JHIDC Health Informatics in Developing Countries

www.jhidc.org
Vol.4 • No.1 • 2010

Analysing the Challenges of IS implementation in public health institutions of a developing country: the need for flexible strategies.

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Abstract

This paper explores the challenges of introducing computer-based health information systems in the context of the Ethiopian public health care system. Drawing empirical examples from the process of introducing computer-based health information system(HIS) in two regional states (Amhara and Benishangul-Gumuz) of Ethiopia, this paper analyses the socio-technical challenges influencing the transition towards a new computerised system and suggested the importance of developing context-sensitive strategies to tackle different challenges in different contexts. Building on the notions of installed base and cultivation the paper examines the socio-technical issues and factors that influenced the process of developing, customizing, and implementing computerised HIS in different settings. The findings of this paper revealed that contextual differences in terms of access to infrastructural reources, availability of adaquate and qualified manpower, and managerial commitment and support would significantly influence the implementation process. I argue that, such context-senitive challenges need to be dealt through flexible startegies that took in to account the specific context. In this paper, four diffferent flexible strategies: the strategy of gateways, top-down vs bottom-up approaches, flexible essential data sets and clustering have beed identified as being useful in implementing computer-based systems in different settings of the Ethiopian public health care system.

Keywords
Health Information systems, implementation, flexible strategies, Ethiopian health care system.

1. Introduction

This paper explores the challenges of introducing computer-based health information systems in the context of the Ethiopian public health care system. Drawing empirical examples from the process of introducing computer-based health information systems (HIS) in two regional states (Amhara and Benishangul-Gumuz) of Ethiopia, the paper analyses the challenges influencing the transition towards the new system and suggests the importance of developing context-sensitive strategies to tackle different challenges in different contexts. The study has been carried out as part of the global Health Information System program (HISP), which is a global research and development initiative working on the design, development and implementation of computerized HIS in various developing countries including Ethiopia (see Braa & Hedberg 2002; Braa et .2004; Braa et al. 2007a).

The importance of strengthening the routine health information systems (HISs) has been well recognized by international organizations (Such as WHO, UNDP), aid agencies (such as World Bank) and national governments as one approach to support the public health reform initiatives of developing countries. More specifically, the Alma-Ata declartion of 1978 set out a new approach leading to the development of health information systems most commonly seen in many developing countries today. The Alma-Ata (1978) confrence emphasised on the importance of well-designed and well-functioning routine health management information system as an essential mechanism to achieve the vision of improved health services delivery in developing countries (WHO 1994) by allowing policy makers, managers and health workers to "identify problems and needs, track progress, evaluate the impact of interventions and make evidence-based decisions on health policy, programme design and resource allocation" (WHO-HMN 2007, pp. 6).

Recognizing the importance of a strengthening existing fragmented and unstractured health information systems for better health care delivery and management; there has been tremendous initiatives in developing countries to reform existing fragmented and paper-based routine health information systems, an "initiative spurred in large part by technological adavances, and the interest these adavances have generated in the health sector" (Vital Wave Consulting 2009, pp. 14). For example, there is growing recognition that ICT can replace traditional routine paper-based HISs with flexible electronic means and could bring significant cost reduction and effectiveness in terms of timely delivery of health care services in developing countries (see Mackenzie 1999, Braa and Hedberg

Referencing this article

Mengiste, S. A. (2010). Analysing the Challenges of IS implementation in public health institutions of a developing country: the need for flexible strategies [Electronic Version]. *Journal of Health Informatics in Developing Countries, 4(1)*, 1-17, from http://www.jhidc.org/index.php/jhidc/issue/view/9

2002; Braa et al. 2004; Braa et al. 2007a). The introduction of information and communication technologies has also been promoted both to automate and make existing paper-based routine data collection and reporting system efficient, such as to make different patterns (e.g. mortality, immunization, fertility etc) visible that are often invisible with manual systems.Technology can also improve data collection quality, accuracy and timeliness. Electronic systems also make reporting potentially much more flexible and efficient by allowing data to be analysed at the level where the data is collected as well as the levels above it. On the contrary, in paper-based systems data is collected and compiled manually at each site where the data is collected, a process that hinders managers and decision makers at higher levels of the hierarchy from viewing the disaggregated data coming from lower levels of the system (Braa et al. 2001).

To tap the potentials of ICT based technologies and tools, various developing countries including Ethiopia embarked in ICT based initiative to transform theor existing paper-based data health management information systems. For example, Alvarez (2004) reported the initiatives of the government of Ecuador in collaboration with donor agencies (such as IDA), to decentralise and modernize the health management, including the HIS, in health districts of the country to support primary health care services. There are also similar reform initiatives to decentralize public health care delivery system and strengthen the existing paper-based HIS though ICT in various African countries including South Africa (Braa & Hedberg 2002), Mozambique (Nhampossa 2006; Mosse 2005), Tanzania (Kimaro 2006; Lungo 2008; Igira 2008), Ethiopia (Mengiste 2005; Bishaw 2008) Nigeria (Shaw, Mengiste et al. 2007) under the frame work of HISP in collaboration with other international organizations such as WHO and regional and national governments (Braa et al. 2004; Braa et al. 2007a).

However, introducing such ICT based initiatives to transform existing paper-based data collection tools and systems in public health institutions of developing countries is a difficalt proces of chage often fraught with several context-sensitive challenges and problems including: lack of adequate resources (such as poor financial resources and uneven infrastructural development) (AbouZahr 2005; Mosse and Sahay 2003); inadequate skills and knowledge at a local level to handle new systems and technologies (Kimaro & Nhampossa 2005); fragmented and uncoordinated organizational structure and heterogeneity of stakeholders (Chilundo & Aanestad 2004); and political and bureaucratic constraints (Heeks 2002; Avgerou & Walsham 2002; Mosse and Sahay 2003). For instance, the public health care system in Ethiopia is characterised by differences across regions and between districts and zones within a region in terms of existing HISs (paper-based, DHIS, and statistical tools such as EpiInfo), uneven infrastructure development (such as access to computers, internet connectivity, availability of telephone & electricity), differences in geographic size (large and small), differences in human capacity and competency (both from the IS and health domains), and varied organizational and managerial commitment and support. In such contexts, it is appropriate to get a deeper understanding of the contextual challeges at a local level and formulate context-sensitive startegies. This paper, therefore, aims to explore the different contextual challeges and choices of action adopted in introducing change to the existing paper-based health mangement information systems (HMIS) in two regional states of Ethiopia (Amhara and Benishangul-Gumuz), and draw lessons and strategies for IS implementation in the context of developing countries.

More specifically, this paper would like to address the following research questions:

- What are the challenges that influence the process of making a transition from paper to digital HIS in different settings of the Ethiopian public health care system?
- What strategies could be formulated to deal with the challenges in different settings and contexts?

This paper is organized as follows. The next section provides the conceptual framework by conceptualizing HIS development and implementation as cultivation of the installed base. In section three, the research setting, research approach and data collection methods employed are presented. Section four describes the case study which is related with the process of introducing computer-based health information software (DHIS) in two regional states of Ethiopia. Section five presents analysis and discussion of findings by emphasising the need for flexible strategies. The last section provides concluding remarks.

2. Conceptual framework: the notions of cultivation and installed base

In recent years, proponents of the Information Infrastructure perspective (for example, Hanseth & Monteiro 2004; Hanseth & Aanestad 2003; Hanseth & Lyytinen 2004) use the cultivation approach as analytical tool to explore socio-technical processes in different contexts of introducing large scale and complex information systems. In this paper, on concepts of cultivation and installed base from information infrastructure (II) theory (Hanseth et al. 1996; Hanseth and Lyytinen 2004; Hanseth and Monteiro 1998) as analytical lens to explore the challenges of introducing computer-based health information systems (HISs) in the context of the Ethiopian public health care system.

Traditional IS design strategy assumes that systems can be developed from scratch, as isolated and stand-alone applications with defined goals, start and ending times rather than as events changing overtime through ongoing process (Orlikowski 1996). However, contemporary approaches treat design and change not as traditional IS but as Information Infrastructure (II) (Hanseth et al. 1996). The II perspective which seeks to analyse systems

as heterogeneous inter-connected socio-technical networks (Hanseth and Monteiro 1997, 1998) is used as an appropriate analytical tool to understand the challenges of introducing change when there are multiple socio-technical factors influencing the change process. The current trend of viewing ISs as Information Infrastructures (see Hanseth 2002; Hanseth and Monteiro 1998) is the result of acknowledging the increasing complexity in terms of technical as well as social entities (see Jacucci et al. 2002) in the process of developing and implementing ISs. For example, socio-technical factors (such as geography, history, legacy systems, technical support and competency, political commitment and support, poor infrastructure and other organizational issues) that are embedded in the broader context significantly influences the process of change and implementation of technical artefacts/software, best practices, standards, experiences and knowledge. Hanseth (2002) in addressing how an Information Infrastructure is changed argued that:

> *"the whole infrastructure can't be changed instantly- the new has to be connected to the old. The new version of the infrastructure or artifact must be designed in a way making the old and the new linked together and interoperable in one way or another. In this way, the old- the installed base- heavily influences how the new can be designed" (no page).*

Strategies for creating and managing such processes are conceptualized as cultivation of the installed base (Hanseth 2002). The process of introducing change to large and complex ISs, therefore, requires taking in to account the existing installed base of work practices, human resource competency, systems and standards, technological artifacts, available resources, organizational commitment and support.

The concept of installed base refers to what already exists (technical and non-technical) in terms of the existing standards, diverse software versions, infrastructure (both physical and digital), human resource, work routines, and organizational structures. As such, any process of designing, developing and implementing an information infrastructure cannot be started from the scratch; it should rather take into account existing systems, procedures, processes and standards while trying to introduce new changes. As such the installed base influences and shapes the evolution and implementation of the new system (Nilson, Grisot and Aanestad 2005). However, the installed base cannot be changed instantly because of its sheer size and degree of embeddedness and its change heavily influences how the new II can be designed (Hanseth and Monteiro 1998). Thus, an II is built through extensions and improvements of what exists - never from scratch. Changes have to be linked to the existing installed base, either as extensions, revisions or replacements. Because of its nature, II evolve beyond a single management or actor's control (Ciborra et al. 2000; Hanseth et al. 2001; Aanestad 2002).

The notion of cultivation (Dahlbom & Janlert 1997; Hanseth and Monteiro 1997, 1998) considers the design and development of II to be a long-term incremental strategy, extending and growing upon an existing installed base rather than to trying and radically changing the installed base (Braa et al. 2007a; Hanseth and Monteiro 1997). The cultivation approach, instead of believing that it is possible to create without being restrained, believes that the appropriate thing to do is to be as sensible as possible of the existing situation and conditions of the part of reality. By doing so, unlike the designer, the cultivator learns how and when to intervene to change existing systems, structures, standards, process and work practices (Söderström. and Nordström 2005). As such, the Cultivation approach requires a prior analysis of the organisational, technological, social and political context of the already existing elements of the installed base (Hanseth and Monteiro 1998). With cultivation approach, it means that an II is never developed from scratch. When designing a new II, it will always be integrated into or replacing a part of earlier one (Braa et al. 2007a).

In this paper, therefore, the notions of installed base and cultivation are used as analytical tools to provide insight on how to deal with the challenges of introducing computerized HIS in public health care institutions of a developing country. More specifically, changing existing routine paper-based HIS which is currently in use at different levels of the public health care system in Ethiopia is a complex process that requires the actions, interactions and negotiations of several stakeholders (including health workers, mangers, donor agencies, system analysts and developers). As such, the transition process requires careful assessment of existing installed bases and formulation of specific strategies on how to deal with diverse challenges in cultivating existing systems, tools, standards and work practices for different settings and contexts. To this end, this article investigated the challenges of making a transition in such complex setting based on empirical findings from the experiences of cultivating existing routine paper-based HIS in two regional states of Ethiopia.

3. Research Setting, Approach and Methods

3.1 Research Setting

This section describes the research setting and research strategy adopted. The empirical setting for this research is Ethiopia which is located in the north eastern part of Africa with a total area of 1.1 million km2 and a total population of 73.2 million growing at a rate of 2.6% per year (CSA 2008). More than 85% of its population is living in rural areas, making Ethiopia one of the least urbanized countries in the world (HSDP III 2005/06-2009/10). Politically, Ethiopia introduced a federal structure since 1994 comprising of 9 National Regional States (NRS) and two city administrative states . The regional states as well as the city governments are further divided into 65 zones, 624 'woredas' (districts) and around 10,000 'kebeles (the lowest administrative bounty) (HSDP III, 2005/06-09/10).

The public health care system in Ethiopia comprises of the Federal Ministry of Health, Regional Health

Bureaus, Zonal Health Departments, and Woreda Health Offices, with their respective health facilities – central referral (specialized) hospitals at the federal level, hospitals at regional, Zonal and district levels, and Health Centres, Health Stations, and Health Posts at district (woreda) levels. The health care system is largely underdeveloped and under resourced and as a result can only provide basic health services for about 60% of the population (HSDP III, 2005/06-09/10). Much of the rural population has no access to modern health care, leading to inability of the health care delivery systems to respond to the health needs of the people.

In Ethiopia, as per a report made by HSDP III (2005/06-09/10), lack of timeliness and completeness of HIS reporting remains a weakness, and such delays contribute to the failure (at all levels) to use data as the basis for informed decision-making in health care planning and management. Recognizing the weaknesses of existing routine paper-based system, there have been repeated efforts to reform HMIS in Ethiopia (WHO-HMN 2007). The government recognizes that an efficient HIS, would play a crucial role in successful implementation of national health sector development program's strategic plan (WHO-HMN 2007).

As a result, both the federal government and regional states in collaboration with international organizations, donor agencies, and bilateral collaborations introduced several reform initiatives to improve the existing poor status of health management information systems at all levels. , Some of such reforms include: "standardization of procedures in data collection, analysis and reporting; selection of sector-wide and programmatic indicators with the involvement of stakeholders, design of simplified items (question) of the formats; and integrated and unified flow of information" (ibid, pp. 4-5). This research is an integral part of this reform process conducted with in the framework of the global HISP initiative which has been working on the design and development of computerized HIS in five regional states of Ethiopia and many developing countries in Africa and Asia (see Braa et al. 2004; Braa et al 2007a; Braa et al. 2007b, www.hisp.info; Sæbo and Titlestad 2003 for details about HISP activities in different countries).

HISP-Ethiopia has been initiated in 2003 as a collaborative project between departments of Information Science, Addis Ababa University and the University of Oslo, Informatics department. Furthermore, an agreement has also been reached between HISP and 5 regional health bureaus (i.e., Oromia, Amhara, Tigray, Benishangul-Gumuz, and Addis Ababa) to change existing routine paper-based HIS by adapting and implementing DHIS software; collaborate on the development of standardized essential data sets, reporting formats and indicators; and in building capacity through training of health workers and managers at different levels of each regional state. Up until HISP initiatives disbanded by the Federal Ministry of Health in 2007 in favour of an American-based consulting agency (John Snow Inc. (JSI)) to undertake all HMIS reform activities both at regional and national levels; HISP has been engaged in building local capacity of health workers and mangers as well as in adapting and implementing district-based health information software (DHIS) across the five pilot regions. For example, in Addis Ababa, the project had supported the full scale implementation of DHIS ver. 1.3 in 11 sub-cities, 5 hospitals and 23 larger health facilities of the regional health bureau that enabled electronic transmission of data from the lower to the upper levels to replace the paper-based reporting system. In Oromia, DHIS 1.3 has been implemented in 5 out of 25 zones and transition from DHIS 1.3 to DHIS 1.4 was undertaken at the time when HISP stopped its operation. In Amhara regional state DHIS 1.4 has been deployed in 11 zones and an effort was underway to scale the system to some selected pilot districts (woredas). In Benishangul, DHIS 1.3 has been piloted at regional health bureau and one zonal health office. In this paper, the challenges and strategies of changing existing routine paper-based HIS drawing on the experiences from HISP initiatives in Amhara and Benishangul-Gumuz regional states is provided.

3.2 Research Approach and Methods

This study employed a qualitative research approach, based in the interpretative tradition (Walsham, 1993), which seeks to understand complex social, technological and organizational issues related to the development, customization, and implementation of information systems in different contexts. As Walsham (1993) pointed out, interpretive research is "aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context" (Walsham 1993, p. 4-5). The empirical data presented here was collected by the author who is an Ethiopian national and a member of the HISP-Ethiopia development and implementation team. As a member of the HISP-Ethiopia team, the author participated in conducting situational analysis, software customization, implementation, and capacity building activities in Amhara and Benishangul-Gumuz regional states since 2004. Apart from the knowledge that comes from different sources during long term exposure in the project, the empirical material for this specific study was collected through semi-structured interviews, observation during meetings and workshops, and document analysis.

Interview:

Interviews were conducted with managers at regional, zonal and district levels, health workers, HMIS officers, and HISP-Ethiopia development and implementation team members. Questions asked during the interview sessions were open-ended and semi-structured. Questions were more specifically structured to reflect on the challenges of transforming existing paper-based HIS and the approaches and strategies adopted to deal with those challenges. Besides, an informal group discussion (during lunch and coffee sessions) with HISP-Ethiopia team members as well as managers, and health workers at regional and district levels was held frequently to get their opinion on different issues related to the problem of existing paper-based system, implication of the new system in changing work practices and the specific challenges encountered in making the transition.

During each interview, notes were taken which was then summarised and rewritten by the researcher.

Participant Observation:
As a member of the HISP-Ethiopia team, I participated in meetings, discussions held with HISP-Ethiopia team members. The issues addressed in those meetings and discussions covered different topics including progress of the project, problems encountered by each team member in the customization process (understanding the technologies, capacity and skill gaps infrastructural problems including weak internet connectivity etc), duties and responsibilities of members, how to link the new system to earlier versions that are in use in different health care institutions of different regions. The issues raised and discussed during those meetings and discussions assisted me to gain an overall understanding on how the project was progressing, what were the impediments and challenges encountered in the development and customization process, and on the technical competency of the local team members

Besides, I also participated in workshops held both in Amhara and Benishangul-Gumuz regional states where health workers and managers from different public health institutions come together and discuss on issues of standards, indicators, reporting formats and the problems and challenges they encounter. This gave me an opportunity to get first hand information about the challenges and, approaches of improving the existing paper-based system. Besides, I was able to have personal and informal discussions with some participants to get their opinions on the potentials of introducing computerised system to improve their work practices.

Document Analysis:
Analysis of existing documents (both printed and electronic) was another source of information. The relevant documents included strategic plans (such as HSDP III, 2005/06-2009/10), reports, and formal "Memorandum of Understanding" documents with the involved partners. These documents were reviewed to gather contextual information regarding public health care practices, policies introduced and strategies adopted to deal with specific challenges and problems.

4. Case Description

The empirical basis of this article is a case study of the initiative of implementing computer-based health information system in the Ethiopian public health care system in the framework of the global Health Information System Programme (HISP). Since its initial development and implementation in the public health care system of South Africa in 1998, several versions of DHIS software have been adapted and are at different stages of implementation in various countries in the South including Mozambique, Tanzania, Malawi, Botswana, Nigeria, Vietnam, India, and Ethiopia. This case study, therefore, focuses on the trajectory of adapting and implementing DHIS ver. 1.3 in Benishangul-Gumuz and 1.4 Amhara regional states. The case study gives emphasis on the contextual factors influencing the adaptation and implementation of the software, the strategies adopted and the lessons learned from the process.

4.1 Benishangul-Gumuz Regional State

Benishangul-Gumuz region is one of the nine regional states in Ethiopia, which is located in Western part of the country. The region is relatively small, covering 51,000 km2, with the capital city Assosa located 687km from Addis Ababa. It is divided into 3 administrative zones, 19 woredas and 33 kebeles. According to the 2007 Population and Housing Census of Ethiopia, the total population of Benishangul-Gumuz region is 670, 847 which gives a population density of 9/Km2 (Flatie et al. 2009). Parts of the region are seasonally inaccessible by road or air. The livelihood of nearly 95% of the population in the region is subsistence farming (Flatie et al. 2009). Although Benishangul-Gumuz regional state is endowed with potential natural resources and has a great development potential (Melkamu 2004); currently it is one of the remotest, and least developed regions in the country and remains food insecure (ibid). The socio-economic conditions and health and nutrition status of the communities are very poor; the prevalence of malaria in particular is very high. HIV/AIDS is on the increase and the status of education across the region is also poor and consequently the majority of people are illiterate (Melkamu 2004).

The public health care system in the region is characterized by poor structure and inefficient delivery of health services to the population. The region has high prevalence of communicable diseases like tuberculosis, malaria, and intestinal parasitosis. The infant and under five mortality rate for the region is 84/1000 and 157/1000 live births respectively (FMoH 2006). The region has 2 hospitals, 15 health centers, and 88 health posts of which 1 hospital, 3 health centers and 44 health posts are located in Assosa zone (where Assosa is the regional capital) (ibid). According to a report by the Federal Ministry of Health (FMoH, 2006), the health services coverage in the region is about 55% of the population and the health services utilization rate is very low. This is mainly due to the fact that actual health service delivery service utilization is influenced by other factors such as transport availability, level of qualification of health workers and distribution of the health facilities and availability of adequate equipments and technologies in health facilities (Melkamu 2004).

4.1.1 Findings of situational Analysis in the region

Situational analysis conducted by HISP-Ethiopia team members (including the author of this paper) to assess the status of existing HIS, infrastructural (including digital and physical), and human resource related issues revealed that existing HIS is highly fragmented at all levels and characterized by poor infrastructure and inadequate manpower to handle the system. The following sub-sections, therefore, provide findings of the situational analysis on how existing HIS operates; infrastructural and human resource challenges and the strategies adopted by the regional health bureau in collaboration with HISP to curb the challenges (see Mengiste 2005 for details of the findings of the situational analysis).

Findings on Existing HIS in the region:
Structurally, the regional planning and programming unit is responsible for coordinating and managing the regional HIS in collaboration with zonal and district health offices. However, this office lacks adequate resources including skilled manpower, financial and material resources and HIS infrastructure (including adequate computers, access to internet and other communication devices) to spearhead the aspiration of the regional health bureau in transforming existing fragmented routine paper-based HIS into a system that supports health care delivery by making essential health data for planning, implementation and evaluation of health programs and services in the region.

The existing paper-based HIS is also highly fragmented. This problem is exacerbated by the continual and persistent demand of vertical programs (such as MCH, HIV/AIDS, Malaria to maintain their own independent reporting systems. This lack of integration impedes the ability of leveraging data from multiple sources in making informed decision on disease patterns, immunization coverage, outbreak of potential epidemics etc. It also put much pressure on health workers at lower levels by forcing them to compile different reports for different programs. A nurse in one of the health facilities visited in the region expressed her frustration as follows:

> *"we often spent many hours every week compiling several forms for different health programs and yet we do not practically see the impact of the data we are reporting in improving health care delivery in our community or district."*

In terms of data collection and analysis, routine health data is collected using registers and paper forms at local community and facility levels from which it is compiled and reported to district health offices on monthly or quarterly basis. Each district again will aggregate the reports of each health facility in each respective district and send it to zonal health offices. The zonal health offices will compile reports for all districts in the zone and send reports to the regional health bureau. The planning and programming office at the regional health bureau, then aggregates the data from all zones and make some analysis on disease patterns, potential outbreak of epidemics and coverage of health services in each zone and make intervention when needed. Health workers and mangers interviewed indicated that most of their time is spent in data collection; compilation and preparing different reports to different health programs and to the regional health bureau (see Mengiste 2005 for details). Regarding the importance of the data they collected and reported to higher levels, respondents pointed out that they don't see any value on the data in changing their day to day work practices or in improving the health delivery system. The respondents view the routine data collection process as a duty imposed by higher levels, and they undertake the data collection just because they are required to do so.

Findings on existing Infrastructure:
As a newly established regional state, the region also suffers from inadequate infrastructural and logistical constraints in terms of access to transport and communication facilities and technologies. Poor physical and digital (such as access to internet, computers, telephone roads, and electricity) infrastructure in the region is an impediment for many socio-economic development initiatives in the region (Melkamu 2004). For example, two of the three zones (Kemashi and Metekel) do not have transportation access during rainy seasons to reach to the capital of the region (Assosa) (see Mengiste 2005; Melkamu 2004). With regard to computers and access to internet, the situational analysis revealed that there are computers at different departments of the regional health bureau, but without internet connectivity. At zonal and district levels, all but Assosa zonal health office had no access to computers. Electricity is a problem in the region, only the regional capital (Assosa) gets power from the central government. Telecommunication and postal services are also at their lowest level in the region. For example, there are only two digital telephone stations in the region one at Assosa town and the other at Pawe. The other zones and districts have only radio communication facilities. This lack of communication and road infrastructure severely affected the possibility of establishing health and education services and distribution of goods and services to the rural population by hindering the flow of resources, facilities and information.

Findings on Existing Human resource:
The empirical findings of this study revealed that lack of skilled and trained manpower with deep knowledge of public health, competency on data collection, analysis, indicator calculation contributes for poor performance of existing HIS and slow pace of introducing change to the existing paper-based HIS.

The human resource challenge is further exacerbated by frequent turnover of existing manpower seeking for better pay and conducive working environment. Most health workers (including medical doctors and nurses) join non governmental organizations working at national and international levels. For example two of our champions (the head of the regional health bureau and maternal and child health coordinator, both of whom are medical doctors) who have exerted so much effort to change the existing fragmented and unstructured data collection and reporting system in the region, end up in joining international NGOs working in Addis Ababa.

Highly bureaucratic recruitment procedures as well low salary scale of the public service system is also another impediment in recruiting and retaining new work force to handle HMIS related activities in the region. The situational analysis also revealed that most of the health workers and managers at district, zonal and regional levels do not have any background or training on computers and associated technologies and tools. For example, the head of the planning and programming unit (who is also coordinating HMIS activities in the region) informed me that:

> *"my background is on statistics and I didn't get any training on computers. With my*

personal effort I can use some Microsoft office applications such as MS-Word and MS-Excel".

4.1.2 The way forward: devise context Sensitive strategies

The findings of the empirical investigation ensured that the only way forward to deal with all the challenges of fragmented HIS, inadequate human resource and poor infrastructural situation in the region is to devise context-sensitive strategies that took into account the reality on the ground at a local level. To this end, the HISP team working in the region in collaboration with the officials of the regional health bureau and heads of vertical programs devised strategies to tackle the challenges encountered in improving the existing paper-based HIS in the region. The following sub-sections, therefore, provide an overview of the approaches and strategies formulated.

Dealing with existing fragmented HIS:
The overall HISP approach and strategy of user participation and involvement at all phases of software customization and data standardization has been used as an approach to deal with top-down, centralized and fragmented HIS. As Braa et al. (2004) indicated, one of the essential issues that contribute for development and implementation of sustainable HIS at a local level is shaping and adapting the system to a given context, cultivate local learning processes and institutionalizing them at a local level. Similarly, to deal with the fragmented and unstructured data collection and reporting system, an agreement was reached between HISP and the regional health bureau to establish an HIS review team comprising of representatives from health workers, managers (from woreda, Zone and regional offices), vertical programs to undertake the standardization of the regional data sets and reporting formats, developing health indicators for the region, and customizing DHIS to cater to the needs of the regional health bureau. Though the overall process of data standardization and its deployment to different levels was fraught with tensions and conflicts mainly emanated from diverse requirements and demands of vertical health programs (due to their interest to maintain their data items), inadequate skilled manpower with bask knowledge on health data analysis, and poor access to resources (including financial and infrastructural); HISP has devised different strategies to tackle the challenges and to make its initiative in the region more sustainable. Some of the strategies include:

- Enhance a bottom-up, incremental and participatory approach in introducing change to existing systems, work practices and standards. This approach empowers health workers and managers at lower levels by creating a sense of ownership to the system and giving opportunity to understand and question the value and importance of the data they collect and report. In Benishangul-Gumuz, this approach has been adopted during the process of developing essential datasets and standardizing data collection and reporting forms.

- Enhance interaction, negotiation and mutual learning through workshops and group meetings organized at different stages of the standardization process.

- Address the challenges of fragmentation and lack of good quality data by developing the regional essential data sets and reporting formats.

- Introduce the notion of flexible standards across different levels (see Braa and Hedberg 2002; Braa et al. 2004) that allows a hierarchy of information needs whereby local users at health facility and district levels can expend the essential data sets to address their specific needs, while still reporting on the essential data required at higher levels.

Dealing with infrastructure related challenges:
The existing poor digital infrastructure in the region (particularly in terms of telephone, computer, fax and internet) significantly affected the exchange of crucial information, for example, on disease outbreaks, or delivery of vital equipments and medicine at the right time. Although addressing the existing infrastructural challenges of the region were beyond the goal and capacity of the HISP initiative in the region; several strategies were devised to cope with these challenges in the process of implementing DHIS in the region. The strategies were developed by HISP team members in consultation with the officials of the regional health bureau. For example, to deal with the problem of computers at zonal and district levels, international organizations (such as WHO, UNICEF, USAID) that have been working in the region were contacted to donate used computers and an encouraging result had been achieved. Due to this approach about 8 used computers were delivered to the regional health bureau,. The then HISP facilitator in the region played significant role in contacting donor agencies and following-up the process. Besides, by consolidating and integrating the existing fragmented data collection and reporting formats, the number of reporting forms to be generated had been reduced which in turn reduce the work load of health workers and allow reports to be compiled and sent from one central location (where there is a generator and computer access) for a cluster of health facilities. In Benishangul-Gumuz, though initial efforts to analyze reports from a cluster of health facilities in Assosa zone brought encouraging results; the strategy was not fully tested at different zones and districts. My view is that, the clustering approach should be further explored in other resource constrained settings to better understand the strategy.

Dealing with human resource challenges:
The importance of building the capacity and competency of existing manpower at different levels of the public health care system had been emphasized as a strategy to deal with the existing poor human resource status (both in terms of access and skills) in the region. To this end, HISP-Ethiopia team members in collaboration with the regional health bureau devised different capacity building strategies. The key intervention strategies devised include: allow participatory adaptation and implementation of DHIS software to facilitate inter-disciplinary learning; organize capacity building programs at different levels to enhance to competency and skills of health workers and

mangers in both data quality, indicator analysis, and reporting as well as on basic computer hardware and application programs. These strategies are discussed as follows:

- Participatory adaptation and implementation of DHIS: This is a strategy that gives the opportunity for all stakeholders to collaborate and develop a feeling of ownership on the system to be introduced. The participation of all involved stakeholders in the process of software adaptation, standardization of existing data sets, indicators and reporting formats created an opportunity for inter-disciplinary learning and collaboration between IS people (including developers, implementers and facilitators) and health workers and managers. In this process, health workers and mangers interact and negotiate on different public health related problems (such as the need for integration of reporting systems and standardization of essential data sets, the importance of indicators for action and decision making, the number, frequency and type of reports to be sent to higher levels and the feedback mechanisms to be established to communicate with lower levels) through formal workshops as well as small group discussions organized at different levels. For example, the two day workshop held in Assosa in June 2004, created an opportunity for several health workers and managers from different levels of the regional health bureau to interact, negotiate and learn on the problems of existing routine health management information system and formulate strategies and tools to curb existing problems and weaknesses of the system.

  Besides, health workers and managers also participate on the customization of the software by giving comments on the layout of reports, the type of data missing, and the quality of reports generated. HISP implementers and facilitators, also got the opportunity to know about public health issues and problems including (indicators, reports, health services and programs) while they collaborated and interacted in standardizing existing data collection and reporting forms and adapting DHIS. The participatory adaptation and implementation strategy also creates opportunities to share the experiences and best practices of other HISP pilot regions. For example, Standardized data collection and reporting tools as well as DHIS software customized for Addis Ababa Health bureau were used as a point of departure to initiate the software customization and standardization process in Banishangu-Gumuz regional state.

- Capacity building through training: this is a strategy employed to upgrade the skills and competency of health workers and managers on wide diverse issues and topics including data management, indicator analysis, report generation, and the application of computers to undertake such tasks. In the context of this study, training aimed to improve the existing poor capacity of health workers and managers working on health data management and analysis were organized by HISP in collaboration with the regional health bureau. For example, in 2004 a one week training on basic computer hardware, MS-Office application packages (including MS-Word, MS-Excel, MS-Access), and on the functionalities of DHIS software were offered to 22 health workers and managers represented from the regional health bureau, the three zones and some districts (woredas). Through capacity building initiative introduced to offer training on computer applications and data analysis and report generation using DHIS; it was possible to create basic awareness to health workers and managers on computer hardware and software, on health data collection, analysis and report generation using graphical tools such as Excel pivot table. To make the capacity building program more sustainable, the need for continuous training and support to people working on health data collection and analysis were underscored. However, in practice there was no any follow up training due to resource constraints (financial and material), infrastructural challenges and due to intense work load of health workers and mangers at health facility and district levels.

4.2 Amhara Regional State

Amhara regional state is the second largest regional state (next to Oromia) with an area of 161, 828.4 km2, located in northwestern part of the country. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA 2008), the region has a total population of 17.2 million with a mean annual growth rate of 1.7% of the total population. The population density varies from 5 persons per km2 in low land areas of the northwest to 281 per km2 in the highlands, with a mean density of 125 inhabitants per km2 (WHO Consultancy Report 2004). The region is divided into 11 administrative zones, 118 districts (woredas) and 3,229 kebeles (the lowest administrative bounty) ((AHSDP III 2006).

The health care system in the region is largely underdeveloped and under resourced as a result of which the current system provides basic health services to only about 60% of the total population. Large proportion of the rural population has no access to basic health services. The region has 16 hospitals, out of which 3 are referral, 169 health centers and 2590 health posts (FMoH 2006).

4.2.1 Findings of the situational Analysis

Findings on Existing HIS

An assessment of the existing paper-based HIS conducted by the regional health bureau in collaboration with ESHE (Essential Services for Health in Ethiopia) project in 2004 showed that health data collection, reporting and analysis in the region is highly fragmented, top-down, inconsistent, and poor quality and redundant data being reported to higher levels. With regard to this, the head of the planning and programming department of the regional health bureau indicated that:

> "our assessment of reporting formats in health institutions, made it clear that our reporting system was fragmented and inconsistent between zones, districts and even health facilities".

In the existing system, data flows upwards from health facilities and districts to the regional and national levels as well as to different vertical programs, but does not flow back down to health care providers and mangers at health facility and district levels. The flow of routine reports in the region starts from health facilities where health workers collect the data on registers, fill it in reports and send to district (woreda) health offices. The district (woreda) health offices then compile summary reports (based on the reports of health facilities), and the aggregated report will be submitted to zonal health offices, which again compile the zonal report and sent to the planning and programming unit of the regional health bureau. However, besides the routine reports; health facilities, districts and zonal health offices are also required to compile independent reports to each vertical program.

Fragmentation of reports is another problem of existing HIS in the region. The system is expected to address the information needs of different health programs (such as Maternal and Child Health, HIV/AIDS, Malaria, tuberculosis etc) that are supported by different donor agencies as well the requirements of government organizations. To conform to the requirements of multiple programs and the regional health bureau, health workers at lower levels are forced to complete separate forms containing the same information to be delivered for different agencies who do not share data among themselves. As it is the case at national levels and in other regional states, vertical health programs significantly contribute to multiple reporting formats, fragmentation of reports, and an increased administrative workload on health workers and managers at health facility and district levels.

In summary, the empirical findings of this study showed that the routine paper-based HMIS in Amhara regional state had several problems including:

- Fragmentation of reports;
- Inconsistency and redundancy of reports;
- No feedback mechanism;
- Inadequate qualified manpower;
- Inappropriate use of available resources and digital infrastructure (including using computers assigned for HIS activities for only secretarial services).

Findings on existing infrastructure:
Although the region constitutes 15 % of the total geographic size of the country and 23.3 % of the total population (CSA 2008); the region is characterized by poor physical and digital infrastructure (including transport, electricity, telephone, internet and computer facilities), inadequate skilled manpower at all public health sectors including health and immense geographical distance between zones, districts and the regional capital (Bahir Dar). However, in recent days, due to the regional governments commitment to improve the physical and digital infrastructure in the region as an approach to improve public service delivery (including health and education); access to telephone, electricity and other digital technologies (such as computers and mobile phones) has improved remarkably.

In the health care sector, as per an assessment made by the researcher (see Shaw, Mengiste et al. 2007), 64 districts (out of the 118) in the region have access to latest computers (Pentium IV), all the 11 zonal health offices have computers in every unit including HMIS unit. Besides, as part of the effort of strengthening HIS capacity at district level, the regional health bureau had also distributed 70 new computers to districts of different zones in August 2007. The survey also revealed that almost all districts have access to telephone and electricity. However, though there is access to computers in all zonal health offices and in many district health offices; this study revealed that computers are not used for storing, analyzing and reporting routine health data at zonal and district levels. At the regional level, there was an effort to use computers for data compilation and analysis by using some statistical data analysis tools such as Excel and Epi-Info. Another positive indicator in terms of access to digital infrastructure in the region is the world bank and IMF funded WoredaNet project which aims to enhance education, healthcare, and agricultural activities by connecting all districts, zones, and regional states through a broad band network which is expected to improve existing state of digital infrastructure at regional and national levels (ICTDA 2007).

Findings on Human resource related challenges:
Lack of adequate and trained human resource for health service delivery and management is one of the long-standing problems in the region that impedes the delivery of appropriate health services to the community (WHO 2004). This shortage of manpower both in number and quality needed is prevalent at all levels starting from the regional health bureau down through the health system up to the smallest health unit (health posts) (ibid). With regard to availability of adequate and skilled manpower devoted to HMIS activities, the empirical investigation conducted in the region revealed that there is acute shortage of qualified manpower to undertake HMIS related tasks at district, zonal and even regional levels. For example, at the regional level, the planning and programming unit is responsible for HMIS related activates, but it is under staffed and most of them lack proper training and skills on health data management and analysis. At zonal levels, there are only few zones that assign manpower to specifically deal with HMIS activities. At district level, there no such a position at all. Most of the respondents interviewed at regional and zonal health offices indicated that the existing poor state of qualified and adequate manpower to handle HMIS activities is exacerbated due to the following reasons:

- High profile requirements set by the regional health bureau (for example it demands at least diploma in health sciences and 5 years working experience);
- Low salary scale, poor remuneration and incentives;
- Lack of on the job training and skills upgrading schemes;
- Negative attitude by managers at all levels for HMIS related jobs (being considered as low standard job);
- Extreme workload in compiling and aggregating reports resulted to high attrition of staffs hired

for the position.

4.2.2 Context-sensitive strategies

As it is the case in Bensihangul-Gumuz, HISP in collaboration with the regional health bureau had also devised context sensitive strategies to deal with the challenges related to existing health management information system (HMIS), human resource and infrastructure. Drawing on the lessons and experiences of the regional health bureau to restructure existing HIS and the findings of the situational analysis conducted by HISP team members (including the author), the following sub-sections provide the approaches and strategies followed in dealing with the multi-faceted challenges of adapting and implementing computer-based HIS in different public health care institutions of the Amhara regional state.

Dealing with existing fragmented HIS:

The regional health bureau had recognized the weaknesses of the existing paper-based routine health management information system (HMIS) in terms of fragmentation of reports, duplication of efforts, unused data being collected, and lack of standardization across all levels. To deal with these challenges, the bureau in collaboration with some international organizations (such as ESHE) took an initiative to standardise existing data sets and data collection tools. Standardization of existing data sets, reporting formats and work practices has been considered as a strategy to cope with fragmentation of existing HIS. To this end, in 2003 the regional health bureau established an ad-hoc committee to make an assessment of how the system works, and to identify the problems that affect the interoperability of the existing HIS at different levels. Regarding the work of the ad-hoc HMIS committee, the head of the planning and programming unit noted that:

> *"The HMIS committee and the experts (ad-hoc committee) discussed many and different sensitive issues of the formats and to do on assignment bases especially how to standardize and identify the bulky formats into monthly and quarterly ones. After this discussion each responsible body took the collected different reporting formats to comment on it. Each member of the group came with their very different idea and a very thorough and detail discussion has been done. All the suggestions could be included in the format (done by the planning and programming service of the Regional Health bureau) and another discussion has been made, of course many times"*

In 2004, HISP initiated its activities in the region and reached agreement with the regional health bureau to collaborate in finalizing the standardization process, customize DHIS software and implement the system to different public health institutions of the region. HISP's initiative to support on data standardization as well as customize and introduce the district-based health information software (DHIS) was accepted with strong support and commitment by the regional health bureau officials and the planning and programming unit. HISP-team members then joined the ad-hoc team at the beginning of 2005 and collaborate on the standardization process while at the same time undertaking the customization of the software. An initial draft of the essential data sets and reporting formats as well as regional indicators was developed by the ad-hoc committee and presented to different stakeholders in a workshop held in September 2005. The final report of the standardized regional data sets and reporting formats was released in December 2005. One of the essential contributions made by HISP in the standardisation process was the introduction of the hierarchy of standards approach in developing essential data sets for different levels. The hierarchy of standards approach gives flexibility for health workers and managers at lower levels (health facilities and districts) to include data sets they need at a local level as they long as they send reports as per the requirements of the higher levels.

The HISP team members used the new standardised format to customize DHIS ver. 1.4 before the system was implemented at regional and zonal levels. However, implementing the system to lower levels was a challenging task for HISP-Ethiopia team members as well as to the regional officials. More specifically, the lack of trained and qualified manpower (with skills and knowledge on computer applications) to handle the system at lower levels had been a threat to sustain the system at lower levels. Besides, due to differences in access to digital and physical infrastructure across districts in different zones, HISP was forced to develop context-sensitive implementation approaches and strategies. The following sub-sections, therefore, provide an overview of how the different challenges were dealt in the region.

Dealing with human resource challenges:

As it reported by Shaw, Mengiste et al. (2007), HISP tackled the challenges of inadequate and trained human resource at all levels of public health care system in the region by introducing a capacity building program in collaboration with the regional health bureau. For example, when a decision was made to implement the system to all zonal health offices, a two weeks training program was organized in May 2006 for trainees from each respective zonal health office. The training focused on two main issues: 1) basic skills on computer hardware, operating systems and application programs (such as MS-Word and MS-Excel); and 2) on functionalities of DHIS 1.4 and principles of data capture, analysis and report generation using the software.

However, short after the training, most of the trainees encountered problems to install and use the system once they were back to their zones which demanded a group of HISP team members (including the author) to travel to all zonal health offices in July 2006 and provide on-site training and support for a group of people including managers, HIS officers and statisticians. In our visit to zonal health offices, we found out that none of the trainees had managed to successfully install the software let alone start to use it. This was partly due to the trainees' lack of background knowledge and skills on computing technologies. As one HIS focal person who participated during the first round training noted that:

"… the training given for us in May 2006 in Bahir Dar was good, but for most of us with less background and knowledge even on basic computer applications, the complex instructions and dialogue boxes popping up during installation of DHIS software makes it very difficult to install the system."

Dealing with Infrastructure related challenges: Compared to the situation in Benishangul-Gumuz, Amhara regional state is in a better position with regard to access to computers, electricity, and communication and transportation facilities especially at zonal and regional levels. At district levels, there is uneven development where we find some districts with full-fledged access to the specified infrastructural facilities, while others remote and inaccessible even with road transportation. Taking this uneven distribution, HISP has devised a strategy that allows uneven development in terms of implementing the computerised system by implementing the system in those districts which have access to computers, communication, electricity and transportation facilities. For those districts without access to basic infrastructural facilities, HISP adopted a gateway strategy that allows integrating paper-based systems with computerised systems at different levels. For example, all health facilities will use the standardized paper-based reporting formats to send monthly or quarterly reports to districts. Those districts without access to computers will also use standardized forms to compile the report from each health facility in that district and sent to their respective zonal health offices. It is at the zonal level that every data coming from all districts will be stored into computers and reports will be sent to the region electronically.

4.3 Outcomes of the context-sensitive strategies

I personnaly believe that strategies should not be evaluated in terms of their results or outcomes, but interms of their strength in linking with the specific context. As such, the context-sensitive strategies adopted and employed in both Amhara and benishangul-Gumuz helped to identify specific contextual challenges contributed in building local capacity, stanadrdizing data sets and data collection formats, establish strong partnership with regional health bureau officials as well as managers of vertical programs. For example, in Benishangul-Gumuz region, in spite of the adverse situation in the region (in terms of infrastructure, manpower, and fragmentation of existing HIS), at the initial stages of the project, the HISP team members in collaboration with the mamagement of the regional health bureau manged to identify constraients and put forward startegies to standardise existing fragmented and inconsistent data elements and reporting formats, build the capacity of helath workers and magers at different level through trainigs, workshops, mutual engagemnt and learning programs. In short period (from July to december 2004) the software was customized implemented at the regional health bureau and one zonal health office. However, when time goes, it was not possible to keep the momentum and reinforce the implementation process due to several factors (some of which are presented in the following section). In Amhara, up until all the HISP initiatives were discontinued due to the decision of the Federal Ministry of Health by giving the mandate of HIMS reform activities both at regional and national level to an international consultancy firm; several context-sensitive strategies were formulated and the softawre customization and implementation process was undertaken based on those strategies. As a result, HISP in collaboration with the mangement of the regional helath bureau managed to develope standardized regional data sets and reporting formats, introduced capacity building initiatives (incuding trainings, workshops, participatory learning, on-site support), and implemented DHIS 1.4 at the regional helath bureau and all the 11 zonal health offices in the period from 2005 to 2007. The strategy of reaching out to districts with access to computers was not materialized due the decision of the Federal Ministry of Health. In sum, the major impediments that influenced the process of customizing and implemnting the computer-based health information system in the two regional states were:

- The implementation was structured to be undertaken by MSC and PhD students (including my self) as part of their research project, and when they are away from the field to pursue their academic work; all the task of software customization, user training and coordinating the implementation process in each respective region stacks eventhough regional facilitators were hiered to maintatin the momentum. The faciliatators often do the technical support in those sites where the system is implemnted and left aside the important task of negotiating with regional health bureau officials for additional resources and reaching out new health fcailities, or ditricts. This lack of progress in reaching out new zones and districts (more specifically in Benishangul-Gumuz) makes the regional health bureau officials unhappy and significantly influenced their motivation and interest to collaborate with HISP.

- The frequent staff turnover (mainly medical doctors and management team members) seeking for better salaries and benefits at international organizations contributed for loosing of key HISP allies who have been leading HMIS reform initiatives in the region. A case in point is the departure of two of our champions in Benishagul-Gumuz regional state to join international non-governmental organizations (NGOs) in Addis Ababa. Their departure was a blow for HISP and partly explains the limited success of HISP in terms of stimulating the change process at district and even zonal levels.

- The decision of the Federal Ministry of Health (FMoH) to disband HISP's operation both at national level and in the pilot regions where HISP was operating.

5. Analysis and Discussion: the need for flexible strategies

The process of developing and implementing IS in the context of developing countries is a challenging task (Heeks 2002; Avgerou 2002, 2007). This challenge mainly emanates from existing adverse situation of the installed base that is characterised by uneven infrastructural development across regions, inadequate skilled manpower, lack of integration and fragmentation of exiting standards, tools, and work practices, and varying political commitment and organizational support at national, regional and district levels. The installed based and the impediments associated with it demand different strategies to be adopted and implemented for different contexts and settings. The strategies and approaches adopted are also influenced by a wide variety of factors including: maturity of the new system to be implemented in the new setting, availability of required skills and knowledge to handle the system, project size and complexity, availability of resources and the required infrastructure, and unanticipated events that occur after the initiation of the project.

As it presented in the empirical findings of this paper, the process of introducing computerised HIS in two regional states of Ethiopia has been fraught with challenges and tensions emanating from fragmented structure of existing programs and services as well as infrastructural and human resource constraints. The empirical findings also provide an account of the different approaches and strategies employed to deal with the challenges encountered in different contexts and settings. Different strategies were formulated based on an assessment of the contextual aspects in terms of access to digital and physical infrastructure, availability of adequate and skilled manpower, and managerial commitment and support to introduce change to existing systems, standards and work practices.

One important implication of the empirical findings is the importance of the cultivation approach to deal with the complex socio-technical challenges of IS development and implementation in the context of developing countries. The cultivation approach allows change to occur in an incremental and step-by-step fashion over an extended period of time with minimal disruption to existing systems, technologies, standards and work practices (i.e. the installed bases). Organizations that adopt the cultivation strategy would nurture continuity and grow in a step-by step fashion by enhancing and improving existing infrastructure, adapting and customizing technologies, strengthening local competency and capacity, and incrementally changing routines and work practices. Although the cultivation approach is useful to deal with specific problems (including infrastructural, human resource and fragmented HIS) in a particular setting; it is difficult to employ it in contexts that require radical changes or in settings that needs to accommodate differences and diversity. The cultivation approach is often criticized for its lack of flexibility to respond to radical changes in the external environment (Salmela & Spil 2002). This paper, therefore, argues that, though the cultivation approach is useful to introduce change incrementally, it can be complemented by formulating flexible strategies to address context-sensitive challenges in the process of introducing computer-based systems and tools in developing countries.

The need for Flexible strategies:
To ensure success in IS development and implementation, the need to account for various contextual factors and issues has been emphasised by several researchers and practitioners (see for example Brown & Vessey 2003; Grossan & Walsh 2006; Robeyb et al. 2002). Different strategies have been proposed ranging from the complete implementation of the system within a short period of time (the “big bang”) to incremental implementation based on a phased approach over a certain period of time (see Brown & Vessey 2003). Heeks (2002) also noted that lack of appropriate strategies are the main cause of failures in IS projects in many developing countries. However, as Gebauer & Lee (2007) noted identifying IS implementation strategies is a challenging task mainly due to uncertainties and trade-off effects that need to be taken into account.

This paper argued on the importance of developing context-sensitive strategies by taking into account diversity and contextual differences in the process of implementing computer-based HIS in different settings of developing countries. Due to uncertain and unpredictable nature of the public health arena and the uneven infrastructural development, poor human resource capacity, and fragmentation of existing systems; it seems to be little value to come up with comprehensive strategies that could be used as universal solutions in all settings and contexts. In line with this, Bhandari et al. (2004) noted that because of the complexities and variations in context, it is not possible to develop generic strategies and deploy them in different contexts and settings. Strategies, should rather be emergent and targeted in tackling impediments posed by contextual factors.

As such, this paper goes one step further and argues the importance of adapting ‘flexible strategies’ to deal with context-sensitive challenges of adapting and implementing computerized IS in the context of developing countries. The uncertain and unpredictable situation encountered in different settings needs to be tackled through flexible strategies that are tailored to comply with specific challenges and opportunities at that specific time and place. As opposed to the cultivation approach which focuses on continuity and gradual change, the flexible approach focuses on the ability to adapt, in a reversible manner, to an existing situation (Bucki & Pesqueux 2000 pp. 2). In the context of this study, four flexible startegies are identified as being essential in the process of adapting and implementing computer-based HIS in two regional states of Ethiopia. The following sub-sections presents gateways, flexible essential data sets and clustering as flexible strategies adopted in this study.

Gateways:
One example of a context-sensitive strategy adopted implementing DHIS was the use of

gateways. The gateway approach had been used to deal with lack of access to computers at zonal and district levels. As Hanseth (2002) indicated, gateways play important roles in different situations at different phases of information infrastructure development. For example, they can be used to connect heterogeneous networks, being built independently or based on different versions of the same standards (ibid).

Similarly, the findings of this paper provide empirical examples on how gateways have been used to create an interface between paper-based and computerised systems in both Amhara and Benishangul-Gumuz regional states. When there is uneven development in terms of access to digital and physical infrastructure across regions and districts as it is the case in this study, gateways provide flexibility to address constraints by allowing data flow and communication through paper-to-paper, paper-to-computer and computer-to-computer interfaces. For example, if we compare the actions and strategies adopted in changing existing paper-based routine reporting system with an integrated computerised HIS both in Amhara and Bnishangul-Gumuz regional states; in Amhara, due to a relatively better access to digital infrastructure, it was possible to establish paper-to-computer gateways for data compilation and transmission at zonal level and even at district levels in some cases. Where as in Benishangul-Gumuz, due to poor access to computers and other infrastructural resources both at district and zonal levels, paper-to-paper gateways have been used for data capture, compilation and analysis all the way to the regional level. Braa et al. (2007a) emphasized on the need for flexibility of standards (such as essential data sets and reporting formats, technical artifacts such as DHIS) to cultivate existing installed bases and accommodate changing requirements over time. As such gateways serve as interfaces between different standards. Gateways, therefore, provide "an interface to link and translate between paper-based and electronic infrastructures, or between incompatible electronic infrastructures" (ibid pp.17). The gateway approach, as such contributed in managing data integration at different levels.

Top-down Vs bottom-up implementation:
Although the philosophy of the global HISP program is on bottom-up development, customization and implemntation of DHIS software (often at district level), in the case of this study we were forced to adapt top-down startegy to deal with the problem of access to computers, electricity and other infrastructural resources at zonal (Benishangul-Gumuz) and district levels (Amhara). In practice the HISP team memebers both in Benishangul and Amhara decided to combine both the top-down and bottom-up approaches. That means when there is acces to infrastractural resources as well as qualified manpower at lower levels, the bottom-up approach will be adopted, but if not the top down strategy will be used. This allowed uneevn developemnt to occur bettween districts and zonesd. For example, due to differences in geographic size and existing infrastructure between Amhara regional state (which has vast geographical size with 11 zones and 119 districts (woredas), relatively better infrastructural access st zonal level and in some districts) and Benishangul-Gumuz (which has smaller geographic size only 3 zones and 19 districts (woredas); poor access to infrastructure both at zonal and distric levels); differet approaches were followed in adapting and implementing DHIS as well as new standards and tools in the two regional states. As such, in Amhara, for example, efforts to implement DHIS 1.4 (see Shaw, Mengiste and Braa 2007)

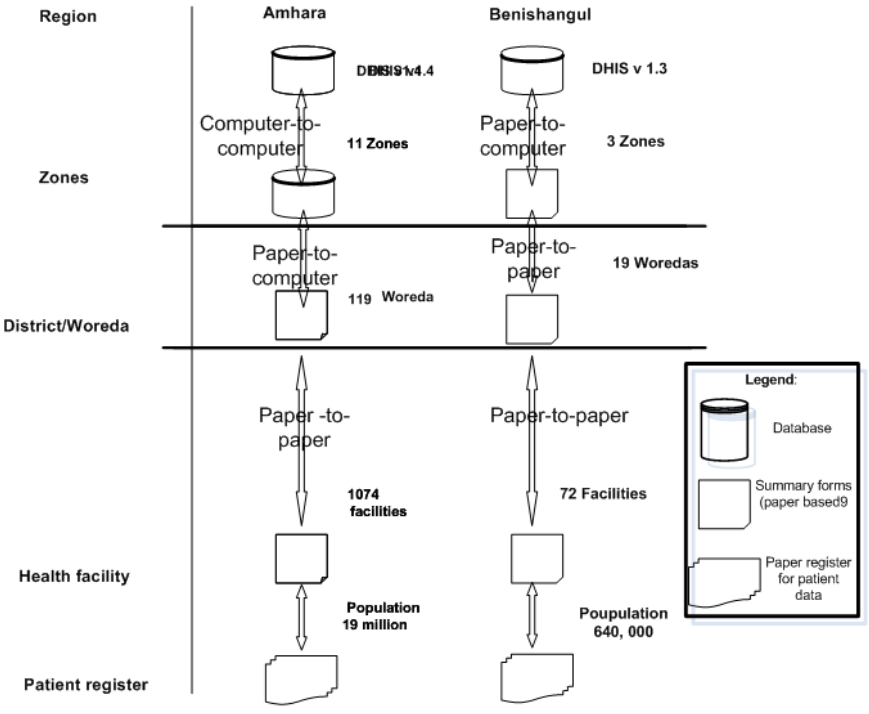

Figure 1
Gateways demonstrating data flow between paper and computer systems

required to mix both the top-down and bottom-up approaches where the system was implemented to all the 11 zones initially and to scale down to the lower administrative levels latter on (to districts) by taking into account availability of technical infrastructure (computers, electricity, telephone). In Bensihangul-Gumuz, however, due to lack of infrastructural resources at two out of three zones the strategy was only to follow the top-down approach and to fcus on improving access to infrastructure at lower levels.

Flexible standards:
The principle of flexible standards (Braa et al 2007a) allows local flexibility in adding data elements required at lower levels (health facility and district), but by conforming to central requirements at the same time. In the flexible standards approach, rather than using one universal standard that covers everything; hierarchy of standards are created (see figure 2 below). One example of flexible standards is the development of flexible "essential data sets" (EDS) by introducing the principle of hierarchy of standards (see Braa & Hedberg 2002; Braa et al 2007a). This approach enables local users to expand the essential data sets to address their specific needs, while still reporting on the essential data required at the central level (Shaw, Mengiste et al. 2007). The strategy of flexible essential data sets have been adopted both in Amhara and Benishagul-Gumuz while standardizing the regional data sets and implementing them. By standardising existing fragmented reporting formats and reducing the number of data elements and reporting formats at all levels, this strategy aimed to reduce the work load of health workers at lower levels, improve the flow of good quality data, and allow the local health workers and mangers to include the data elements they need at a local level as long as they conform to the requirements of the higher level. This approach, with or without the application of computers can contribute for good quality data to be reported to higher levels. For example in Amhara, though DHIS was implemented at the regional and zonal levels, the standardized system and reporting formats were implemented to heath facility and district levels allowing an integrated data flow at all levels.

Clustering:
This strategy had been adopted in Benishangul-Gumuz regional state mainly due to inadequate capacity and poor infrastructural situation to deploy computers at district and health facility levels. This strategy allows gradual expansion whereby priority was given in identifying alternative approaches to deal with the adverse state of infrastructural problems at zonal and district levels and in mitigating human resource challenges through on-going capacity building programs. With regard to the infrastructural challenges (mainly related to access to computers at zonal and district levels), an effort was exerted to alleviate the problem both by convincing officials of the regional health bureau to purchase and distribute computers to lower levels and by reaching out non-governmental organizations (NGOs) working in the region to donate used computers. In the clustering approach, computers and generators will be deployed centrally in a health facility and serves as a hub to a group of health facilities that have geographical proximity. Then all the health facilities will send their paper-reports to the central location whereby data capture, compilation will be made centrally for all health facilities in that hub and reports will be sent to the higher level electronically from the central hub. The same structure can be made fro different districts that have geographic proximity. This arrangement allows optimal utilization of resources and technical support can easily be delivered to the central hubs. In this study, the clustering approach was tested in one district (Menge Woreda) in Benishangul-Gumuz and an encouraging result was achieved. A similar approach had been reported by Sahay and Walsham (2006) in the process of scaling computerised HIS in India.

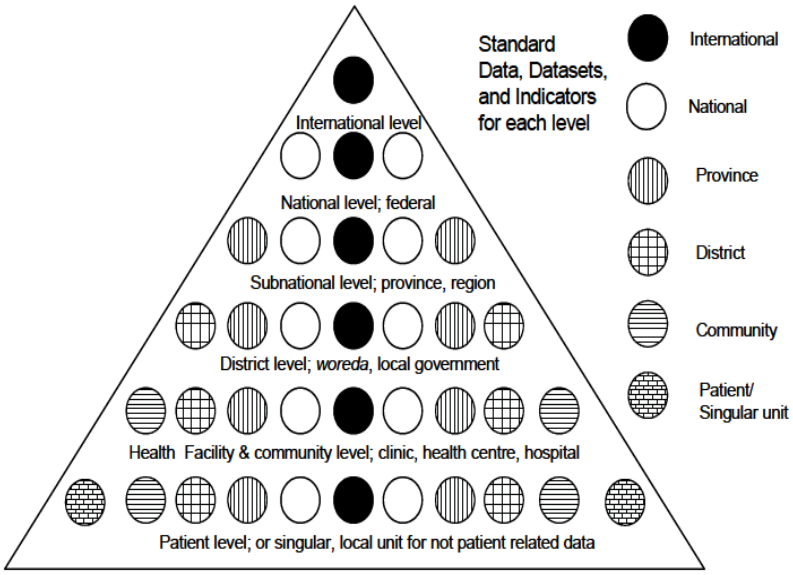

Figure 2
Flexibility through Essential data sets (as presented by Braa et al. 2007a)

6. Concluding Remarks

In this paper, we investigated the diverse socio-technical challenges of adapting and implementing computerised HIS in public health settings of Ethiopia. By comparing the infrastructural, human resource and structure and functioning of health management information systems in two regional states; the paper analysed the challenges and approaches of introducing computer-based information systems in resource constrained settings. The dilemma faced by those who are engaged in reforming health management information systems in the context of developing countries is the uncertain and unpredictable environment of public health care system of developing countries as well as uneven infrastructural development, fragmented nature of HIS and poor human resource competency across different levels. The public health arena is uncertain and unpredictable because of new policies, strategies, and regulations both on public health care and HIS activities that are triggered by the requirements of international agencies (such as WHIO-HMN 2008 for example), national governments, NGOs supporting vertical programs, and regional and district governments. The importance of the attitudes and preparedness of policy-makers and managers towards the change process cannot also be underestimated. One important lesson that come out of this study is that, lack of resources (infrastructural, financial and skilled manpower), as well as uncertain and unpredictable environments constrain the process of introducing ICT based systems and tools in the context of developing countries. In such settings, it is problematic to formulate comprehensive strategies that would address different challenges and problems in different contexts. As such, this paper suggested the importance of adapting flexible strategies to deal with context-sensitive challenges.

The empirical analysis of this study showed how it is difficult to employ strategies developed in one setting to address challenges encountered in another setting before they are appropriated and adapted to fit to the new context. Lessons learned and strategies developed in one setting could only be used as points of departure to develop new strategies by taking into account infrastructural, human resource, existing systems, and work practices and tools in the new setting. Strategies developed for one setting can't also be used for good to deal with all the problems in that setting. They should rather be regularly negotiated and reformulated based on emergent trends and problems, new interests, new policies, new actors, and uncertainties from the external environment. Such strategies should only be developed and maintained through continuous learning, negotiation, and by being sensitive to changes and uncertainties in the environment. That is why, this paper emphasized the importance of developing flexible strategies to deal with context-sensitive challenges in the process of implementing computer-based IS in developing countries which are often characterized by uneven development across regions in the same country and between zones and districts within the same region.

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