. Especifique				
INFORMAÇÃO:	META:			
1.				
2.				
3.				
4.				
M.4. você Conhece os seguintes indicadores?	1. Sim	2. Não	3. Não sei	Indique a %
M.4.1. Crianças com idades entre 0-16 anos a serem totalmente imunizadas?				
M.4.2. Casos de ANC (anemia) Com factores de risco?				
M.4.3. Crianças que não ganham peso?				

K. VISÃO/ PLANOS

K.1. Existe algum Plano de Acção para a Instituição?	1. Sim	2. Não	3. Não sei

K.2. Quem elaborou?	12. Participei pessoalmente 13. Foi elaborado pela instituição 14. Não sei 15. Outros			
K.3. Você usa os dados locais para elaborar o plano de acção?		1. Sim	2. Não	3. Não sei
K.3.1. Explique:				
K.4. Onde você poderá obter o Plano de Acção? Escolhe uma das opções indicando com um Círculo no número apropriado.		1. Pessoalmente	2. Através do chefe da instituição	3. A nível superior
		4. Não sei		

L. ACESSIBILIDADE

	1. Sim	2. Não	3. Não sei
L.1. Existem facilidades suficientes para servir a população?			
L.2. Como é que a maioria dos doentes se desloca ao encontro de tais facilidades?	1. A pé		
	2. De cavalo		
	3. Caro dos correios ou de autocarro		
	4. De ambulância		
	5. Outro		
	6. Não sei		
	Indicar a percentagem (%)	Se não sabe marque aqui com X	
L.3. Qual é a proporção da população que vive à 5 Km da Instituição sanitária?			

L.4. Quanto tempo em média, os doentes levam para chegar à esta instituição sanitária?

1. 0-30 minutos	
2. 30-60 minutos	
3. 1-2 horas	
4. 2-3 horas	
5. mais de 3 horas	

L.5. Quanto tempo em média, os doentes ficam a espera antes de ser atendido?

1. 0-30 minutos	
2. 30-60 minutos	
3. 1-2 horas	
4. 2-3 horas	
5. mais de 3 horas	

M. QUALIDADE E COBERTURA

M.1. O que entende por cobertura? _____

	1. Sim	2. Não	3. Não sei
M.2.1. Você usa os cálculos sobre cobertura para avaliar a qualidade dos serviços tais com:			
M.2.2. Parto nos hospitais?			
M.2.3. Controle infantil (0 até 1 ano)			
M.2.4. Vacinação completa de crianças até 5 anos?			
M.2.5. Controle de gravidez até ao sétimo mês?			

M.3. você tem algum guia ou protocolo sobre:	1. Sim	2. Não	3. Não sei
M.3.1. Coleção de dados?			
M.3.2. Diagnósticos?			
M.3.3. Tratamentos?			
M.3.4. Procedimentos?			
M.3.5. Outros (especifique):			

N. FERRAMENTAS E FORMAS DE COLECTA DE DADOS

Você usa as seguintes formas/ ferramentas na colecta diária de dados?	1. Sim	2. Não	3. Não sei
N1. Tally sheets?			
N2. Registos?			
N3. relatórios?			
N4. Gráficos?			
N5. Mapas?			
Outros (especifique)			

O. TREINAMENTO

	1.Sim	2. Não	3. Não sei
O1. Você teve alguma formação sobre o uso da informação? Se sim, indique o tipo de formação:			
O2. Uso de informação (indicadores)?			
O3. Formação no uso de computadores?			
O4. Análise de dados?			
O5. Outro (especifique)			
O1.1. Você tem termos de referência do seu trabalho?			
O1.2. Os termos de referência especificam o uso de informação como uma tarefa?			

P. TRABALHO EM EQUIPE/ SUPERVISÃO

	1.Sim	2.Não	3, Não sei
P1. Você alguma vez teve reuniões com as pessoas com quem trabalha?			
P2. Alguma vez se discutiu sobre os dados colectados nessas reuniões?			
P3. Quantas visitas de apoio você recebeu, nos últimos três meses:	Indicar o número de visitas		
P3.1. Do Pessoal da capital Provincial?			
P3.2. Do Ministério da Saúde?			
P4. Alguma vez eles discutiram os dados que vocês recolhem?			
P5. Você supervisa os mais novos?			
P6. Você alguma vez perguntou a eles sobre os dados recolhidos?			
P6. Descreve			

Q. COMENTÁRIOS

Q1. Que lacunas acha que existem entre a informação que **POSSUI** e a informação que **PRECISA**?

Q2. Por favor especifique as áreas onde você precisa de **MAIS** informação:

1. _____

2. _____

3. _____

4. _____

Q3. Como é que o **SISTEMA DE INFORMAÇÃO** e o uso de informação podem ser melhorados?

1. _____

2. _____

3. _____

4. _____

NOME DO ENTREVISTADOR: _____

DATA DA ENTREVISTA: _____/_____/_____

MUITO OBRIGADO

8.15. APPEDINX O

Questionnaire on design, development and support of HIS.

Questionnaire Prepared by Nhampossa and Kimaro (2003)

Health information system development

<u>Date and time:</u>		Place:	
Position:			
#	Question		
1	What was the purpose of the project?		
2	What were the expected outcomes		
3	Who were the target end-users		
4	Who were involved in defining the purpose of the project? Donors? Consultants? Managers?		
1	How end users were involved?		
2	What role did you play in this process?		
3	How was the decision on functionality, user interface design and development platform taken?		
4	Who were involved in the design process and what were their roles?		
5	How long was the design process?		
1	What kind of development approach was followed and who proposed it?		
2	What were the criteria for selecting the developer?		
3	Who were involved in the development process and what were their roles?		
4	How long was the development?		
5	What was the mode of payment? Deliverable dependent, by installments or completion-dependent?		
6	Was the system evaluated or tested?		
7	If yes how? Before or after delivery and by whom?		
1	How was the appropriateness of the system tested before implementation and who tested?		
2	To whom the system was delivered, when and how?		
3	Who were involved in the implementation process and what were their roles?		
4	What was the rolling out strategy?		
5	How long was the implementation process?		
1	Was any training conducted before the implementation?		
2	Who were involved in the training process and what were their roles?		
3	How the top managers were trained?		
4	How many training cycles were conducted after implementation?		
5	What were the criteria for selecting of trainees?		
6	What was the purpose of training?		
7	What was the background or position of the trainees?		
8	How many trainees or trainers per unit were involved?		
9	Where the training was conducted and how was it organized?		
10	Do you need more training?		
1	Does the system satisfy the needs of the MoH? (or of your work)		
2	How effective is the data handling process?		
3	Is the system output reliable for making decision?		
4	Is the system easy to install, understand and use?		
5	Is there any documentation or user manual available?		
6	Is the system free of bugs or errors? If yes what kind of bugs are generated?		
7	How often do you use the system and for what purpose?		
8	What factors contribute negatively to the use of the system?		
1	Is there any user support?		
2	Who provides support? MoH or developer?		
3	Who provides technical support? E.g. Hardware or software?		

4	The support is on request or regular basis?		
5	How often the support is provided?		
6	What kind of support is provided to the users?		
7	How is this communication facilitated among top managers, lower-level users, developers and donors?		
8	Have you ever received feedback? How long did it take?		
9	What kind of feedback did you receive?		
10	What kind of problems you often face when using the system?		
11	To whom you report the problems?		
1	What were the sources of funding for design, coding, testing, implementation, and training?		
2	What was the role of the local government in funding the HIS?		
3	How long was the donor funding for design, coding, testing, implementation, and training?		
4	What were the sources of funds for maintenance and further development?		
5	How the donor funds were monitored or coordinated?		
6	How was the funds given to the MoH? As a full package or by installment?		
1	There is any plan to improve the system?		
2	If yes what is the plan?		
3	How the plan is going to be accomplished?		
4	What factors are likely to affect the plan and how do you intend to address them?		

