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Towards a sustainable framework for computer based health information systems (CHIS) for least developed countries (LDCs)

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Abstract

Purpose – The purpose of this paper is to argue for a theoretical framework by which development of computer based health information systems (CHIS) can be made sustainable. Health Management and promotion thrive on well-articulated CHIS. There are high levels of risk associated with the development of CHIS in the context of least developed countries (LDC), thereby making them unsustainable.

Design/methodology/approach – This paper is based largely on literature survey on health promotion and information systems.

Findings – The main factors accounting for the sustainability problem in less developed countries include poor infrastructure, inappropriate donor policies and strategies, poor infrastructure and inadequate human resource capacity. To counter these challenges and to ensure that CHIS deployment in LDCs is sustainable, it is proposed that the activities involved in the implementation of these systems be incorporated into organizational routines. This will ensure and secure the needed resources as well as the relevant support from all stakeholders of the system; on a continuous basis.

Originality/value – This paper sets out to look at the issue of CHIS sustainability in LDCs, theoretically explains the factors that account for the sustainability problem and develops a conceptual model based on theoretical literature and existing empirical findings.

Keywords Sustainable design, Health services, Information systems, Developing countries

Paper type General review

Introduction

The assurance of an efficient and effective health system seems a dream to most LDCs as compared to their counterparts in the developed world. Health indicators today, have deteriorated compared to the 1960s (ECA, 1999). Consequently this has put inordinate pressure on governments of LDCs, especially those in Africa, to invest substantial amounts of resources to increase accessibility to healthcare, train more health professionals, construct more health facilities and increase national capacity to conduct research (ECA, 1999). Despite these interventions, health indicators in most LDCs (especially in Africa) continue to deteriorate. For instance in Ghana, infant

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mortality continues to decline despite about 400 percent increase in government budget allocation to the health sector over the last three to four years.

It has been suggested that investments in computer based information systems (CHIS) in the health sector could substantially improve health indicators and assist in the development of an effective and efficient health sector (Mackenzie, 1999). CHIS has the prospect of creating the much needed opening for health managers to introduce improvements into the delivery of healthcare through planning and monitoring of health programmes and interventions as well as effective communication across the hierarchies of health organizations (Bhatnagar, 1992). The proponents of this view argue that the massive improvement in the delivery of healthcare in South Africa is as a result of the introduction and integration of CHIS in the delivery of healthcare (Braa and Hedberg, 2002). Robust computer based information systems have the potential to develop more successful social marketing programmes and generally allow health professionals to improve their service delivery capacities.

Several attempts by less developed economies such as those in Africa to improve their healthcare delivery systems through the use of computer based health information systems have proven unsustainable (Avgerou and Walsham, 2001). Apart from a few unusual cases like South Africa, there are numerous cases of several LDCs that have tried to implement CHIS but with little success (Braa and Hedberg, 2002). In Ghana for example, an appraisal of the information, monitoring and evaluation system of the health sector revealed among others, serious weaknesses such as:

- human resource constraints;
- absence of policy guidelines to implement new systems and improve on existing ones;
- weaknesses in management and service delivery systems; and
- the absence of corporate culture and internal marketing systems for use and dissemination of information.

Another study that confirms the unsustainable nature of CHIS implementation in most LDCs is that carried out by Kimaro and Nhampossa (2004). The study reviewed the implementation of CHIS in Tanzania and Mozambique. In the case of Mozambique, the system was described as a perfect example of a disintegrated system which captured data redundantly in different computer systems and generated output that are sent through overlapping and strange information flows. They adduced that, three reasons accounted for this state of affairs; multiplicity of donor support, lack of institutional coordination and lack of technical compatibility.

Whilst our case evidence of unsustainable CHIS might not be exhaustive, it is important to understand that there are many cases of unsustainable CHIS in Africa. However what is yet to be established is an explanation of the factors that account for this state of affairs. The aim of this paper therefore, is to conduct an appraisal of the problem of sustainability in the context of CHIS development and deployment and how routinization affects the sustainability of CHIS in less developed economies. Additionally, a theoretical model is developed, that is proposed to inform the development and implementation of computer-based health information systems in the health sector of less developed countries.

Boateng and Hinson (2007) have noted that in every research or academic study, literature review plays a very critical role. Adopting a literature survey approach in this theoretical paper as a methodology tool in understanding IS, internet or e-commerce research (from an LDC perspective) has precedence in the work of Hinson (2006) and Mutula (2005).

The study draws on the strengths of organizational theory to explain the role organizational routines play in the process of institutionalization and sustainability. Research findings on case studies on development and deployment of computer-based health information systems in LDCs will also be looked at in drawing conclusions and making judgments on CHIS development and deployment in LDCs

Sustainability

The concept of sustainability refers to the continuation of programmes (Shediac-Rizkallah and Bone, 1998). According to Scheirer (1993), a sustained programme or project is defined as a set of durable activities and resources aimed at program-related objectives. The health literature uses several synonyms for sustainability (see Bracht and Kingsbury, 1990; Bracht *et al.*, 1994; Goodman and Steckler, 1989; O'Loughlin *et al.*, 1998; Weisbrod *et al.*, 1992). Kimaro and Nhampossa (2004) refer to sustainability as the tendency of a system to endure over time and space and the ability of the system to become institutionalized.

Whichever way one defines sustainability, one thing is clear, the ability of an already existing system to last over a long time without necessarily having access to external support (Reynolds and Stinson, 1993). Korpela *et al.* (1998) suggest that the issue of external support is very crucial in defining sustainability of CHIS in the context of developing countries. As such, he defines it as the capacity of user organizations to control the risk that threatens the long term viability of information systems after the withdrawal of external support. The emphasis on the withdrawal of external support does not mean that sustainability should start with the withdrawal of external support. For CHIS to be sustainable it is imperative that the approach to development incorporate sustainability principles from start to finish; that is design through implementation till external support is withdrawn. This will ensure that the effect or benefits of the CHIS is maintained over a long period of time (Puska *et al.*, 1996) and illicit continuous support and participation of all stakeholders in the development and deployment of future projects of its kind (Goodman *et al.*, 1993; O'Loughlin *et al.*, 1998; Goodman and Steckler, 1989; Yin, 1979).

Factors affecting the sustainability of CHIS

Having defined sustainability and the need to identify and manage issues that contribute to the sustainability problem, it is important to highlight some critical issues that have been identified by researchers as contributing to the problem of CHIS sustainability. These include poor infrastructure, approach to systems development, inappropriate donor policies and strategies, uncoordinated donor efforts and human resource capacity issues.

Poor infrastructure

Poor technical and physical infrastructure is a major problem that confronts the implementation of information communication technologies (ICTs) generally in Africa.

The absence of appropriate hardware and networks (both local and wide area) coupled with poor physical infrastructure such as inefficient power supply and poor telecommunication systems have compounded the problems inherent in the implementation of ICT systems. Implementing CHIS to be used by different entities located in different geographic regions of a country in the light of the above conditions will be problematic (Kenny, 2000; Walsham, 1992).

Approach to systems development

One critical factor identified by the IS literature as accounting for the sustainability of computer based information systems is the approach to development. In most successful IS development programs, the approach has been bottom up (Cibulskis and Hiawalyer, 2002). Unfortunately for most developing countries (such as those in Africa), the approach has been top down with top officials of the sector ministry (Ministries of Health) and foreign experts being the sole decision makers and often side-lining employees at the lower levels of the organization and failing to address institutional and cultural variables all of which can have profound impact on sustainability (Okot-Uma, 1992; Walsham, 1992; Lippeveld *et al.*, 2000). This situation is more difficult where such foreign experts do not have a good understanding of national languages, local culture and processing requirements at the peripheral level (Kimaro and Nhampossa, 2004). Further, it is difficult to build local capacity for sustaining the system after the foreign experts have departed; therefore making the whole system unsustainable.

Inappropriate donor policies and strategies

Better health is seen as fundamental to the survival of the economies of most LDCs. Assisting in developing the health sector of LDCs has been the fixation of a multiplicity of donors. These donors usually have the objective of helping to improve healthcare either through direct participation or providing funding to supplement government's budgetary allocation to the sector. Unfortunately however, the funds provided by most of these donors are project-driven short-term funds, which do not factor into the whole funding mechanism policies that will ensure that such projects become sustainable after donor funds have been withdrawn (Heeks *et al.*, 2000; Heeks, 2002b; Baark and Heeks, 1999). It is important to note that the presence of a well thought out strategy that not only looks at how a donor funded project is completed, but also the means to continue with the project after donor funds have been withdrawn is critical to the project's sustainability. (Young and Hampshire, 2000). In the absence of such plans, a CHIS implemented, either at the district or the national level is destined to collapse after donor funds are withdrawn.

Uncoordinated donor efforts

Donors in most African countries or LDCs direct their effort at supporting interventions in specific disease areas, programmes or projects rather than a unified integrated approach to developing the health systems of the host countries. This creates a multiplicity of parallel and fragmented programmes funded by different donors in all sectors of the health system. However, while fragmentation and parallel implementation is not ideal the uncoordinated and disorganized manner in which these programmes are implemented is problematic (Lippeveld *et al.*, 2000). This leads to a

multiplicity of systems working parallel to each other and creating a problem of standardization of outputs (Chilundo and Aanestad, 2003).

Human resource capacity

One of the critical issues facing Africa's development is the issue of numbers and the right mix of skills in various sectors of the economy including health. In the area of ICT, the situation is utterly horrendous (Walsham *et al.*, 1988) and further exacerbated with the ever increasing rate of attrition of health professionals to the western world. Thus the requisite pool and skill portfolio needed to develop the technical components and manage the social and organizational aspect of an effective and sustainable computer based health information system is non-existent (Bhatnagar, 1992; Waema, 2002). As a result the operation and management of most CHIS in LDCs depend to a great extent on the availability of foreign experts and representatives of donors. Since donor funding in most instances are short-term and may not include a component for the continuous training of local personnel for the operation and management of such projects (CHIS), they are left in the hands of unskilled local personnel when the foreign experts and representatives of the donors are withdrawn (Heeks and Baark, 1998; Braa *et al.*, 2004).

It is clear that poor infrastructure, inappropriate approach to systems development, inappropriate donor policies and strategies, uncoordinated donor efforts and inadequate human resource capacity are critical factors combining to create risk factors that threaten the sustainability of CHIS especially in the context of LDCs such as those in Africa.

The findings of several public health research studies have suggested that routinization, which has also been referred to as institutionalization (Bracht and Kingsbury, 1990; Bracht *et al.*, 1994; O'Loughlin *et al.*, 1998; Thompson and Winner, 1999; Weisbrod *et al.*, 1992) is the primary or fundamental process in ensuring the sustainability of health programmes and projects (Goodman and Steckler, 1989; Yin, 1979; Pluye *et al.*, 2004). In a study on the development and deployment of health information systems in Tanzania and Mozambique (Kimaro and Nhampossa, 2004) concluded that the sustainability of health information systems depends on the level of institutionalization or in other words routinization. These findings suggest that development and deployment of CHIS in developing countries risk being unsustainable unless institutional structures allows for easy integration into daily activities (that is organizational routines) requires attention.

Organizational routines

Organizational routines are defined as activities for which sustainable resources have been mobilized (Yin, 1979).The decomposition of this definition reveals three issues:

(1) that organizational budgets capture the financing of routinized activities;

(2) permanent employees are put in charge of routine activities which are also subject to formal task description; and

(3) materials required for completing routines appear on organization's inventory.

Routines include rules, procedures, strategies, conventions, cultures and beliefs around which organizations are built and operate.

Katz and Kahn (1978) and Goodman *et al.* (1993) define routines as official activities in relation to four organizational functions:

(1) production; portraying the fact that routinised activities are part of an organization's plans;

(2) maintenance; that routinised activities are carried out by regular employees and supported by the management of the organization;

(3) support; routinised activities benefit from secure financing and materials; and

(4) management; that routine activities are officially supervised in an organization and subject to documented task descriptions.

Cyert and March (1970) define organizational routines as collective procedural actions that have the natural tendency to be perpetuated. Four characteristics that have led to the development of an authoritative framework for defining organizational routines emerge through the organizational learning literature namely: memory, adaptation, values and rules.

Memory

From a realist perspective, organizational memory means the record of an organization that is embodied in a set of documents and artifacts. This perspective does not include the memory of individuals (Conklin, 1996) because it is strictly based on an objective ontology. Others have looked at organizational memory as the shared interpretations of past experiences that have some effect on present activities (Stein, 1995) and consist of three key element; social networks, paper-based manuals and computerized memory (Huber, 1996). These components or elements of the organizational memory need stable and secure resources for their maintenance. For instance, the organizational literature suggests that a component like social networks is very vulnerable and thus need stable and secured resources for maintenance (Stein, 1995; Carley, 1996; Girod-Seville, 1996; Argote, 1999)

Adaptation

Adaptation is concerned with how routine activities are adopted to their context (Cyert and March, 1970). In a study of the hiring procedures of residence halls in a University, Feldman (2000) identified how these procedures have been adopted and used by all the halls in that University in an unsophisticated manner. There are also, instances where such routinised activities might not be adapted appropriately to a context and therefore create an injurious effect which is referred to by Edmondson and Moingeon (1998); Argyris (1993); Levitt and March (1996) as defensive routines.

Values

From the perspective of organizational literature, routine activities in an organization depict the value and belief system of the members of the organization. This invariably defines what is excellent, acceptable aesthetic and right for the purpose of defining the objectives of the organization (Cyert and March, 1970). These beliefs and value system are articulated through cultural artifacts such as symbols, codes, rituals or jargons and that people create inter-subjective meanings that are uttered in and through these codes, jargons or artifacts (Cook and Yanow, 1993). The values and belief system of an

organization constitute the guiding beacon which directs the process of organizational development and growth.

Rules

To end with, routinized activities conform to rules governing decision-making and actions (Cyert and March, 1970). These rules invariably account for the way things are done (Levitt and March, 1996). Rules are therefore social conventions that define a set of implicit policies to moderate the interactions between the members of an organization. Rules therefore define how the various roles in the organization are supposed to be performed and who can do what.

Conceptualizing CHIS sustainability

Several factors (human resource capacity, poor infrastructure, inappropriate donor policies and strategies, uncoordinated donor efforts and approach to systems development) appear to contribute to the sustainability problem in the context of computer-based health information systems development and deployment in LDCs. The literature also shows that the sustainability problem in the context of information systems development and deployment in the health sector is pervasive, especially in the context of LDCs and that organizational routines constitute a solid platform for initiating the required actions to entrench the activities involved in developing and deploying these systems. As already discussed, four characteristics of organizational routines (memory, adaptation, values and rules) were identified in the organizational literature (Pluye *et al.*, 2004; Goodman *et al.*, 1993) which will form the basis for developing a conceptual model to discuss how organizational routines can entrench the activities embedded in CHIS development and deployment and there by strengthening their sustainability.

Memory

Effective organizational memory is a pre-requisite for organizational learning (Balasubramanian, 1995) as without it, an organization may forget the assumptions, constraints and design rational associated with its programmes and projects. In using organizational memory to explain programme sustainability Pluye *et al.* (2004) adopted the framework from Goodman *et al.* (1993) to investigate the following issues that border on the sustainability of the projects that constituted the object of his study:

- Whether financial resources were made available by the formal budget for the employment of key personnel involved in the project under study? This kind of question addresses the issue of funding especially when external support is withdrawn. One of the factors identified as accounting for the low sustainability of CHIS in LDCs is the withdrawal of external support. Thus if additional bureaucracies are not created for the development and deployment of CHIS but incorporated into the daily routines of the health sector, then it is likely that those activities will be counted as part of the official activities of the sector for which funds will be continuously allocated during the budgeting process. Otherwise the sector will have to continuously look for funds from other sources (which in most cases are unreliable) to support these projects when the initial financiers (donors in most cases) have left. The unreliability of these other sources creates difficult

cash-flow problems for the units running these systems and in most cases creates disillusionment and abandonment of the system.

- Whether human resources are in place in the form of permanent positions either managerial or otherwise? This also addresses the human capacity issue identified as one of the main factors accounting for unsustainable CHIS in LDCs. If a new bureaucracy is not created every time the need arises to develop these systems but the activities thereof incorporated into the daily routines of the organization (that is the health sector in LDCs), then organizations will find the need to create permanent positions and staff establishment for those that carry out these activities. This will ensure that the requisite human resources needed to perpetuate the existence of the systems (especially in the absence of experts supported by donors) are planned for and made available.
- Are there material resources such as permanent office space or equipment required for the project? This question also addresses the issue of poor infrastructure to a certain extent. Unfortunately in most LDCs whenever there is a project (developing and implementing CHIS) a separate bureaucracy is created to take care of the project. To make matters worse, the new structures are mostly controlled administratively and financially by the financiers of the project (which in most cases are donors). If physical facilities such as accommodation and equipments needed to deploy and provide after installation support to CHIS are captured as part of the routine activities of the health sector in LDCs, then the budgeting process will ensure that resources are allocated to those activities to guarantee their perpetuity.
- The extent of time committed to the activities of the programmes investigated and whether it is on a permanent basis? Implementing CHIS places great demands on the time of those involved and foreseeing this in advance and incorporating it into routine organizational activities ensures that resources are made available to pay for the time involved. Unfortunately this critical and very important variable is always left out of the plans of officials responsible for developing and implementing CHIS. The reason is that at the initial stage of these projects, needed personnel are made available by the donors. Unfortunately, when donors withdraw, they withdraw their experts also, without any provision to take care of the time demands of the system. The system automatically collapses if the government system is unable to allocate resources to carry out the activities of the project.

Adaptation

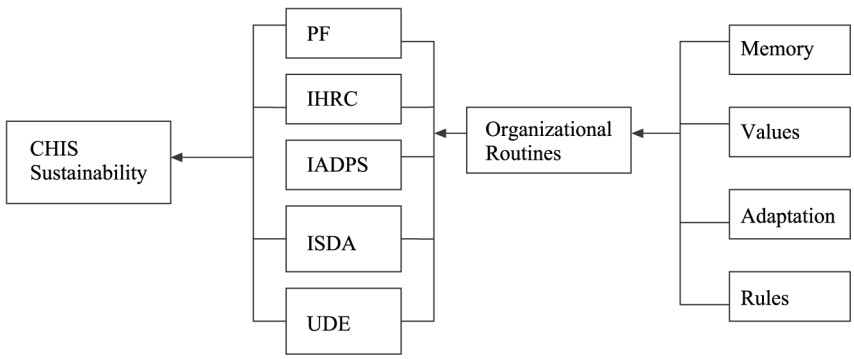
The organizational literature abounds in evidence that the ability of organizations to survive is to a certain extent dependent on their ability to adapt their activities to the environment within which they operate. A compelling issue contributing to the sustainability problem is foreign experts coming into most of the countries in the developing world with ready made software applications that are incompatible with existing systems and procedures. Thus routinizing and adopting the activities of CHIS development and deployment to organizational wide conditions and requirements will go a long way to enhance the sustainability of these systems. Again the framework

used in Goodman *et al.*, 1993 and Pluye *et al.*, 2004 are exploited to discuss adaptation and how it enhances the sustainability of CHIS in LDCs (see Figure 1).

A question posed by Pluye *et al.* (2004) is whether the activities involved in the projects under investigation had been adapted to the local context? Additionally, Pluye *et al.* (2004) investigated whether the activities involved in the projects were adapted to their estimated effect. For instance if a CHIS is expected to produce a certain output, are the activities involved carried out in such a way that they finally result in the production of that specific output or some other output that is feasible for the system to produce. From an adaptation standpoint, it might also be opportune if assessment results (generated from a CHIS) constitute feedback to the system to refine its activities and ensure that it continues to produce its expected results.

Values

Values are the basis for achieving culture change and engendering professionalism necessary for organizational success. It also defines what an acceptable behavior and role performance is. Often, the values incorporated into the implementation of CHIS, in most developing countries are different from that of the mainstream organization (say the Ministry of Health). The question that can then be asked in developing and implementing the CHIS is whether it objectives are coherent with that of the organization. Again the values of and organization brings to the fore certain rituals (for example; data is processed in a certain manner, reports are generated a certain number of times in a certain period and in certain format, all systems installed must make use of some specific tools etc). Knowledge of these, help to ask the right question during development and deployment of the system. It is important to realize that if members of the organization will have to change the way they do things just to suit the new system deployed, then it might not last since people might not be willing to change.



Key: PF: Poor Infrastructure, IHRC: Inadequate Human Resource Capacity, IADPS: Inappropriate Donor Polices and Strategies, ISDA: Inappropriate System Development Approach, UDE: Uncoordinated Donor Effort

Source: Based on Goodman *et al.* (1993); Pluye *et al.* (2004)

Figure 1.
Conceptual model for CHIS sustainability

Rules

Rules are social conventions that enforce organizational routines. As discussed one of the challenges confronting the sustainability of CHIS is the non existence of organizational wide rules for deploying systems. There is evidence to suggest that in some cases, different rules are applied in doing the same thing in different sections of one organization due to differences in donor interest. Different donors deploying information systems to collect data for different disease areas may put in place different rules which only suit their individual interest to the detriment of the bigger organization. This makes compliance to these rules difficult especially for organizational members who see these rules as alien. However if a set of standard rules exist across the organization that regulates all activities irrespective of the financiers, then CHIS development and deployment will enjoy the support of all organizational members to ensure that the objectives for which they were implemented are achieved.

In using the framework adopted from Goodman *et al.* (1993) to explain how organizational rules ensure programme sustainability, Pluye questioned:

- Whether supervisors are formally assigned to the activities of the programme? This question addresses the issues of supervision and ownership of the CHIS. When permanent organizational members are assigned the responsibility of supervising CHIS, the natural result is that things get done. Secondly, these supervisors will have a sense of ownership of the system and therefore will do whatever there is, to sustain the system when the foreign experts are withdrawn.
- Whether programme activities are included in a formal planning process?
- Are there activities subject to written rules such as procedural manuals?
- Are specific activities covered by task descriptions? These three questions deal with standardization that addresses the issue of policy fragmentation especially at the donor front.

Conclusion

This paper set out to look at the issue of CHIS sustainability in LDCs, theoretically explains the factors that account for the sustainability problem and to develop a conceptual model based on theoretical literature and existing empirical findings. From the discussions so far, it is clear that the process of routinization can play an important role in ensuring the sustainability of computer-based health information systems. Incorporating the activities involved in the development and deployment of CHIS into the routine activities of the organization will help secure continuous flow of resources to deliver project objectives even in the absence of external support from donors. It was also realized that the process of routinization could assist in the creation of standards needed in terms of rules procedures and the inappropriate cultures needed to support the development and deployment of computer-based health information systems. It is also important to note that, the model might need some refining in some aspects because it currently emphasizes organizational routines as a very strong platform for ensuring the sustainability of CHIS development and deployment in less developed countries. For now, we are of the strong opinion that routinization offers a needed platform for improvements in the levels of sustainability of CHIS for LDCs.

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