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Research Paper

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ABSTRACT

Standardization and integration of Health Information Systems (HIS) in most developing countries haves been reported as a complex undertaking due to poverty, multiplicity of diseases and diverse actors working in various initiatives within the healthcare context. The need for collaborative investments in HIS strengthening is highlighted by major actors such as WHO, as significant to achieve an integrated HIS. However, despite the fact that the involvement of multiple partners is desirable as a vehicle to attain an integrated HIS, entailed challenges should be understood and well managed. By drawing on the concept of translation from the actor network theory supplemented by the notion of boundary objects, we examine the HIS standardization challenges and the strategies to curb them in the context of several different actors engaging in HIS integration process in Tanzania. The article stresses the need to coordinate the standardization process through circulation of boundary objects across the multiple actors involved.

Keywords

Health Information Systems, Actor Networks, Boundary Objects, Implementing Partners

INTRODUCTION

Health information systems (HIS) have been recognized by both healthcare practitioners and the information systems community as a vital tool for improving health services in developing countries (DCs). As a result, HIS strengthening which involves standardization and integration of various systems is an important component of most health sector reform initiatives (Igira 2008; Nyella and Mndeme 2010). However, HIS standardization and integration in these countries haves been described as a very challenging undertaking because of healthcare contextual complexities. Some of the contextual challenges include multiplicity of diseases attracting multiple development partners working in vertical health programs, several divergent rationalities among the health systems' actors, power tension resulting from asymmetric ownership and control of resources among the actors, tension between standards and local

adaptation, divergent agendas and political interests of multiple actors involved (Chilundo 2004; Braa et al. 2007; Sahay et al. 2009; Nyella and Mndeme 2010; Bakar, A., et al. 2012; Effah and Abuosi 2013, Nguyen et al. 2015).

Due to poverty and the need to improve healthcare services, the multiplicity of actors in the healthcare context are justified as desirable by major actors such as the United Nations and the World Health Organization (WHO) as a strategy to deliver the Millennium Development Goals (MDGs) for health. This is evident in most health sector reform initiatives where the issue of partnership is at ~~in~~ the forefront. For instance, in the healthcare sector in Tanzania, which is the empirical setting for this article, the top agenda in the health sector strategic plan III (July 2009 to June 2015) inscribed at the cover page is 'partnership for delivering the MDGs'.

In terms of HIS strengthening in developing countries, major actors such as the WHO believe~~s~~ that coordinated partnership and investment is significant to attain an integrated HIS (WHO 2008). While some partners fund initiatives without their direct engagement in the activities, some do both provision of funds and implementation of various healthcare related projects. This leads to so- called~~,~~ implementing partners (Edi and Setianingtias 2007).

Due to the multiplicity of partners, the need to coordinate their resources and activities is highlighted as significant in order to accrue benefits from their involvement in the healthcare sector (OECD/DAC 2006). Nevertheless, coordinating development partners~~'~~ is highly documented as a very challenging phenomenon. This is evident from the multiplicity of coordinating mechanisms that exist (Dodd et al. 2007, McCormick et al. 2007). We argue in this paper that, while involvement of multiple partners in HIS standardization is desirable as a vehicle to utilize their resources, standardization challenges in such context and the strategies to curb them must be well understood in order to achieve that goal.

The challenges of HIS standardization and integration in a context of multiple implementing partners are not a widely researched topic. Most of the contemporary studies on HIS in DCs have reported on initiatives involving one implementing partner or the healthcare ministries supported by partners to carry out the project (Sheirk 2005, Braa et al. 2007, Kossi et al. 2009, Nyella and Mndeme 2010). The article strives to contribute to this 'unexplored tableland' by drawing on an ongoing efforts to strengthen HIS in Tanzania mainland, where a number of implementing partners working in various sites are engaging in the HIS strengthening process. This article seeks to meet the following objectives: analyze the challenges of HIS standardization and integration in the face of multiple implementing actors~~;~~, and propose strategies to deal with the challenges. The HIS strengthening in Tanzania is done as part of the research network on the Health Information Systems Program (HISP), which operates in many other developing countries (Kossi et al. 2009; Braa et al., 2007).

Analytically, the paper draws on the Actor Network Theory (ANT), particularly the translation concept (Callon 1986 & 1991), complimented by the concept of boundary objects (Star and Griesemer 1989). These concepts enable us to research the multiple translation processes taking place resulting from the involvement of multiple and heterogeneous actors, and analyze/discuss various strategies through which the tension between heterogeneity of the actors and the need for standardization can be handled. The rest of this paper is organized as follows~~.~~ : in the subsequent section we present the literature on the healthcare

context in developing countries followed by our theoretical framework where we present the concept of translation from the Actor Network Theory (ANT) complimented by the boundary objects concept. The theoretical framework forms the basis for our empirical analysis and discussions. Research context and the methodology used in the study are presented next, followed by the empirical case description. The analysis and discussion of the empirical material is then set forth. The paper ends with a conclusion section presenting the implications of the study and the final remarks.

HEALTHCARE CONTEXT

Health is considered as an important indicator for development. Chudi (2010) argues that health indicators in developing countries are still deplorable, and adverse health consequences have been linked to poor socio-economic growth and development. Due to the burden of disease, Africa comprises a large share of the least developed countries. Looking at three major diseases for instance, Barbiero (2007) reported that, though Africa comprises only about 15% of the world's population, over 60% of the world's HIV infections are on the continent; with the highest estimated incidence of tuberculosis (TB) worldwide where 500,000 people die each year, or nearly 1,500 per day; and malaria kills almost 900,000 people annually, of whom 750,000 are children. The disease burden is described as both a cause and a result of poverty on the continent. The link of diseases and development is further highlighted by the global strategies to fight diseases, where out of eight MDGs, three relate directly to health (Dodd et al., 2007).

Consequently, the health sector in most developing countries is leading in terms of the number of development partners funding and working towards reversing the disease burden. For instance, within the health sector of Tanzania mainland, which is the empirical setting for this article, there are more than seventeen development partners funding and working with various healthcare initiatives. Some partners provide~~s~~ fund to support initiatives without their direct involvement in the activities, while others do both provision of funds and implementation of various health programs (UNDP 2010, Edi and Setianingtias, 2007). However, an increasingly high number of development partners with diverse uncoordinated interests, has been reported as a challenge to the possible impact of development cooperation.

> *"… multiplicity of donors, many with projects, programs, interests, concepts, structures and procedures of their own, increases the transaction costs of development cooperation for donors and partner countries and diminishes the possible impact of development cooperation.,"* (Ashoff 2004, p1).

Furthermore, lack of coordination among the partners' activities within the same sector present a number of side effects which include duplication of efforts where the intended effects are already being achieved by another donor, and mutual obstruction where the effects cancel each other out (OECD/DAC 2006). Ashoff (2004) alluded to an example where in some countries; several donors have become involved in vocational training, but have pursued it with different concepts to the extent that the reform of vocational training sought for by the countries concerned was hampered. As a result, coordination of development partners has become an important item on the international development agenda. This is evident from the most explicit and detailed agreement called 'Paris Declaration of 2005' in which donor agencies commit to co-ordinate amongst themselves and support the recipient government's own development strategies (Edi and Setianingtias 2007).

Nevertheless, coordination of development partners' resources and activities in the healthcare sector is a challenging undertaking. Different coordinating mechanisms exist in various countries (WHO 1996; DAC 2003; Bigsten 2006; Dodd et al. 2007; McCormick et al. 2007; Edi and Setianingtias 2007). For instance in Tanzania, there have been attempts to coordinate efforts and resources from donor agencies using different approaches such as the sector wide approach (HSSP-III 2009; Dodd et al. 2007; Kamuzora and Toner 2003) and direct budget support in which donors contribute directly to the central budget (DSW 2010; Kamuzora and Toner 2003). Edi and Setianingtias (2007) argue that donors are often unwilling to coordinate with one another due to the divergence of procedures and agendas among donors, which can complicate their efforts to coordinate with each other and requires substantial resources. Meanwhile for these different actors to work together in a meaningful way, the need for standards and a standardization process to enable information sharing between them, agreement of common concepts, priorities, policies and principles, and the acceptance of a clear set of procedures and practices for the implementation of activities in terms of joint support programs, budget support programs and pooling funds (Disch 2002; Ashoff 2004; OECD/DAC 2006) is indispensable. However, highlighting the tension between the heterogeneity of the actors and the need for standards to enable cooperation, Ashoff (2004) argues that coordination can be very unattractive if it results in more joint donor programs-and so restricts the range and diversity of activities of individual development cooperation institutions.

As pertaining to the countries HIS, the multiple partners are involved in different ways and at different levels in generating, analyzing, and using data for monitoring and evaluation of their interventions (WHO, 2008). As a result, the existing HIS in most countries are institutionally and historically complex and dysfunctional, due to fragmented uncoordinated 'vertical' information systems' demands (Nyella, 2011; Braa et al. 2007; Aanestad et al. 2005). As part of the general healthcare sector reform initiatives, most of the countries are in the process of strengthening their HIS through standardization and integration of multiple fragmented systems (Sheirk 2005, Kossi et al. 2009, Sahay et al. 2009). According to the WHO, the two core requirements of health system strengthening in low income countries should include:

> *"First, the need to enhance the entire health information and statistical systems rather than focus only upon specific diseases. Second, to concentrate efforts on strengthening country leadership for health information production and use"* (WHO, 2008, p7).

The argument of this major actor is that, collaborative investment and efforts for HIS standardization and integration in these countries will be more efficient and effective in creating synergies among multiple partners than individual initiatives. In this article we argue that, while this collaborative investment and engagement in HIS standardization is desirable as an attempt to synergize in terms of resource sharing to attain an integrated HIS, there is a need for the entailed standardization challenges to be well understood and managed in order to realize that goal.

In the contemporary literature on HIS implementation in developing countries, not much is known in relation to HIS standardization and integration in a context of multiple implementing partners. By drawing on an initiative to standardize and integrate the HIS in Tanzania, with a number of diverse partners engaging in the process, this article attempts to make contributions in that direction. In the subsequent section, we present our theoretical framework which is the concept of translation from the Actor Network Theory complimented by the boundary objects concept.

INFORMATION SYSTEM STANDARDIZATION

As the number of information systems (IS) and computing devices grow inside organizations, the need to standardize and integrate them becomes crucial. For instance, the healthcare setting consists of abundance of different ISs, which mirror the vast variations in the healthcare work along several dimensions spanning from levels, geography, professional groups, and agencies to various specializations (Jæger, and Monteiro 2005). However, data processing, technical, and electronic standards are essential if equipment and multiple diverse systems are to be able to interoperate, and for the healthcare professionals across the different dimensions to communicate, data definitions (standards) and terminologies are indispensable (PAHO 1999). Furthermore, standards and standardization process are viewed as a means for rationalizing coordination between dissimilar systems, cutting transaction costs, and simplifying complexity of IS development (Jaccuss, 2006).

Unlike most of the previous studies which took a more technical stance, the contemporary IS literature conceptualize standards and standardization process as a social-technical enterprise, where emergence and use of standards is seen as a result of actions of individuals, organizations and the networks of organizations (Hanseth & K. Braa 2001; Jaccuss 2006; Ellingsen et al. 2007; Braa et al. 2007). The socio-technical perspective is especially pertinent in developing countries context characterized by poverty, diseases burden and multiple uncoordinated healthcare initiatives supported by different donors with diverse interests. Thus, standardization process refers to harmonization of various actors' interests, information systems, data elements, data tools, work routines and practices, organizational structures and procedures.

Standardization in the IS discourse has been described as a challenging socio-technical undertaking characterized by emergence of paradoxes, tensions, side-effects and ambiguities (Timmermans & Berg 2003; Jaccuss, 2005; Hanseth et al. 2006). One of the typically recount challenges related to IS standards and standardization process is the issue of flexibility for local adaptation and innovation. While standards are cardinal for coordination between different actors, future innovations can sometimes be hampered by the previous innovations which now are standardized (Dunphy et al. 1996).

For example, due to inflexibility of the previous health IS standards in Tanzania new local requirements could not be assimilated and therefore led to local improvizations to introduce parallel standards leading to massive fragmentation of the mainstream health IS (Igira 2008). Thus, standards and flexibility are interdependent and both necessary for changes to occur (Hanseth 1996; Braa et al. 2007).

However, in the healthcare context of developing countries, HIS standardization is challenged by multiplicity of levels of the health system hierarchy each with its own needs regarding data and reports, asymmetric inter-organizational power relations, multiplicity of diseases attracting multiple development partners, multiple divergent rationalities among the health systems' actors, and divergent agendas and interests of the multiple actors involved (Chilundo 2004; Braa et al. 2007; Sahay et al. 2009; Nyella and Mndeme 2010). Our argument is that most of these issues reinforce the tension between standards and local adaptation across different actors and even challenge the concept of flexible standards. Though studies have shown the importance of flexible standards to alleviate some of these challenges, we submit that more research is needed in these contexts.

What attest to this fact, are the multiple coordination mechanisms trying to rationalize interests, concepts, projects, programs, structures, procedures, activities and resources of the multiple actors in these contexts.

This is especially vital where other studies have shown that even in the face of standardized and integrated HIS, fragmentation still creeps back in the picture (Nyella and Mndeme 2010). Hence, the healthcare context of developing countries provides a rich case for studying the dynamics of IS standards and standardization process, which may sometimes be rare to find in most developed countries.

Most of the previous studies on HIS standards and standardization process focus on a context where a single actor seems to be driving the implementation process. Thus, the standardization process included negotiations and activities culminating to new data and tools standards, which are thereafter implemented across the entire health system hierarchy. Our argument is that in a context of multiple actors engaging not only in the process of coming up with new standards but also in the implementation of the standards in multiple local sites, to ensure standardization of activities across sites one needs to go beyond the need for standards within a single network of actors. Rather one needs to juggle around multiple networks of actors with multiple logics and meanings, which need to be accommodated and yet maintain coordination across the networks.

Drawing on Actor-network theory Monteiro and Hanseth (1995) argue that in a context of multiple networks with multiple meanings and logics what we need, are concepts to deal with larger numbers of actor-networks and how they connect and interact rather than concepts for dealing with only one actor network. According to the authors, Leigh Star's concept of boundary objects is a step in that direction (Star and Griesemer 1989). Thus, this article draws on the boundary objects concept and Actor-network theory, to study the HIS standardization challenges and strategies in the context of multiple networks of divergent actors involved in the process. The article contributes in the IS discourse through the study of standards as boundary objects and the type of such standards needed to maintain coordination across multiple networks of actors.

THEORETICAL FRAMEWORK

We use the actor-network theory (ANT)~~,~~ complimented by the concept of boundary object as primary theoretical devices to conceptualize HIS standardization in Tanzania as an actor-network building process involving multiple and heterogeneous actors~~;~~ , and to analyze and examine the socio-technical means in which mobilization and coordination of the actors is~~/~~ or can be achieved. Monteiro and Hanseth (1995) argue that diffusion and adoption of standards depart from other kinds of ISs by requiring the coordination of the surrounding actors, institutional arrangements and work practices. Thus, to accommodate this kind of conceptualization, a number of IS studies have drawn on the ANT to study standards and standardization process (Nhampossa 2005; Hanseth et al. 2006; Nielsen and Hanseth 2006).

The ANT proposes a socio-technical account where neither social nor technical positions are privileged. The theory considers the 'world' to be full of hybrid entities (Latour 1993) containing both human and non-human actors. It provides a network-building metaphor and a vocabulary for describing the process of coordinating social and technical actors' interests as a cascading stream of transactions (Tilson et al. 2006). Thus, the ANT suggests that the aligning of the interests of actors in the network involves the

translation of those interests into a common interest in adopting and using the technology. This translation is achieved in the network through common definitions, meaning and inscriptions attached to the technology (McBride, 2003). The ANT considers translation of human, social, and technical elements into a single heterogeneous network.

However, Star and Griesemer (1989) critiqued the concept of translation as deployed by Law & Callon (1992) and Latour (1993) as being almost like the imperialist action of an innovator or scientific entrepreneur, who seeks to control other actors via the creation of an obligatory passage point. Instead, the authors argued for a more ecological approach which takes into account the coexistences of multiple translation processes with multiple view points and obligatory passage points of which the overall coherence forms the core of the problem. The multiple translations can occur simultaneously as various heterogeneous networks are assembled.

According to the authors, there is an indefinite number of ways in which entrepreneurs from each cooperating social world may set up their heterogeneous networks and therefore an indeterminate number of possible sets of translations. Thus, each heterogeneous element can belong to multiple networks, undergo multiple translations, and contain multiple meanings at the same time. In such a context, the solution invented by actors would, according to Star and Griesemer (1989), involve methods standardization and development of boundary objects. Standardization of methods emphasize the how, and not the why or the what; it makes information compatible and allows for a longer 'reach' across divergent worlds. In the heterogeneous work of building a research museum, methods standardization included elaborate collection and curation guidelines, and course hand-outs, establishing a management system in which diverse allies could participate concurrently (ibid). This way of meaning and a common ground is created through which diverse worlds could contribute to a common good.

> *"The methods standardization allowed both the collectors and professional biologists to find a common ground in clear, precise manual tasks. The methods provided a useful lingua franca between amateurs and professionals. They also make the amateurs to make substantial contribution to science and to conservation,"* (Star and Griesemer 1989 p 407).

Conversely, boundary objects may be abstract or concrete objects, whose structure is sufficiently robust and common to several social worlds to make them recognizable means of translation of the specific needs and constraints of each of these worlds (Star and Griesemer 1989, Trompette and Vinck 2009). It has different meanings in the different worlds, but those meanings are sufficiently structured to be recognized by the other. Trompette and Vinck (2009) argue that the notion of boundary object is used to describe how actors maintain their differences and their cooperation, how they manage and restrict variety, and how they coordinate in space and time. That means, it is not just a matter of monitoring the way the innovator gets everyone on board, step-by-step, rather it's about reporting more broadly on the work of coordination, alignment mechanisms and translation chains between the different actors and worlds involved.

Thus, translation operations are distributed without necessarily establishing the pre-eminence of one actor over others. While Stars and Griesemers' notion on translation like Callon, Law and Latour, are interested in the creation of associations, the target of the former is less in retracing the dynamic and uncertain process of "stabilisation of facts" than getting to grips with the mechanism of associations itself and the way in which they tolerate the tension between cooperation and heterogeneity (Trompette and Vinck 2009).

For this reason, the creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds. Coherence is the degree of consistency between different translations and social worlds. A successful translation and negotiation process is one that supports and maintains a high level of coherence between social worlds. The high level of coherence

should result from carefully managing the creation, crafting, meaning, and representation of boundary objects and the interfaces they provide between and across social worlds. For instance Bechky (2003) discusses the role of boundary objects in reducing misunderstandings among heterogeneous professional groups in a production company. By utilizing boundary objects, members of different professional groups created common ground which transformed their understanding of the product and the production process, and enhanced cross-boundary knowledge sharing.

Wenger (2000) on the other hands specifies four dimensions of boundary object to include:

- abstraction where it facilitates dialogue between worlds
- multi-tasking in which several activities or practices are possible
- modularity where different parts of the object can serve as a basis for dialogue between actors
- and standardisation of the information contained in the object thereby rendering the information interpretable.

Furthermore, boundary objects facilitate flow of resources such as concepts, skills, materials, techniques, and instruments across several different worlds (Fujimura 1992).

Different artefacts in different contexts have been studied as boundary objects. For example, Shegaw (2010) discussed the case of Ethiopia, where a software tool was used as a boundary object bringing public health officials, medical doctors and software development team to initiate and engage in a dialogue thereby facilitating collaboration and knowledge sharing across divergent social worlds. On the other hands, Yakura (2002) looked at timelines – a graphical representation of a set of temporal units in the lifetime of a project as boundary objects, and demonstrated their ability to reconcile diverse socially constructed temporal arrangements. Visual representations have been discussed as boundary objects in the world of design engineers enabling communication and collaboration (Henderson 1991).

So far, the concept of translation from the ANT has widely been used in HIS research to investigate a variety of issues around design, development and implementation of information systems in different contexts. Nhampossa (2005) for instance, used the concept of 'mutable mobiles' from the ANT to argue that adoption of technology for health care in different countries is not merely a technology transfer but a translation process through which the technology shapes and is shaped by the contextual realities. He emphasizes four factors which influence the translation process, these include: history, adaptation, participation, and process of customization.

Our argument is that most of these studies have applied the translation concept in a context where a single actor strives to establish itself as mandatory passage point. However, our study is unique in the sense that we apply the concept in a context of multiple distributed translations with multiple viewpoints and mandatory passage points. In such a context, it's not about how one actor translates others' interests by imposing a program of action, but rather it's about the work of coordination across multiple heterogeneous worlds without a single actor establishing pre-eminence over others. The task then becomes how to manage and balance the tension between heterogeneity and cooperation to ensure standardized HIS across the multiple worlds.

The scope to explore the translation processes in HIS standardization and integration initiative in the context of developing countries and particularly in the Tanzanian health sector is vast, given the number and variety of actors (partners) engaging in the HIS strengthening project. The gist is to analyze the challenges around the multiple translations taking place as the result of the involvement of multiple

implementing actors and examine the role of boundary objects in achieving cooperation and standardized HIS in the face of multiple heterogeneous actors.

RESEARCH SETTINGS AND METHODOLOGY

Our research setting is Tanzania, a low income country. It is the largest country in East Africa, occupying an area of about 945,087 sq. km, and has common border with 8 neighbouring countries. Tanzania mainland had a total population of approximately 38 million as of the year 2006. Administratively, the mainland has 11,764 villages and 5,728 total number of health facilities.

Tanzania is classified by the UN as one of the least developed countries. The average national income (GNI) per person was US$350 in 2006 (HSSP III, 2009). About 25 % of Tanzanians were living below the poverty line in 2007. The health sector in Tanzania is facing a serious human resource crisis which negatively affects the ability of the sector to deliver quality health services. There is severe shortage of human resource at all levels~~.~~ which is exacerbated by the expanded population, HIV/AIDS pandemic, malaria, tuberculosis and others (HIRS, 2008). For the entire staff needed to provide quality healthcare, on average there is deficiency of almost 66% of the professional staff. It is estimated that the development partners provide more than 40% of the funding towards health sector in Tanzania (ibid).

The research is part of a 'global' Health Information System Program (HISP) which involves countries from Africa, Asia and Europe. Following an action research approach, HISP started in South Africa in 1994 with the aim to strengthen the health information system through the introduction and local adaptation of open source software known as the District Health Information Software (DHIS) (Braa et al 2007). The initiative moved to a number of other countries in Africa and Asia such as, Malawi, Nigeria, India, Botswana, Mali, Tanzania, Sierra Leone, Kenya, Nigeria, Malawi and Vietnam. Currently, there are two versions of the software, DHIS1.4 which is purely standalone and DHIS2 which can be configured to run in a standalone or in an online mode, depending on the availability of supporting infrastructures such as local area network or the Internet. The HIS strengthening initiative in Tanzania mainland is based on DHIS2, which is currently implemented in seven regions – Pwani/Coast, Mtwara, Lindi, Dar es salaam, Arusha, Tabora and Shinyanga regions.

The study draws on an interpretive epistemology. Interpretive researchers attempt to understand phenomena through assessing meanings that people ascribe to them (Klein and Myers 1999; Walsham 1993). As interpretive researchers, our study relies on participant observation and interviews with healthcare organizational members, and uses qualitative analysis to interpret the HIS standardization in Tanzania. Walsham (1993) argues that interpretive researchers often use an underlying theory as sensitizing device for collecting and analyzing research data. The study draws upon the ANT concepts to guide the data collection, analysis and reporting. Both formal and informal interviews were carried out ~~to~~ with different actors ranging from the MoHSW and implementing partners' officials, regional and district HIS staff, to DHIS technical staff. As indicated in Table 1, 32 formal and informal interviews were conducted.

Informants	Number Interviews
National level staff	9
Regional staff	5
District staff	7
DHIS technical staff	5
Implementing partners	6
Total Number of Informants	**32**

Table 1. Interviews Conducted

Authors of this paper have worked with HISP in Tanzania for a period of more than ten years. As participatory observers we have worked with different implementing partners such as the Clinton Foundation in Mtwara and Lindi, Ifakara Health Institute in 27 districts scattered in all the regions in Tanzania, Japan International Cooperation Agency (JICA) working in Coast region, and Elizabeth Glaser Pediatric AIDS Foundation (EGPAF) working in Arusha region. The activities embarked on included installation of DHIS2 in their sites, training, and supporting use of the system for a period of time. This gave the authors, opportunity to get firsthand experience and learn the challenges in dealing with multiple implementing partners. Moreover, a number of documents were reviewed ranging from DHIS implementers' progress reports, Health sector strategic plan III, to summarized meetings and workshops reports. Furthermore, authors attended a number of workshops, meetings and training programs organized by the MoHSW and sometimes by the implementing partners.

In parallel with these field activities, the authors as a part of HISP team in Tanzania participated in collaboration with the MoHSW and other partners in the preparation of the national HIS strengthening plan and budget which was endorsed in 2010 and attracted funds from various development partners including Global Funds, Dutch Government, and NORAD. This HIS national plan and budget led by the MoHSW with technical support from HISP Tanzania that operates under the University of Dar es Salaam, set clear plans and budget for DHIS2 implementation as a national HIS system. Following this, the authors and other HISP members participated in various HIS strengthening activities such as design of new data collection tools, customization of DHIS2 to reflect the new tools, DHIS2 rollout trainings and provision of continuous user support.

CASE DESCRIPTION

Historical Background

The current routine health management information system (HMIS) in Tanzania was conceptualized in the 1990s by external consultants with support from the Danish International Development Agency (DANIDA). The system consisted of formalized paper based tools at health facility and district level and computer based system at the regional and national level. However, a number of studies described the system as dysfunctional and inflexible (Lungo 2003; Shidende 2005). Such inflexibilities led to difficulties in absorbing changes and new requirements from different health programs and health care services. For

instance due to the inflexibility of the system resulting from standards being 'set in stone', new changes for programs like the Expanded Program for Immunization (EPI) could not be effective and therefore, the program decided to run a separate reporting system. Moreover, emerging new health programs such as the HIV/AIDS with a number of subprograms could not be absorbed in the HMIS, instead run as separate programs. Such HIV/AIDS subprograms include: Voluntary Counselling and Testing (VCT), Provider Initiated Counselling and Testing (PICT), Care and treatment (CTC), and Prevention from Mother to Child Transmission (PMTCT).

At the district level, demands of data which was not included in the current tools led to improvisations to introduce new tools in order to meet data demands from the national level and other stakeholders. The new tools introduced in different districts were given names like 'HMIS/MTUHA shortcomings' or 'Reports outside HMIS/MTUHA' to indicate that they were separate from the unified HMIS.

As an attempt to resolve the HIS challenges, a pilot study was conducted by the Health Information System Program (HISP) team in two districts in the Pwani region, followed by implementation of District Health Information Software (DHIS) (Lungo 2003; Igira 2003). DHIS, as an open source software (Mengesha, 2010; Effah, and Abbeyquaye 2014), was demonstrated as flexible and capable to handle multiple programs and data sets in an integrated manner giving the ministry and other actors, accessibility to comprehensive information. Following lengthy discussions and negotiations with the MoHSW officials, in 2007 DHIS was endorsed as a standard for countrywide implementation.

HIS Strengthening

The MoHSW formed an alliance of partners to work out a plan for strengthening the HIS in Tanzania which would include rollout of the DHIS software. The plan was also meant to solicit funds from donors to support implementation(Nyella, 2011). While the MoHSW was in pursuit for donors to support the plan for systematic implementation, other actors working in the health sector learned about DHIS and requested immediate implementation in their respective locations. The Japan International Cooperation Agency (JICA) working on VCT and Sexually Transmission Infections (STI) programs was the first one to request implementation of DHIS in one region with their own support.

Site one - Japan International Cooperation Agency

The National AIDS Control Programme (NACP) supported by the Japan International Cooperation Agency (JICA) were working on a project called institutional capacity strengthening for HIV prevention, focusing on VCT and STI services, since march 2006. The project aimed to improve the quality of STI and VCT services, through standardization of services, strengthening monitoring and evaluation, and supervision processes. As part of the project, MoHSW through NACP, therefore revised and distributed paper-based recording and reporting tools to all health facilities providing STI and VCT services throughout the country.

In search for a computer-based system to be used for processing and analysis of monthly facility reports at the districts level, NACP/JICA approached a local software development company. The company pledged to develop two separate systems, one for VCT and another one for STI services. While they were still at the negotiation stage, NACP/JICA came to learn about DHIS and the fact that the MoHSW had endorsed it for countrywide implementation and as part of a wider HMIS strengthening initiative. The fact that DHIS could handle multiple data sets such as that of VCT and STI services dismissed NACP/JICA idea of having two separate systems for the two services. NACP/JICA then approached the MoHSW and

the HISP team, requesting implementation of DHIS in one region (Pwani/Coast) where they were operating. At first, their request was perceived as violating the national plan, targeting systematic implementation. However, through negotiations between the MoHSW, NACP/JICA and the HISP team, it was agreed that the NACP/JICA implementation be sanctioned and be taken as a 'test' site for the overall HMIS strengthening. Furthermore, the decision was strategically taken as an opportunity to make use of the NACP/JICA support to start the HMIS strengthening.

A situation analysis of the STI and VCT information management in Pwani region was conducted by the HISP team from 24th November to 12th December 2008. The situational analysis found among other things the need for new computers at both the district and regional level, and the need for the health facilities to be retrained on the paper-based tools. Following the requirements from the situational analysis, customization of DHIS2 was done where STI and the VCT paper-based tools were implemented in the database.

Figure 1: DHIS2 training

Two weeks training (Figure 1) on data management using DHIS2 was conducted in March 2009 by the HISP team to the district and regional health officers. NACP/JICA provided new computers to all the districts and the regional level for data management. The training was immediately followed by the roll out of DHIS2 software in all districts, including the regional level. Figure 2, presents the setup of DHIS2 installation. As a strategy to avoid virus related problems into the data warehouse, the team chose to use Linux operating system for the DHIS2 database.

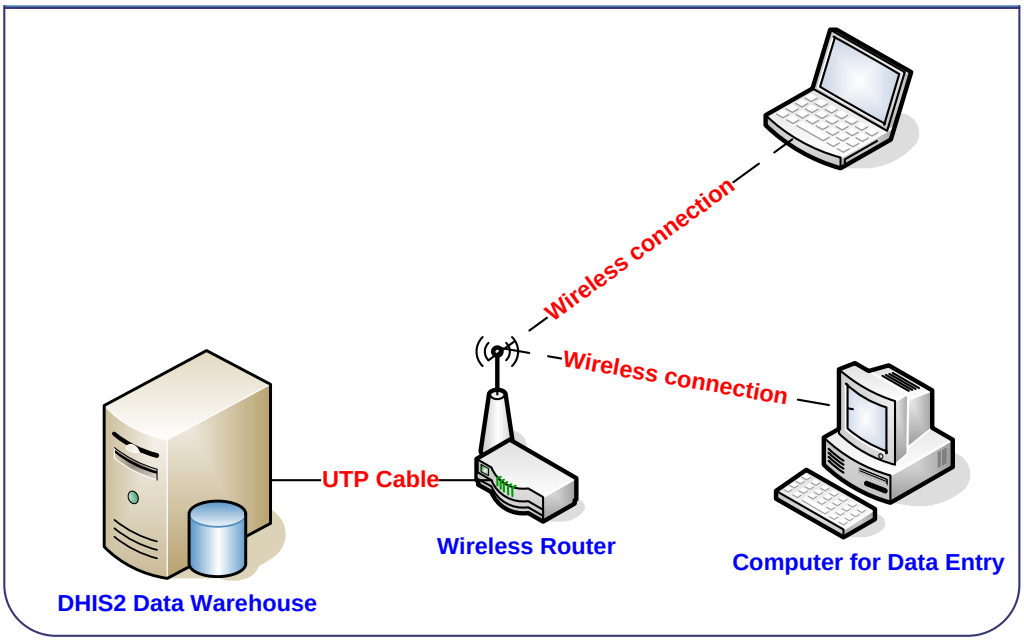

Figure 2: Setup for DHIS2 installation

Other Actors join the 'test' region

The national PMTCT program in collaboration with the national HMIS officers and other partners such as ICAP, EGPAF and CHAI, working in the same program, revised the PMTCT paper tools including registers and monthly summary tools, in 2008. The revision was supported by the WHO. In need of an electronic tool for computerizing the summary reports, the national PMTCT officers and the partners attended a stakeholders meeting where DHIS2 with the results from the 'test' region were presented based on the VCT and STI data. Among other things, the partners learned the capacity of DHIS2 of accommodating multiple data sets in an integrated manner and that it had been endorsed as a national standard. Promptly, a decision was made to implement the PMTCT summary tools using DHIS2 within the 'test' region.

All the new PMTCT data sets were codified in DHIS2 and rolled out into all six districts in the test region in July 2009. So far DHIS2 had three data sets, VCT, STI and PMTCT, captured at the district level and sent to the regional offices. The rest of the reports such as EPI, CTC, antenatal care (ANC), postnatal care (PNC), family planning (FP), labor and delivery (L&D), were yet to be included in DHIS2, instead their data was collected using ad hoc means under the old HMIS/MTUHA system. The Norwegian Embassy working with child and maternal health, provided funds to support implementation of the rest of the data sets using DHIS2 within the 'test' region. The HISP team in collaboration with the district and regional level HMIS staff started the implementation of the rest of the data sets. EPI being a stable data set in terms of being standardized across the nation, the team decided to start to implement it in the DHIS2.

Now, moving to ANC, PNC, FP, L&D, and child health, the team learnt that almost each district had its own separate tool for collecting data. A meeting was held bringing together, the regional medical officer (RMO) from the 'test' region, reproductive and child health services (RCHS) coordinator, districts officers

and the HISP team, to decide on how to go about the data sets. The decision reached was to redesign standardized tools for the data sets and roll them out across the 'test' region.

Following intensive discussions and upon receiving the green-light from the RMO, new tools were redesigned. However, before the revision work could be finished, the revision team learnt that, the national RCHS program with support from WHO and in collaboration with the national HMIS revised the RCHS data sets and created new data collection tools. RCHS is an umbrella program which brings together EPI, ANC, PNC, PMTCT, FP, L&D and Child health. The new RCHS tools cover all these programs in an integrated manner including EPI and PMTCT diffused in other data sets such as the ANC, PNC and the Child health. A compromise had to be reached by the 'test' region team to drop 'their RCHS tools' and wait for the national tools.

Site Two - Clinton Health Access Initiative (CHAI)

The Clinton Health Access Initiative (CHAI) has been collaborating with the MoHSW since 2005, to expand access to HIV/AIDS care and treatment in Mtwara and Lindi. The aim of the project is to demonstrate that ARVs can be provided through Health centers and dispensaries thus expand access to rural areas. However, CHAI learned that the status of HMIS in Mtwara and Lindi could not provide the needed data of sufficient quality for the monitoring and evaluation (M&E) essential indicators for their initiatives and for the general healthcare services in the regions. In need of an M&E tool CHAI approached the MoHSW and the HISP team requesting to implement DHIS in the two regions.

The request was granted to implement DHIS2 in the two regions which include all the data sets implemented in the 'test' region. Still CHAI requested the addition of one more data set – the care and treatment data set. A situational analysis was done in August 2009 in one of the regions where one of the important findings was the need for computers at the district and regional level for data management. CHAI provided new computers to all the districts and the regional level in the two regions. From September to October 2009, the HISP team conducted DHIS2 training, followed by installation of the software into the districts and the regional level computers, in both Mtwara and Lindi. The DHIS2 installations were done on a Microsoft Operation System unlike in the test region where Linux OS was used. In order to ensure availability of data into the system, CHAI hired three data clerks in Mtwara and four in Lindi to work on the backlog for 2007 and 2008. Furthermore, CHAI hired one personnel who was trained on DHIS2 as a super user to provide technical support to the districts and the regional levels.

> *"CHAI provides regular supportive supervision to the districts and the regions. This involves solving some of the problems encountered during use of DHIS"* (CHAI, June 2011).

Due however to ICT related problems, CHAI contracted a company to provide regular ICT support to both Mtwara and Lindi regions in terms of computer repair and maintenance (hardware and software). Apart from the initial training provided by the HISP team to the data clerks and managers at the district and regional level, CHAI provides extra training through their support staff.

> *"As part of capacity building, we sometimes provide DHIS training to the district and regional HMIS staff. These trainings are conducted by CHAI staff unlike the initial training which is normally done by the HISP team"* (CHAI, June 2011).

Data entry is done at the district level and an export file is transmitted to the region where it is imported into the regional DHIS2. From the regional level, some aggregated reports are sent to vertical programs at the national level.

> *"At the end of November 2009 all the 2009 quarter three PMTCT data was entered into the database and was also sent to the National PMTCT Unit, and now all the 2009 PMTCT data is available in DHIS,"* (CHAI, Feb 2010).

Apart from Mtwara and Lindi, CHAI have implemented DHIS in two more other regions.

> *"We implemented DHIS in Tabora and Shinyanga regions. Though we did not have funds for it to run as a project, ~~but~~ we had to depend on funds from another project running in the two regions,"* (CHAI, June 2011).

When CHAI were asked whether they have any plan to set up DHIS server in their central offices for management of data from their working sites, one official noted:

> *"Our aim is not to have DHIS server in our office. This is the work of the MoHSW. Maybe if they ask us, we can have it as a mirror to their server, not as a separate DHIS server,"* (CHAI, June 2011).

Site Three – Ifakara Health Institute (IHI)

Ifakara Health Institute (IHI) is a research and training institute whose mission is to develop and sustain a district-based health research and resource center capable of generating new knowledge and relevant information for public health policy and actions. In 2010 IHI launched a health research project - Sentinel Panel of Districts (SPD) in 27 districts of Tanzania Mainland, aimed at improving availability of timely data as an attempt to increase government's efficiency in planning. According to the IHI official, the project dwells on facility based information and population based demographic and mortality data in all 27 districts.

> *"The project has received support for five years and will provide annual - age, sex and cause-specific mortality estimates from a population of about 25,000 to 30,000 in a sample of 27 districts…,"*(IHI official, TDNP 2010).

Explaining the importance of the project, the IHI official further noted:

> *"From a recent survey, it was established that only 20 percent of the deaths in the whole country takes place in health institutes, the rest 80 percent happens in homes and elsewhere. Likewise, many births are not recorded and this is bad for the government as it can't have effective plans. The SPD aims at bridging the gap,"* (IHI official, TDNP 2010).

In support of the project, one of the MoHSW officials noted that the government was looking forward to use the SPD data in planning and health policy making.

> *"The government has been facing the challenge of producing timely, accurate and reliable health data. The launch of this project will definitely answer all these challenges and will be a good platform in policy making,"* (MoHSW official, TDNP 2010).

The MoHSW official further noted,

> "*We will use SPD in measuring the failure and successes that we have registered in the implementation of several policies. It will also help in improving the health care at the household level*," (MoHSW official, TDNP 2010).

IHI being part of the HMIS strengthening consortium, took the SPD project as an opportunity to contribute to the countrywide HMIS strengthening through implementation of DHIS2 in 27 districts scattered all over the country. The IHI approached the HISP team upon being sanctioned by the MoHSW, to implement DHIS2 in the 27 districts. The implementation included training of data clerks and CHMT members, and installation of DHIS2 in all the districts. IHI recruited one information officer in each district, to do data entry, to follow up reports from the health facilities which have not yet reported and to perform data analysis and transmission to the central IHI offices. The information officers work in collaboration with the council health management teams:

> *"I sometimes work with the CHMT in doing follow up, and in generating reports for local consumptions at the council,"* (Data clerk, SPD).

Furthermore, IHI recruited one ICT personnel who was later trained on DHIS2 as a super user to provide support to the 27 districts.

Site four - Elizabeth Glaser Pediatric AIDS Foundation (EGPAF)

Elizabeth Glaser Pediatric AIDS Foundation supports Tanzania's Ministry of Health and Social Welfare (MOHSW) with technical support at national, regional and district levels. The Foundation works directly with individual districts and faith-based organizations to implement a broad range of HIV/AIDS services focusing on: expanding the provision of comprehensive PMTCT services;, improving access to HIV care and treatment;, reducing stigma and increasing awareness;, and strengthening systems and building capacity. As of December 31, 2010, the Foundation was supporting prevention of mother-to-child transmission (PMTCT) services at nearly 1,100 sites and care and treatment services at 165 sites in six regions within Tanzania. Arusha is one of the regions where the PMTCT services are supported by the foundation (EGPAF, 2009).

In January 2010, EGPAF, through the HISP team, implemented DHIS2 in all the districts in Arusha including the regional level. The program was ready to support only PMTCT data sets. The implementation process included training and installation of the software in the existing computers at the district and the regional level. EGPAF hired one ICT officer who also received DHIS training in order to provide support to the districts and the regional levels. According to the project's technical staff, DHIS2 was slow, due to some of the existing computers being old. However, they have acquired a new computer for the regional level which receives all the reports from the districts. When asked whether there is any plan to scale up DHIS into other regions the official noted:

> *"We have plans to expand to other regions where we are working, following successful results from Arusha,"* (HMIS Officer, Fieldwork 2011).

Commenting on the HIS strengthening in Tanzania one national HMIS officer noted the following:

> *"Coordinating the implementing partners is a big challenge, and currently there is no HMIS policy guideline to hold them responsible,"* (HMIS Officer, Fieldwork 2011).

The issue of coordination is further pointed out by an external evaluation team as a challenge facing the HIS strengthening in Tanzania.

> *"No organization is the dominant node in the network. All had the same number of connections to the others and no single node is a gateway or coordinator,"* (PATH, 2011 p 23).

ANALYSIS AND DISCUSSION

In this section we draw on the concept of translation from the ANT complemented by the boundary objects concept to analyze the case. We begin by the analysis of the multiple translation processes taking place. Then we analyze the standardization challenges across the multiple translation processes, where the similarities and differences between them are cited out. Lastly, we discuss proposed strategies to address the challenges.

HIS Standardization Challenges: Juggling Across Multiple Translation Processes

The context of HIS strengthening in Tanzania consists of multiple–heterogeneous actors with varied interests. The actors include the Ministry of Health, HISP team, implementing partners (IHI, CHAI, EGPAF, JICA, JHPIEGO, etc), paper tools, software tools, and computers,–to mention just a few. At the genesis of the HIS strengthening, the MoHSW aimed to set itself as an innovator or network builder by mobilizing an alliance of actors and formed a consortium, which came up with a comprehensive plan for systematic HIS strengthening. The MoHSW aimed at using the plan as a program of action to translate the interests of various actors, which would then lead to a well aligned actor network with the MoHSW as the gate keeper.

As part of the program of action, the MoHSW identified DHIS2 as the standard software for the health sector. However, while the MoHSW was in the process of soliciting funds and preparing to implement the plan, other actors working in various initiatives and in different sites got to learn that the MoHSW had endorsed DHIS2 as the national standard, and that the software was flexible and capable of handling multiplicity of data sets and health programs' data in an integrated manner. In need of an M & E tool for their initiatives, these heterogeneous actors from multiple social worlds requested for DHIS2 to be installed in their sites. At first, the MoHSW viewed the request as it would undermine the overall plan of action. However, the first actor (JICA) was sanctioned under the premise that their implementation should be taken as the 'test' site for the overall plan. Furthermore, this was seen as an opportunity to start the implementation by taking advantage of their resources.

With the consultation of the HISP team, DHIS2 was customized with two data sets, VCT and STI, which were the programs of interest for JICA. The implementation which included training and installation of the software into new computers provided by JICA was effective at the districts and regional level of the 'test' region – called Pwani (Coast). Demonstration of the results from the 'test' region into a stakeholders meeting spurred other actors to enquire for their data sets to be implemented using DHIS2 in the same region. At this juncture, DHIS2 became an actor mobilizing other actors with their resources and align their interest with the HIS strengthening initiative.

However, emergence of other heterogeneous actors such as the CHAI, IHI, and EGPAF as DHIS2 implementing partners working in other regions changed not only the role of the MoHSW as an innovator imposing its program of action on others, but also the role which DHIS2 played as an actor in the networking building process. Our argument is that the emergence of heterogeneous actors spurred multiple concurrent translation processes with multiple view points and mandatory passage points of which the overall coherence forms the core of the problem (Star and Griesmer 1989). For instance as part of the translation process, CHAI working in two regions aimed to demonstrate that ARVs can be provided through health centers and dispensaries and thus expand access to rural areas. Hence, the need for data of sufficient quality to monitor essential indicators related to that initiative.

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Conversely, IHI focusing on 27 districts aimed at improving availability of timely facility based and demographic information-, and mortality data in all the districts in a bid to increase government's efficiency in planning. Likewise, EGPAF works with MoHSW in the provision and expansion of comprehensive PMTCT services and improving access to HIV care and strengthening systems and building capacity. In such a context of HIS standardization, it is not about how the MoHSW gets everyone on board, step-by-step, rather it's about reporting more broadly on the work of coordination, alignment mechanisms and translation chains between the different actors and worlds involved (Trompette and Vinck 2009). Thus, the argument is that while the involvement of multiple partners in HIS strengthening is desirable as a vehicle to utilize their resources to attain an integrated HIS, failure of the MoHSW to recognize and actively take the coordination role challenges the goal of HIS strengthening.

Table 2 presents similarities and the differences between the multiple translation processes across the multiple sites. As the case indicates, all the sites are making use of DHIS2, however not all sites implemented all available data sets. EGPAF for instance, implemented only the PMTCT data set. Furthermore, almost all the implementing partners provided new computers at district and the regional levels for DHIS2, except EGPAF who made use of the existing computers which according to technical staff made DHIS2 to run slowly. As a result, this required the acquisition of a new computer for the regional level where all data from the districts converges. In terms of the OS, all sites are making use of Microsoft Operating System except the test region where Linux OS, which is perceived as less prone to viruses, is used.

Following the initial training of data clerks and HIS managers, and installation of DHIS2, regular support in the sites is provided by the implementing partners. However, the support activity is carried out differently across all sites. Until the time of this writing there was no guideline on how the support activities should be carried out. While some actors such as the IHI recruited data clerks in all the districts and ICT personnel at the central level to support the districts and the regional level, other actors like CHAI went a step further and contracted a private company to provide ICT support. Moreover, data transmission ends at the regional level where the central level seems to have been left out of the flow. At the same time, in order to ensure an integrated HIS, data from all the regions need to converge at the national level.

	JICA & Others (Coast region)	**CHAI (Mtwara and Lindi)**	**IHI (27 districts)**	**EGPAF(Arusha region)**
Use DHIS2	√	√	√	√
Employed data clerks	x	√	√	x
Recruited ICT technicians	x	√	√	x
Provides support to districts	√	√	√	√
Implemented *all* data sets	√	√	√	x
Provided new computers	√	√	√	x
Data transmitted to the regional level	√	√	√	√
Data transmitted to the national level	√	To programs at the central level	x	x

Table 2: Translation processes across multiple sites

As argued by PATH (2011) there is no actor in these multiple translation processes acting as a gateway or coordinator. Lack of coordination is further manifested by the duplication of work in some districts, where two different implementing actors find themselves working on the same project. The IHI covers 27 districts scattered all over the country. Some of the districts fall in the regions where other partners like CHAI or EGPAF are working, and as the case suggests, without coordination there is duplication of work and resources.

HIS Standardization Strategies: Use of Boundary Objects to Enable Multiple Translations

We argue that in order for the MoHSW to attain its goal of HIS strengthening within the context of multiple implementing actors, recognition and pursuit of its coordination role is indispensable. The role of the MoHSW as coordinators is to ensure that translation and negotiations across the multiple implementing actors, is one that supports and maintains a high level of coherence between the actors. The high level of coherence should result from carefully managing the creation, and crafting of boundary objects and the interfaces they provide between and across social worlds (Star and Griesmer 1989). The decision of the MoHSW to use DHIS2 as the national standard for HIS, led to the implementation of the same standard across the multiple implementation sites. As such DHIS2 facilitates dialogue and supports multiple translations across the multiple social worlds. Moreover, DHIS2 has a modular architecture where various data sets such as VCT, STI, and PMTCT are implemented as sub components. In that case, different parts of the object serve as a basis for dialogue between actors (Fujimura 1992). These characteristics qualify DHIS2 as a boundary object. By drawing on Star's categorization of boundary objects, DHIS2 can be conceptualized as a repository which gives a common reference point of data, measures, or labels across functions that provide shared definitions and meanings across the

multiple worlds (Star and Griesmer 1989, Carlile, 2002). As such, DHIS2 as a repository functions as a shared resource from which to compare across the different sites.

Standardized data collection tools used across sites, is our second boundary object of interest in our case, which provides a shared format for data gathering across the different settings. The standardized forms come in a mutual understood structure and language that includes standards for data reporting. Apart from guiding data collection across sites, the same forms are codified into DHIS2 thereby providing uniform data capture across divergent sites. This layering of different boundary objects provides a mechanism for dissimilar sites in terms of technological standards to collaborate and share resources. For instance, the standardized VCT and PMTCT forms are implemented across the various regions by the diverse implementing partners. These forms are captured in DHS2 at the district level, thereby providing a possibility of data sharing and integration across districts and regions.

As argued by Trompette and Vinck (2009), the notion of boundary object is used to describe how actors maintain their differences and their cooperation, how they manage and restrict variety, and how they coordinate in space and time. We see with the decision of the MoHSW that every implementing actor should make use of DHIS2 as one of the very vital steps towards ensuring coordination across the multiple translation processes. However, we submit that more needs to be done to ensure coordination which will lead to the availability of useful and comprehensive health data from all sites. For instance, from the case, not all the implementing partners put into action all the required data collection forms. Furthermore, not all of them are transmitting data to the national level. Mostly the data transmission ends at the regional level. Our argument is that in order to ensure coordination across the divergent sites the MoHSW need to do more than just circulation of boundary objects (see Figure 3).

According to Star and Griesmer, (1989) coordination and cooperation across multiple divergent heterogeneous actors and sites can be achieved not only through the use of boundary objects, but also through methods standardization. Our argument is that though the MoHSW managed to decide on the boundary objects to be used across sites, not much has been done as it pertains to methods standardization. Standardization of methods emphasize on '*how'* the multiple translations across the divergent worlds should be carried out. This include training guidelines stating clearly how trainings need to be conducted, number of days required, training categories available such as basic, intermediate or advanced training, depending on skills levels of users. As explained above, apart from the initial training provided by the HISP team, some partners conduct extra trainings in their working sites. The training guidelines are vital ~~in~~ to ensure common set of skills and capacity of the users across the divergent sites.

Supportive supervision is a continuous activity performed by each implementing partner to ensure smooth running of the systems on the ground. Guidelines on how supervision should be conducted across sites are important. This involves generalized categories in form of checklists of items covering different areas of the health information systems.

Other important documents include the HIS policy guidelines. In general terms, the document provides overall guidelines on the design, development, and operation of the country health information system. Among other things, it explains in general terms the architecture of the system, the need for each actor to use standardized objects such the DHIS2 and paper based forms, when and how should the revision of

standards be conducted, the information flow and when should every level of the health system send information to its immediate level. These standardized methods provide a common ground and a management system through which the multiple heterogeneous actors make substantial contribution to the general HIS strengthening, which is significant for developing world contexts.

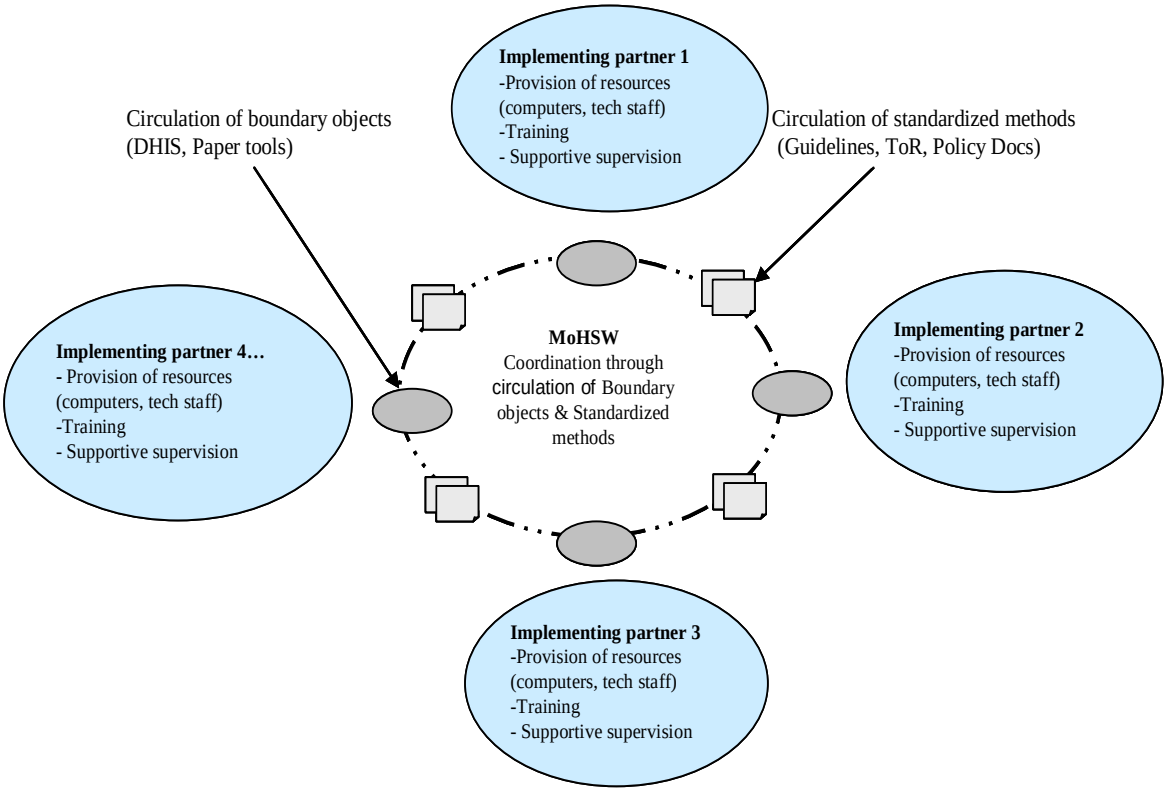

Figure 3: Working with Multiple Distributed Translation Process

The resource base of most implementing partners compared to the poor state of national authorities in developing countries makes formal top down managerial control ineffective (Aanestad et al. 2005; Nyella, 2011). As these actors draw on their resources to implicitly exercise control, this results to a situation where neither the MoHSW authorities nor the partners are in control in any strict sense (Nyella and Mndeme 2010). To attest to this fact, PATH (2011) evaluation report on DHIS2 implementation argued that '*no organization is the dominant node in the network'*. In such a context, control seems to be more or less stable or shifting network of alliances extended over shifting terrain of practices which discursively constitutes interests of the multiple actors (Clegget al. 1991). This accounts to Star's caution that the multiple actors should not be overly-disciplined. However, through managing the flow of boundary objects and the use of standardized methods (see Figure 3), the MoHSW gradually and implicitly exercise control and thereby strike a balance between multiplicity and heterogeneity of the actors and the need for cooperation and coordination (Star and Griesmer 1989).

CONCLUSIONS

Standardization and integration of HIS in most developing countries has been characterized as a complex and challenging undertaking, mainly due to poverty, multiplicity of diseases with myriads of diverse actors working in various initiatives within the health care context. While major actors such as the WHO insisted

on the need for coordinated partnerships and investments in health information systems (WHO, 2008), not much has been done to look at how it can be achieved in practice. As a contribution in this direction, our paper looked at the standardization challenges in the face of multiple partners funding and engaging in HIS integration in developing countries context. By drawing on the translation concept from the ANT supplemented by the notion of boundary objects, the paper analyzed the multiple translations processes, and highlighted the similarities and differences between them. Through the analysis the paper further stressed the need for the national HIS authorities to coordinate the multiple translations through circulation of boundary objects such as the software and standardized paper forms,; and standardized methods such as the HIS policy, training and supervision, and data flow guidelines, across the multiple implementing partners.

While many studies have used the translation concept to analyze HIS implementations, our study is unique in the sense that we have applied the concept in a context of multiple distributed translations with multiple viewpoints and mandatory passage points. In such a context, it's not about how one actor translates others' interests by imposing a program of action but rather it's about the work of coordination across multiple heterogeneous worlds without a single actor establishing pre-eminence over others. The task then becomes a search for a way to strike a *pragmatic balance* between multiple heterogeneous actors and the need for cooperation. As the paper suggests, this can be achieved through managing the flow of boundary objects and the use of standardized methods.

The paper contributes to policy and practice by stressing the fact that, bureaucratic control mechanisms in the context of multiple actors engaging in HIS standardization process is a futile exercise. Rather HIS authorities need to put in place and circulate across the multiple sites and actors, clear HIS policies and guidelines as *coordinating devices*. The study further suggests that the HIS authorities' choice of the software standard as a boundary object to be used across the heterogeneous actors is an important factor that determines the success of the project. In our case DHIS2 software standard played an important role in the coordination process, due the fact that it has in-built capability to accommodate and satisfy multiple and diverse data needs from a number of actors.

Future research can look at how the translation and the boundary object concepts apply in other similar contexts with multiple implementing actors, and how the role of the HIS authorities as coordinators affects the results of the project. Moreover, further research can empirically look at how is the choice of boundary objects affects the coordination process in other contexts with multiple actors engaging in the HIS standardization process.

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