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.

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; Heaks, 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; Heaks, 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 on 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 km^2 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 km^2 (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

[1]The 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

[2]MTUHA: 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.

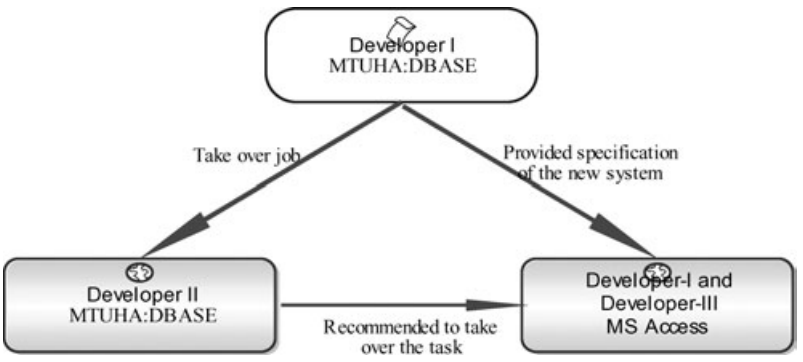

Figure 1 The relationship between the three developers (I, II, III).

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

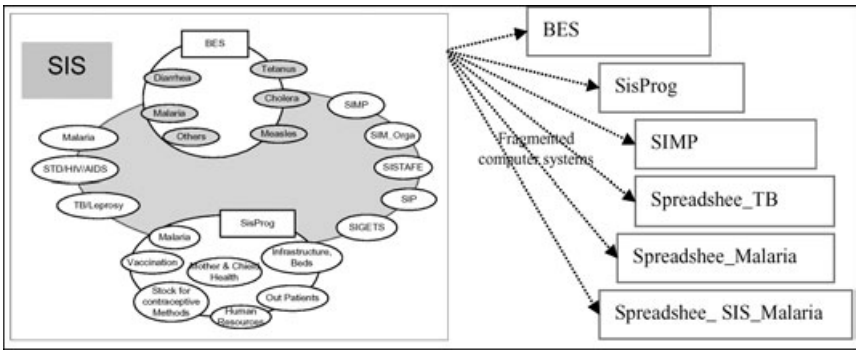

Figure 2 The SIS software and associated subsystems (see Table 2 for more details).

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:

> MISAU[3] 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

[3]MISAU: 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 unsustainably 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, & Rumbaug, 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 singlepsystem 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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