

**Analysing the Dynamics of Multi-level Learning in Implementing
computerised HIS in Developing Countries: Case Study from
Ethiopia**

**Shegaw A. Mengiste
University of Oslo
Department of Informatics
P.O.Box 1080
Blindern N-0316
Oslo, Norway
e-mail: mengisa@ifi.uio.no**

Abstract

This paper presents a perspective for looking at the development and implementation of large scale computerised HIS as a multi-level learning process. Drawing on the empirical evidences from the ongoing Health Information systems program (HISP) initiatives on the development, customization and implementation of computerised HIS in Ethiopia, the paper analyses the learning mechanisms, learning outcomes and obstacles for learning at individual, group, and organizational levels. Empirical data on two distinct phases of software development and customization (District health Information Software (DHIS) versions 1.3 and 2.0) are contrasted. More specifically, we tried to show the dynamics of learning and the specific learning mechanisms by analysing and contrasting the interaction between IS developers and public health care domain experts, technological capacity at individual, group, and organizational levels, and organizational commitment and buy-in in the process of developing, customizing, and implementing the two distinct versions of DHIS software.

Introduction

Information systems development and implementation can not only be seen as a process of designing and implementing technical artefacts, it should rather be treated as mutual and interactive learning: “systems developers learn about the non-technical context and would-be users learn about the features and functionalities of the hardware and software” (Braa et al., 1995; Aerts et al. 1998; Bondarouk, 2006). As Lyytinen and Robey (1999) pointed out, Information systems developers usually learn from their own and others’ experiences (domain experts) and use this knowledge to change their skills and development practices. Besides, organizations and would be users develop their capacity about systems development and view themselves as learning organizations which are able to learn from their experiences and effect changes in their own actions (Lyytinen and Robey, 1999; Scott and Vessy, 2000). Similarly, Bondarouk and Ruel (2002) noted that when a new information technology is introduced to individuals or groups, learning develops through specific interaction mechanisms, through which they share knowledge, express their attitudes towards the system, exchange experience while interacting with the system, and even collectively plan for further improvement and implementation (ibid).

In recent days, a number of scholars have conceived of IT/IS development, implementation and use from the perspective of organizational learning (see Attewell, 1992; Pentland, 1995; Lyytinen and Robey, 1999; Scott and Vessey, 2000; Robey et.al., 1995, 1999, 2000; Ang et al., 1997; Huysman, 2000; Bondarouk, 2006). Robey et al. (2000) noted that although the link between IS/IT development & implementation and organizational learning has only begun to be explored, two related streams of research are emerging. The first stream of research applies organizational learning concepts to the process of implementing and using information technology in organizations (this perspective was used in this study); where as the second stream is concerned with the design of information technology applications to support organizational learning and knowledge management (Robey et al., 2000). The first stream which is mainly related with using organizational learning to understand IS/IT implementation processes claims that organizational learning concepts would be instrumental in overcoming IS/IT implementation problems (ibid). The second stream of literature on the other hand, is mainly related to using IS/IT to support organizational learning processes such as knowledge acquisition, information distribution, information interpretation, and organizational memory (Robey et al., 2000). For example, Stein and Zwass (1995) noted that technologies such as data warehousing, expert systems, best practice databases, and internet/intranet systems potentially comprise components of organizational memory which support organizational learning processes.

However, in spite of the growing body of literature which addresses IS implementation from the perspective of organizational learning; the existing literature lacks a thorough theoretical elaboration on individual, group, and organizational levels of learning and the specific learning mechanisms used in the process. More specifically, in the context of HIS

development and implementation in developing countries, although the notion of learning is used to denote some examples of how local learning and best practices are shared and transferred across networks of individuals and organizations (see for example Braa et al., 1998; Braa et al., 2004; Braa et al., 2007); issues related to what has been learnt, by whom, and using what learning mechanisms are not exhaustively investigated and reported in the existing HIS literature. Besides, a systematic conceptualization of the learning perspective in HIS development and implementation is missing.

In this paper, therefore, we draw on a learning perspective to understand the dynamics of learning at individual, group and organizational levels in the process of developing, customizing and implementing large scale computerized health information system (HIS) in the Ethiopian public health care system. Building on the notion of “networks of action” (Braa et al., 2004; Engelstad and Gustavsen, 1993), this paper conceptualizes the heterogeneous institutions and actors involved in the process of HIS development and implementation as a network of learning. The network comprises of academic institutions, national ministry of health, regional health bureaus, PhD and MSc Students, software development teams, full time research staff and facilitators, international & local donors, and researchers. The context is an array of large and complex independent institutions involving a wide variety of actors with varied interests. While these institutions and actors have a degree of autonomy, they are intrinsically linked in a form of collaborating actors aiming at the development and implementation of an integrated national health information system. As such, there is always ongoing negotiation on the scope and activities of the project, new requirements and standards from user organizations (such as Federal Ministry of health, Regional health bureaus), the role of each actor in the network (individual or institutional), the required or expected deliverables (outcomes) at different levels, duties and responsibilities of the project team members collectively and individually... etc.

As such, the paper analyses the dynamics of learning in this network of varied institutional and individual actors at different levels (individual, group and organizational) by adapting the 4I organizational learning framework of Crossan et al. (1999). The primary focus of this paper is, therefore, to understand HIS development and implementation as a multi-level learning process that occurs at individual, group and organizational levels by drawing empirical data from the on-going global Health Information Systems program (HISP) initiatives in Ethiopia. Building up on the experiences of customizing, implementing, and scaling two distinct software versions (DHIS 1.3 and DHIS 2.0); the paper addressed the following research questions:

- What is learnt and what are the dynamics of learning in HIS Development, customization and implementation in the context of developing countries?
- What are the learning mechanisms that facilitate individual, group, and organizational learning in the process?

The paper is organized as follows: in section two, we present our theoretical framework on the 4I general organizational learning literature and the 4I organizational learning framework which used as analytical lens in this study. Section three introduces the research approach and methodology. The next section deals about the case description which compares the process of developing, customizing and implementing the two distinct versions of DHIS software and the specific learning mechanisms observed at each phase. Section five presents the analysis and discussion, where as the last section provides concluding remarks.

2. Theoretical Framework

2.1 Organizational Learning

Organizational learning is defined as the capacity or the process within an organization to maintain or to improve performance on the basis of experience (Nevis et al., 1995), a capacity to encode inferences from history or from experience into routines that guide future activity and behaviour (Levitt and March, 1988), systematic problem solving, and ongoing experimentation (Gravin, 1993). However, in spite of such definitions, there is little convergence or consensus on what is meant by the term, or its basic nature. Besides, the existing literature on organizational learning tends to be theoretically fragmented. Different researchers have applied the concept of organizational learning to different domains (Huber, 1991; Kim, 1993; Crossan et al., 1999). For example, Huber (1991) takes an information-processing perspective of organizational learning, whereas Nonaka and Takeuchi (1995) applied the term in studying product innovation, and March and Olsen (1975) use the term in exploring how the cognitive limitations of managers affect learning. As such, Robin et al. (2000) point out that: since organizational learning has a diverse origin, it is difficult to draw a uniform understanding of the term to be used and shared widely. Researchers have long drawn a distinction between two types of learning- exploitation and exploration (March, 1991), first- and second- order learning (Lant and Mezias, 1992), and single- and double-loop learning (Argyris & Schon, 1978; Argyris, 1982).

The term organizational learning is also applied to draw on analogies of individual learning or simply using organizational learning as an explanation for many different kinds of observed organizational change or adaptation (Argote et al, 1990; Crossan et al., 1999; Levitt & March, 1988). Some authors (see Argyris & Schon, 1978) explicitly deal with individual learning while others (see Lant & Mezias, 1992) propose a learning model which accounts for patterns of changes at the level of organization. Attewell (1992) emphasized the importance of individual learning only in so far as personal skills, insights and knowledge become embodied in organizational learning routines, practices, and beliefs that outlast the presence of the original individual. Unlike other approaches that treat organizational learning as a multi level process (see Crossan et al., 1999), Roby et al. (2000) view organizational learning as an organizational process where learning occurs only at organizational level.

Robey et al (2000) view organizational learning as a process that only occurs at organizational level and distinguish it from learning that might occur at other levels of social analysis, such as the individual, group, and inter-organizational. Attewell (1992) on his part argued that: “the organization learns only insofar as individual skills and insights become embodied in organizational routines, practices, and beliefs that outlast the presence of the originating individual.” Huysman (2000) on his part argued that an outcome perspective of learning focuses on activities that result in organizational efficiency, intelligence and flexibility, where

as a process oriented perspective is more likely to reveal the underlying dynamics of learning which either produce or impede positively valued outcomes.

In this paper, we primarily draw upon the 4I (intuiting, interpreting, integrating and institutionalizing) framework of Crossan et al. (1999) which views organizational learning as a multi-level (individual, group and organizational) interaction and learning process. This framework was chosen based on the following considerations. First, it adopts a process orientation to learning rather than considering learning as an outcome variable. Second, unlike the majority of organizational learning literature which mainly focuses on organizational level learning, the 4I framework brings the centre of attention in organizational learning research from a single level process to a multi-level learning process which involves individual, group and organizational level learning. Third, by treating HIS development, implementation, and use as a multi-level learning process that involves intuiting, interpreting, integrating, and institutionalizing, we believe that we can provide a richer theoretical exposition on the learning mechanisms and dynamics at different levels. As such, the following section presents Crossan et al. (1999) 4I framework.

2.2 The 4I Framework of Organizational Learning

Crossan et al. (1999) described organizational learning from the perspective of strategic renewal and developed a framework (which they call it 4I) to understand the process of organizational learning by presenting it as four related processes- intuiting, interpreting, integrating and institutionalizing- that occurs over three levels: individual, group, and organizational. The authors identified four key premises or assumptions and one proposition that form the basis of their framework:

Premise 1: Organizational learning involves a tension between assimilating new learning (exploration) and using what has been learned (exploitation).

Premise 2: Organizational learning is multilevel: individual, group, and organization

Premise 3: The three levels of organizational learning are linked by social and psychological processes: intuiting, interpreting, integrating and institutionalizing (4Is).

Premise 4: Cognition affects action (and vice versa)

Proposition: The 4Is are related in feed-forward and feedback processes across the levels (See Figure 1).

According to Crossan et al. (1999) *intuiting* is the “preconscious recognition of the pattern and/or possibilities inherent in a personal stream of experience.” It is the beginning of new learning. *Interpreting* is the “act of explaining through words and/or actions of an insight or idea to one’s self and others”. The third process of learning-*Integrating* – is “the process of developing shared understanding among individuals and of taking coordinated action through mutual adjustment”. The final process-*Institutionalizing*- is the process of ensuring the routinized actions which means that the learning that occurred among individuals and groups is embedded into organizations through “systems, structures, procedures, and strategy” (Crossan et al., 1999). For Lawrence et al. (2005), it is this process which makes organizational learning distinct from individual or group learning. However, the institutionalization of new ideas and practices does not simply happen; it depends on the actions of interested actors who work to embed them in the routine, structures and cultures of organizations (Lawrence et al., 2005; Lawrence, 1999; Dimaggio, 1998).

The three learning levels (i.e. individual, group and organizational) define the structure through which organizational learning occurs (See table 1 below). As such, intuiting and interpreting occur at the individual level, interpreting and integrating occur at a group level, and integrating and institutionalizing occur at organizational level. There is a sequence and progression to these processes through the different levels, and while there is some “spill over” from level to level, not every process occurs at every level (Crossan et al., 1999).

In a nut shell, “the 4I learning framework” developed by Crossan et al.(1999) has three important characteristics which can be summarized as follows:

- It is multilevel, bringing together individual, group, and organizational levels of learning and analysis;
- It is dynamic and tries to bridge the different levels of learning with specific mechanisms: and
- It clearly articulates four processes of learning: intuiting, interpreting, integrating and institutionalizing- that allow learning to feed forward to the organizational level and feedback to the individual and group level.

Table 1: The 4I Framework of Organizational Learning: Four Processes through Three Levels (Adopted from Crossan et al., 1999)

Level	Process	Inputs/Outputs
Individual	Intuiting	Experience Images Metaphors
	Interpreting	Language Cognitive map Conversation/dialogue
Group	Integrating	Shared understandings Mutual Adjustment Interactive systems
Organizational	Institutionalizing	Routines Diagnostic systems Rules and procedures

2.3 HIS development and implementation as a multi-level learning process

In this paper, we argue that HIS development, customization, implementation, scaling and use can be conceptualized as a multi-level (individual, group, and organizational) learning process. To understand the dynamics of learning and specific learning mechanisms, at different levels we adopt Crossan et al. (1999) 4I framework (see figure 1 below) as analytical lens. A brief conceptualization of the learning process that took place at different levels (from individual to organizational level) in the context of HIS development and implementation is presented in the following sub-sections.

Individual level Learning:

At the individual level, intuiting, entails recognition of patterns or possibilities emanating out of the individual's cumulative experience in software development and customization or in using different applications related to his/her work. Interpreting enables him or her to engage in a process of sense making to bring this understanding to the conscious level. As such, to interact with the technology, individual users or developers have to make sense of the functionalities of the technology and link with prior knowledge and skills related to the technology. This level of learning involves both intuiting and interpreting, and refers to individual competence, capability and motivation to undertake the required task. In the process of HIS development, customization, implementation; individuals both from the IS and health domains start to make sense of a given technology through formal training or through individual efforts by operating different functionalities and modules, searching for new techniques in the system, or replicating techniques they acquired during training.

Group Level Learning

Group learning refers to a group interaction and integration process through which members of a group change their knowledge and behaviour which balances between exploration of new operations, and exploitation of routine actions with newly introduced system (Crossan et al., 1999; Bondarouk and Sikkel, 2003). It involves the individual interpretations to integrate and develop a shared understanding among group members. Coherent collective actions would then become routines, and grow into institutionalized systems to be used by individuals and groups in their day to day routine activities. In the context of HIS development, customization, implementation and use; learning mechanisms such as group discussions, dialogue, meetings, software demonstrations, and informal conversations are the ways for integration and development of shared understanding and for further institutionalization of the software and standards.

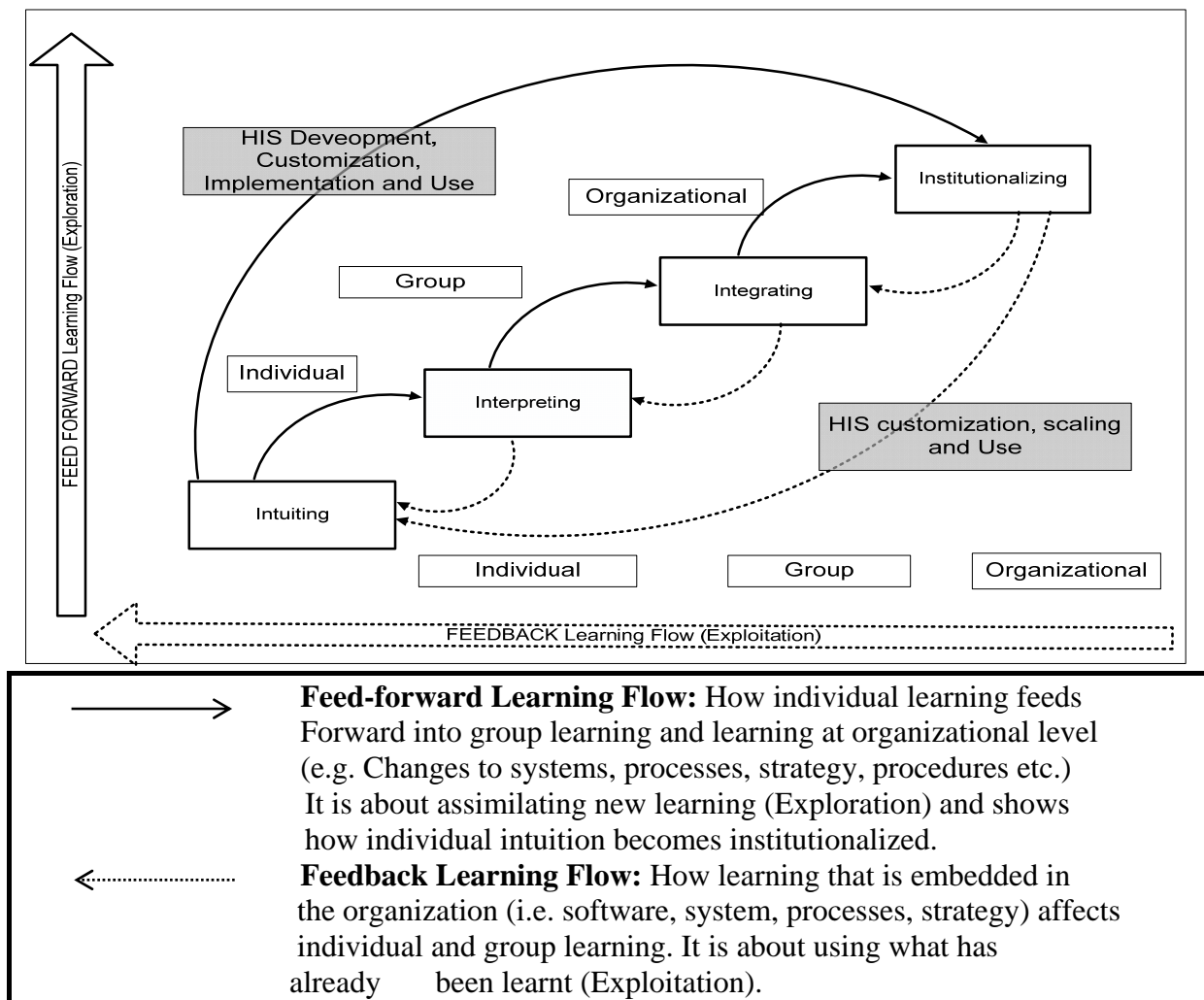
More specifically, the group learning process among health care professionals would involve issues such as: discussing difficulties in using the software, comparing the benefits of the software with the manual system or other software they know, develop common understanding on what is missing and what to be added to the software; request for further training, develop common understanding on the role of the system and its functionality etc. On the other hand, IS professionals involved in software development, customization, and implementation process would also be engaged in group learning and reflecting process through: deliberating on potential technological options to develop the application, communicating technical difficulties encountered in the development process informally among smaller groups; posting technical problems to the mailing list of international developers; demonstration on different modules developed; in-house training for team members on new technologies, evaluation of results achieved, working with health workers and managers on the requirements, reflecting on users comments on what to incorporate to the system and conducting post-implementation evaluation and assessment on the systems usability.

Organizational Level Learning

Organizational level learning represents the translation of shared understandings into new systems, procedures, processes and strategy. It involves embedding individual and group learning into the non-human aspects of the organization (Bontis et al., 2002). Incorporating institutionalizing as a critical element in the process of HIS development, implementation and use allows us to look beyond the role of specific individuals and to include in the overall

process the critical roles played by internal/external actors and members of the network in the wider organizational context. For example, once DHIS software has been implemented and become part and parcel of the routine activities of HIS staff in Addis, it creates a learning opportunity to health workers and managers at different levels of the health care system to understand and exploit further new standards, tools, procedures and functionalities which in turn brought a feed-back learning flow from the organization to group and individual levels as it is depicted in figure 1 below.

Figure 1: HIS Implementation as multi-level Learning Process (Adopted from Crossan et al. (1999) 4I Learning Framework)



3. Methods

This study used a qualitative research approach, based on the interpretive research tradition (Walsham, 1993), which seeks to understand complex social, technological and organizational issues in connection with the design, development and implementation of information systems in different contexts. This study is part of the global Health Information System Program (HISP) (Braa et al., 2004) initiative being undertaken in Ethiopia since 2003 aiming to design and implement a sustainable district based computerised HIS in the Ethiopian public health care system. While the overall HISP project understands itself as an action research project,

this research is not framed not in an action research framework; rather in an interpretive research framework.

Data was collected in two field works (May to August 2006 and October to January 2006). As a member of HISP-Ethiopia team, I participated in different activities of the project including: situational analysis, software customization, implementation, and capacity building activities in different regional states since the inception of the project in 2003. Apart from the knowledge that comes from different sources using the long term exposure in the project, empirical data for this specific research was collected through semi-structured interviews, observation during meetings and workshops, document analysis and analysis of e-mails distributed through group mailing list.

4. Case Description

4.1 Background

HISP is a large scale and on-going global program which is engaged in the design, development and implementation of health information system in many developing countries including Ethiopia (Braa et al., 2004; Braa et al., 2007). HISP was initiated in Ethiopia in early 2003 to:

- Undertake the design, development, customization, and implementation of open source application software called DHIS (District based health Information Software) in the Ethiopian public health care system;
- Build capacity of health workers and managers through training and on-site facilitation and operational support for implementation at different sites.
- Enrol PhD and MSc students both in Informatics and Public Health streams who are also doing their research on health information systems development and implementation. Currently about 5 PhD and 10 MSc (including those who completed their studies) students are studying at the University of Oslo.

HISP-Ethiopia was initiated as a collaboration project between the Department of Information Science, Addis Ababa University and Department of Informatics at the University of Oslo. Initial attempts by HISP to get the formal approval of the Federal Ministry of Health were not accepted mainly by giving a pretext that they are intending to undertake the development and implementation of HIS using their own experts, and indicating that their priority was the development of a national HMIS (Health Management Information System) strategy. As such, HISP was forced to establish collaboration with regional health bureaus and an agreement was signed between HISP through Addis Ababa University and 5 regional health bureaus (i.e., Oromia, Amhara, Tigray, Benishangul-Gumuz, and Addis Ababa) to carry out HIS development and implementation. So far, HISP is at different stages of implementation in the pilot regions. For example in Addis Ababa, DHIS (District based Health Information Software¹) version 1.3 has been implemented in all sub-cities and scaled down vertically to 5 hospitals and 23 larger public health facilities; in Oromia, DHIS 1.3 has been implemented in 5 zone and transition

¹ DHIS is a district-based health data management information software which was originally developed in 1994 to support the health information management activities in South Africa and it is currently being customized in many developing countries including Ethiopia. It undergoes several version changes of which the most significant is the current effort of developing a platform independent, web-enabled, and open source software called DHIS 2.0

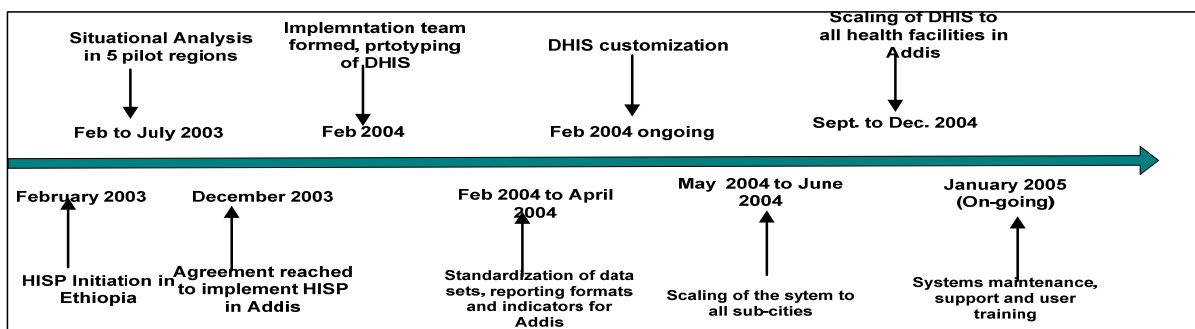
from DHIS 1.3 to DHIS version 1.4 was conducted in all the 5 zones and currently they are trying to scale DHIS 1.4 to all the 17 zones; in Amhara DHIS 1.4 has been deployed in 11 zones and an effort is underway to scale the system to some selected pilot districts; in Tigray there was unsuccessful effort to implement DHIS 1.3 in 2004 and currently an effort is underway to implement DHIS 2.0 in two pilot districts. In Benishangul-Gumuz, DHIS 1.4 has been implemented in 3 zones in August 2006 and an effort is under way to scale the system to districts (See appendix 1 for summary of major milestones about HISP Implementation in Ethiopia).

Therefore, in this paper, the case study focuses on HISP experiences in the process of computerised HIS development and implementation in the Ethiopian public health care system by taking DHIS 1.3 customization and implementation in Addis Ababa and the development and customization process of a new platform independent, web-enabled, open source software called DHIS 2.0. The two cases were selected due to the differences in the learning mechanisms and learning experiences at individual, group and organizational level. In the case of DHIS 1.3, the software was customised and implemented in all public health institutions of the Addis Ababa health bureau which involves action as means and mechanism for individual, group and organizational learning; whereas in the case of DHIS 2.0 development and customization process that action which brings the system to the public health institutions is missing and the system is yet under development which affects the mutual learning process and not yet institutionalized which affects the feedback learning flow.

4.2 DHIS 1.3 Customization and Implementation in Addis Ababa

Initial efforts to change the existing paper-based HIS in Addis Ababa started in December 2003 as a result of the agreement reached between HISP and the Addis Ababa city government health bureau.

Figure2: Important Milestones in the process of DHIS 1.3 Development & Implementation in Addis Ababa



Assessment made on the existing paper-based HIS in the city demonstrated the existence of inconsistencies in reports and duplication of data elements and reports as well as existence of incomplete and untimely reporting. As the strategic plan (2004- 2007) of the regional health bureau disclosed:

“... poor data management system and poor utilization of information for action are the main problems of the existing paper-based HIS in the region. It has been seen that the codes of diseases are not updated and there is lack of standardised formats for all types of health related information. On the other hand, there is redundancy of similar

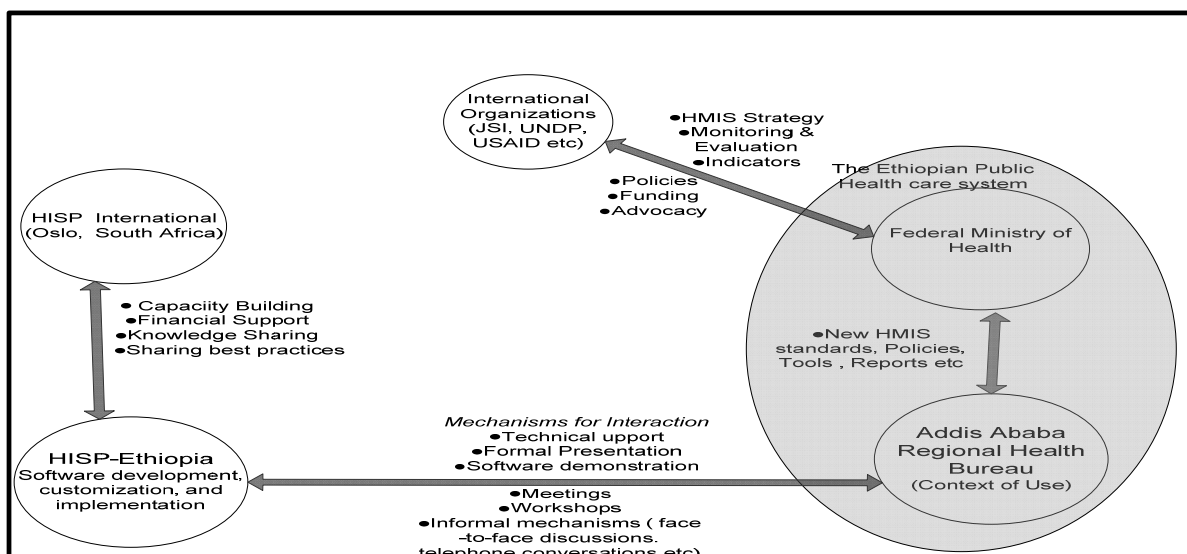
formats by different programs and lack of summary sheet. One important weakness of the current HMIS is the absence of accountability in the whole process of information flow.”

It was at this critical moment that the HISP-Addis Ababa team members approached the regional health bureau officials and propose for standardization and integration of existing data elements and reporting formats as well as replacement of the existing paper-based reporting system with computerised system. The proposal got the full support of the head of the regional health bureau and many other department heads. As a result, in December 2003, the management of the health bureau endorsed the district-based health information software (DHIS version 1.3) to be customized and implemented at all levels of the public health hierarchy (i.e. health facility, sub-city and regional levels) in Addis Ababa. This formal acceptance of HISP by top officials of the regional health bureau created an opportunity to sign a formal framework of agreement between the two parties which in effect allowed HISP to start the customization and implementation DHIS 1.3 in Addis. The following sub-sections will present the specific learning experiences at individual, group and organizational level and the learning and interaction mechanisms among different individual and institutional actors in the process (see figure 3 for pictorial representation of the network of actors and the interaction mechanisms).

4.2.1 Who learns what and what are the learning mechanisms?

Following the formal agreement between HISP and the regional health bureau, a local team consisting of HISP team members and domain experts from the health bureau was formed to undertake standardization of existing paper-based data elements and reporting formats, as well as to customise, prototype and implement DHIS 1.3. The following diagram (figure 3) summarises the network of actors and institutions that are directly or indirectly involved in the process of DHIS 1.3 customization and implementation in Addis Ababa regional health bureau and the interaction mechanisms among those actors involved.

Figure 3: Summary of interaction mechanisms among major actors in the development and implementation process of DHIS 1.3 in Addis Ababa



Individual Level Learning (Interpreting):

It is known that individual insights, talents, technical competency and skills both from the IS and health domains makes a difference for the successful implementation of HISs. Individual insights as well as technical competency and skills could help to develop a sense of shared understanding among different group members which in turn would lead to institutionalization of the system, standard, processes, and procedures. Similarly, during DHIS 1.3 customization and implementation process, individual talents as well as shared understanding among group members played a significant role for the successful customization and implementation of the software in all public health care facilities of the Addis Ababa city government. For example, the then HISP-Addis Ababa team leader's insights, technical competency in mastering and customizing the software played a significant role for the successful implementation of the software at all levels of the public health care system in Addis. Besides, her approaches in convincing the management and health workers about the software had also significantly contributed in building shared understanding among domain experts and HISP team members. Besides, the insights and commitment of the then regional health bureau head to support the ideas of HISP and commit resources for the purchase of computers and other required resources, for training and allocation of office space and recruitment of manpower for HIS related tasks had significantly influenced many health managers and health workers to collaborate with HISP team members and ensure the successful implementation of the software across all levels of the public health institutions of the Addis Ababa city government. Similarly, insights and initiatives of individual users' from the health domain to understand and use the computerised system improved their technical competency and enabled them to explore the different functionalities of the system by their own effort (through learning by doing). As one HIS officer in one of the Hospitals indicated:

"...although I didn't take the training given by HISP, when I was assigned to this position I tried to understand the system (DHIS) by asking some help from the facilitator....Now I almost managed to use all functionalities of the software by my own personal effort. I even start to use pivot table and manipulate e the data by taking to excel so that I can easily make graphs and charts and present the reports using graphs and charts."

Group Level Learning (Integrating):

A group of developers or users of a computerised HIS would also start to learn, reflect, and share their understandings when a new technology is introduced to them. This can develop through various mechanisms including formal training and demonstration about the functionalities of the system or informally through operating with basic modules in everyday task performance, or searching for new techniques in the system. Shared understanding and knowledge dissemination could also be conducted by demonstrating the operations of technical modules in workshops, seminars, meetings; by deliberating on the mechanisms to improve some modules and functionalities of the software; by clarifying difficulties and problems through questioning and discussion. Group members could also take initiatives to request for additional training, instructions, support, and other learning activities based on their reflections and shared understanding. Similarly in Addis, in order to gain the support and commitment of all actors and stake holders towards the successful implementation of the software in the region, the HISP team in Addis used different mechanisms including software demonstration and prototyping, standardization using participatory approaches, discussions, formal and informal meetings and workshops.

Prototyping:

A prototype of DHIS software was developed using real data taken from different health facilities and demonstrated in order to show the functionalities and potentials of the software. In the process of preparing the prototype, the HISP-Addis Ababa team conducted several consultations and discussions with the domain experts to learn about their needs and requirements and those requirements were incorporated into the software. This in turn helped to customise and adapt the software locally to fit local requirements based on end users' comments and requirements. Then the prototype was demonstrated in a workshop held at the regional health bureau in February 2004. The workshop created an opportunity for further discussion and mutual learning on the weakness and strengths of the software. As one of the HMIS coordinators at the regional health bureau indicated:

“... the prototype demonstration created a better environment for the domain experts not only to comprehend the system and express their needs and requirements but also to appreciate and develop interest in the DHIS software. Besides, this process also helped to easily identify inconsistencies and problems (such as existence of similar data elements in multiple reporting formats with different purposes) in the current reporting formats. We were really happy to see the sample reports generated using our own data, and understand that we can generate ad-hoc reports easily using pivot table reports”

Standardization:

The process of standardizing data elements, identify required health indicators, and design integrated reporting formats for all health programs and services was also used as mechanism to facilitate learning among domain experts and the technical HISP team members in Addis. The domain experts and the HISP team combined and formed a team to undertake the standardization process. The team managed to prepare a draft standardised data sets for different health programs and services including: maternal and child health, disease prevention and health programs, health education, and health services. The team also compiled data elements that are collected at sub-city health departments and at the regional health bureau levels. In the process of preparing the first draft of the standardised data sets and reporting formats, regular meetings, workshops, visits to health institutions etc were conducted along with the day to day informal face to face discussions and telephone conversations among the team members. Regarding the lessons gained in the standardization process, one of the HISP team members noted the following:

“... the standardization process was the best way to better understand the domain area(i.e. the health care domain) including the data elements and indicators for each health program and service.... The discussions with in different groups and presentations of different working groups in workshops enabled most of us to be more familiar to the terminologies of the domain and helped us in our effort of designing reports and customizing the software according to the requirements of the users.”

Software Customization:

Customizing DHIS 1.3 software so that it fits to the local requirements was another efficient learning mechanism both for the IS people and the domain experts. The domain experts' active participation in the customization process played a significant role in understanding the complex public health data and to incorporate it into the software. For example, the incorporation of the new morbidity and mortality module into DHIS would be difficult

without the support and ongoing collaboration of health workers and managers. In the process both the domain experts and the technical team members improve their knowledge and learn from each other. As one of the HISP-Addis team members indicated:

“... based on the comments received from the domain experts , some changes were made on the newly designed ICD code module. Some of the changes made were: adding ICD description column in addition to the ICD column in the report, mimicking the paper format for Morbidity & Mortality data entry and reporting forms, cutting long names of fields to fit the data entry window...”

Training:

Capacity building by offering formal training to health workers, statisticians and managers on basic computer applications (such as MS Windows, MS-Excel and Ms-Access) and on the functionalities of DHIS software was also used as a means to strengthen their competency in health information system management and use. The impact of the training on DHIS was so positive that all of the trainees requested the regional health bureau to speed up the installation in their respective sub-cities and health facilities so that they proceed using the software before their knowledge on the software fades. Besides, the training had also created an excellent opportunity for increased awareness and participation of the domain experts and users of the system in improvising the system (such as the report lay out, the interface of the system and the data entry forms) as per their local requirements. Conversely, the training also created opportunity for the IS team to get better knowledge and understanding on the requirements of the users in a practical and interactive session since they clearly express their needs while they attend the training using the software (DHIS 1.3) and practical data.

Organizational Level Learning (Institutionalizing):

Following the standardization, customization and users' training; the software was successfully implemented in 10 sub-city health departments, 5 hospitals and 23 larger health centres in one year period (from December 2003 to December 2004). Currently, DHIS 1.3 has become part of the routine day to day activities at various levels of the administrative hierarchy (health facilities, sub-city health departments, and the health bureau levels). This ensures the institutionalization of the system in all public health care institutions of the Addis Ababa Health Bureau and improved the operational capacity of health workers and managers since they were given the chance to perform their routine tasks using the software. In addition to the training offered on basics of computers and on the functionalities of the software, users were also able to improve their skills and knowledge on the software through practice (learning by doing). As one of the HIS staff in one of the sub-cities indicated:

“...the software enabled us to do our job much faster and with much less error compared to the way we were doing our job manually only using pen and paper. Besides, it enabled us to become more familiar with computer technology in general and the functionalities of the system in particular through hands on day to day practice... I think it significantly increased our technical skill, knowledge, and competency in data management, analysis and report generation.” (HIS Staff at a sub-city; July 2006).

So far, there is a two and half years report generated electronically and the software is well accepted and has been integrated into day to day routines of health workers, statisticians and managers at different levels. Besides, the experiences of software customization and data standardization were taken as point of departure to introduce the system in other pilot regions such as Oromia and Amhara. Generally, the successful implementation and scaling of DHIS 1.3 in Addis Ababa city government is mainly a result of strong team work and collaboration between HISP Ethiopia team members and other actors in the wider implementation network including the commitment and support of the domain experts (end users), the support of the top management at all levels in allocating resources and their time for the realization of the system, and the support from global development team mainly from Oslo and South Africa. The relative success in customizing and adapting the software to fit for local context and its implementation and use across levels is mainly linked with the technical competency of the HISP team in Addis, their knowledge and understanding of the social and organizational context where the system is to be implemented, the political support and commitment of the top management and the mutual learning and collaboration between the technical people and the domain experts.

4.3 DHIS 2.0 Development and Customization

To deal with the drawbacks of older versions of DHIS, in May 2004, the global HISP hired a full time researcher to work on a new platform independent, web-enabled and open source software called DHIS 2.0. Another PhD student joined in June 2004 and together they started the initial phase of DHIS 2.0 project which involves assessment of potential technologies and free and open source frameworks. Basically, since the idea was to link earlier versions of DHIS (mainly 1.4) with the new version, the functional requirement and structure of the new version was influenced by the former versions of DHIS. The three most important technical requirements of the new version were: it must be platform independent; must run on most relational database servers; and must be possible to develop both web-based and standalone modules for the system. Since then, several modules and milestones have been released and several modifications and adaptations have been made to adopt the system to the context and needs of different countries where HISP is working.

The idea of customizing and implementing DHIS 2.0 in Ethiopia was initially brought for discussion when two professors from university of Oslo visited Ethiopia in March 2006, and had a discussion with HISP-Ethiopia team members about current activities in the pilot regions, future strategies of implementation and scaling of DHIS in Ethiopia. In that meeting, implementing DHIS 2.0 in two pilot regions namely Tigray and Benishangul-Gumuz² was proposed and an open discussion through HISP-Ethiopia mailing list was conducted to brainstorm ideas and get feedback from different actors including PhD students from Ethiopia most of whom were in Oslo at that time. Several ideas were raised through the mailing list and some of them are presented as follows:

- PhD student1 and HISP researcher1: “limit the implementation of DHIS 2.0 to Tigray and implement DHIS 1.4 in Benishangul. DHIS 2.0 is being updated frequently and the current strategy proposed for Ethiopia requires more resources (specifically support) to incorporate the changes if we want to scale the system to many sites.”
- PhD student1: “Limit the installation of DHIS 2.0 in Tigray only at the regional health bureau level until the software matures and the team gains experience.”

² These are the two regions where there is no as such significant progress in the implementation process mainly due to infrastructure (in Benishangul) and political as well as institutional (Tigray) factors.

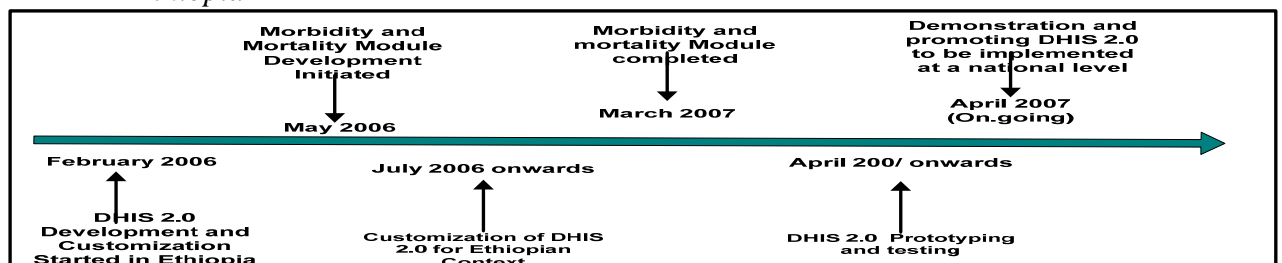
- PhD student 2: “Because of infrastructural problem, it may be difficult to implement DHIS 2.0 in Benishangul so go for DHIS 1.4 in Benishangul. What is the position of the Tigray regional health bureau about their former position of ‘wait and see’ from the Federal Ministry of Health?”
- Professor from University of Oslo: “my suggestion is to think about possible strategies to address the challenges, rather than take the view that it is not possible.”

Based on the different ideas raised through the mailing list, another meeting was held on March 31st, 2006 at HISP-Ethiopia office at Addis Ababa University (AAU) to decide on which version to implement in both regions. After a thorough discussion, consensus was reached to go for the implementation of DHIS 2.0 in Tigray and Benishangul-Gumuz.

In April 2006, a new HISP-Ethiopia development team comprising of 4 Ethiopian MSc students from University of Oslo, 2 HISP researchers, and 1 full-time developer was formed to carry out the development and customization of DHIS 2.0 as per the requirements of the Ethiopian public health care system. The composition of the team in terms of experience and technical knowledge is wide diverse. The new Master students have a relatively better exposure and background on Java and other DHIS 2.0 core technologies (such as Eclipse, Hibernate etc) since they took a course dealing with open source technologies while they were in Oslo in fall 2006. On the other hand, most of the full time staffs of the project do not have the exposure and background on Java and open source tools and technologies since they didn’t receive any formal training on these technologies. This in turn posed a challenge on how to deal with the development and implementation strategies. For example, the HISP-Addis Ababa team members felt that they have very limited experience and knowledge with the tools and technologies that are being used to develop DHIS 2.0. With regard to this, one of the team members indicated that:

“...before we decide on the transition to the new version, we need to build the capacity of the technical team in order to customize the software for the needs in Addis. The HISP team members in Addis are not familiar with many of the DHIS 2.0 core technologies and Java programming. This needs some time before we understand and start customization.”

Figure 3: Important Milestones in the process of DHIS 2.0 development and Customization in Ethiopia



4.3.1 Who Learns what and what are the learning Mechanisms

DHIS 2.0 implementation has not yet started in any of the pilot sites and the local technical team members in collaboration with developers from Oslo and Vietnam are still struggling to make the system work and to incorporate the required modules locally. As such, since there is no any link established between the public health domain and the IS domain as it was

experienced in the case of DHIS 1.3 customization and implementation; this case study deals about the individual and group level learning and the specific learning mechanisms employed among developers and systems people in the process of developing and customizing the software.

To address the existing inadequate knowledge base mainly on Java and DHIS 2.0 core technologies, one full time local programmer was hired to lead the development and customization work and at the same time build the capacity of the local team (mainly for the full-time staff) through in-house training of Java and other development tools. Besides, both online and on-site support from the global HISP development network was obtained. For example, one Vietnamese developer stayed in Ethiopia for about three months (April to June 2006) and contributed on local technical capacity building of the local team by imparting skills to the local teams on the development of PHP based system for ART(Anti-Retroviral Therapy) management system and helped to initiate DHIS 2.0 customization during the initial stages of the local software customization process; two developers from University of Oslo stayed in Ethiopia for about two weeks in August 2006 and supported the local team in adding the indicator module, assisted in the development of morbidity-mortality module, import-export module etc. They also offered an intensive training on Java and DHIS 2.0 core technologies. In addition to this on-site support, the local team support through online electronic collaboration platform (mailing lists and a collaborative web site called wiki) and works in collaboration with globally distributed HISP developers in Norway, Vietnam and India. However, the online support is so far limited due to poor internet connection in Ethiopia to upload or download codes and development tools as well as due to lack of responsible person to answer question posted by local team members. As one of the respondents indicated:

... it was really difficult and still is to download different milestones from the remote server in Oslo when new versions are released. For example it took many days to download milestone 2 from the remote server. When we have technical difficulties we always depend on the technical team in Oslo to upload source code for us. However, unlike previous versions of DHIS (1.3 and 1.4) where there was one focal person in South Africa responsible in dealing with problems,, in the case of DHIS 2.0 development, there is no any focal person to deal with the problems and questions raised from different developers. Rather questions are posted to developers list and only those interested would give answer. We usually post questions to the developers list, but in most cases we didn't get replies even after posting it so many times. There should be one focal person to deal with such problem (MSc Student: August 2006).

Although the plan was to start implementation of DHIS 2.0 in Tigray and Benishangul in May 2006, it was not even possible to finalize the customization and development of new modules specifically required for the Ethiopian health care system (such as Morbidity and Mortality Module). As one of the MSc students pointed out:

“...there is no any implementation so far, no data entry as well. The customization is not yet completed since the stable and final version of the software is not released. So, as a strategy, we are focusing on building the capacity of the technical team in Ethiopia and customize the software according to Ethiopian need by developing modules that are specifically required in Ethiopia rather than waiting international developers to develop all the modules that we need. As such, currently, most of the technical teams are taking intensive course on Java and DHIS 2.0 core technologies in collaboration with developers from university of Oslo and the plan is

to develop the morbidity/mortality and import/export modules locally in the coming two months.”(MSc Student: August, 2006).

Several factors could be attributed for the lack of success in this whole process of developing, customizing and implementing DHIS 2.0. The main reason is the weak technical competency (with regard to Java and DHIS 2.0 core technologies) of the local team and lack collective commitment and responsibility on how to deal with the problems. For example, the lack of agreement on how to deal with the development and implementation of the new system among the older staff and the new comers is basically a matter of a difference in background and experience. The new comers were more enthusiastic and supportive of the new DHIS 2.0 core technologies since they have the basic knowledge and familiarity on Open Source software and java frameworks as they took the course given at the University of Oslo in Autumn 2005. Where as the former staffs were sympathetic to the earlier versions of DHIS 1.3 and 1.4 since they have been highly engaged in customization and implementation process.

The unexpected and sudden departure of the local programmer who was recruited to lead the development and customization task was also a blow and had significantly hampered and delayed the development process. Geographical distance between nodes and the cost of travel to get developers from other nodes (such as Oslo or Vietnam) at the time required is also another impediment that negatively affects the development process.

Building on the positive and negative experiences so far, a new initiative is being underway since January 2007 with the aim of finalizing the development of the required modules and customization of DHIS 2.0 so that it fits to the requirements of the Ethiopian public health care system. As part of this effort, three full time local programmers have been hired and an encouraging result is being registered. For example, the first version of the morbidity-mortality module has been developed by one of those new programmers in collaboration with the MSc students the global network of developers and it is currently being tested with actual data. A calendar converter that converts the European calendar into the Ethiopian calendar (since we have a different calendar system) is being developed by the other new developer. The following diagram (figure 3) provides a summary of the interaction between various actors and institutions and the interaction mechanisms in the development, customization and implementation of both DHIS 1.3 and 2.0.

Besides, since all the local development team members (both new comers and former HISP Ethiopia staff) share the same office, it created a situated learning opportunity for developers to learn through discussions and arguments on different issues, problems, challenges encountered by each individual developer which in turn stimulated mutual learning and shared understanding to happen through time.

5. Analysis and Discussion

In this section, we shall discuss how the story provides empirical examples of learning at individual, group and organizational levels. More specifically, we try to answer our research question of what is learnt and what are the learning mechanisms that facilitate individual, group, and organizational level learning in the process of developing, customising, implementing and scaling different versions of computerised HIS in the context of developing countries in general and in the Ethiopian public health care context in particular. Our discussion is framed into three main sections: Interaction between the IS and Public health domains, Technological capacity at individual, group and Organizational levels, Commitment of the user department.

Interaction between IS/IT and public health domains:

As it is indicated in the introduction of this paper, IS development and implementation can not be seen as only a process of designing and implementing technical artefacts, it is rather a process of communication and mutual and interactive learning: “systems developers learn about the non technical context and the domain experts (would be users) learn about the technical aspects and functionalities of the system (Braa et al., 1995). Shaw, Mengiste and Braa (2007) also reported the occurrence of such mutual learning in the process of HIS development, implementation and scaling in a comparative study conducted in Nigeria and Ethiopia. The authors argued that “while the users of the system from the health domain learn how the system can serve their needs and thereby sparking gradually more advanced requests, those involved in the systems development and implementation are also learning how to meet these requests.”

A similar type of mutual and interactive learning had been observed between IS domain experts and public health domain experts in the process of customising, implementing and scaling DHIS 1.3. As it can be seen in the case material, all activities of standardization, prototyping, software customization and implementation was conducted with close collaboration and negotiation between the IS people (HISP team members) and domain experts (including health managers, statisticians, and health workers). The process enabled IS professionals to understand and learn how things are done practically in the public health domain; public health professionals, in their part also learn on how to use computers for data entry, analysis, and report generation to support their routine activities. As Braa et al (Forthcoming) pointed out, the inextricably interlinked nature of context of use and software development, customization and implementation allows mutual learning to happen between professionals in the two domains. Braa et al (Forthcoming) further argued that this process is supported through large scale capacity development efforts involving short and long term courses in health informatics. The participatory approach in adapting and implementing DHIS 1.3 software can also be understood as a mutual learning process that occurred between IS professionals and the domain experts. Although such type of mutual learning had been experienced in the DHIS 1.3 customization and implementation process, similar type of mutual learning based on a strong link between the context of use (health professionals and health services) and the IS development and implementation team is not so far experienced in the development and customization of DHIS 2.0. This is mainly due to lack of practical action in implementing and institutionalising the software in health care institutions which is a direct outcome of the slow pace of customization and development process which is partly

influenced by the local teams' poor technical competency and the inconsistent support provided from the international development team mainly from Oslo.

The relative success achieved in the DHIS 1.3 customization and implementation at different levels of the Addis Ababa Health bureau is partly related with the creation of a strong collaboration and learning environment between the technical HISP implementation team and the context of use in regional health bureau, sub-cities and health facilities. Using different learning mechanisms such as formal presentation, group-meetings and discussions, technical support (in terms of software installation, trouble shooting, training, hands on exercise etc), and through informal mechanisms(such as face to face dialogue and discussion, telephone conversations etc.) individuals and groups from the health domain acquire knowledge about new ways of data entry, analysis and report generation using DHIS1.3 software and its different functionalities, on how to use different data analysis tools such as excel to generate reports on graphs and charts; share experiences and best practices among themselves during training sessions, conferences etc on how to use new technologies; and at organizational level, the learning occurs when the standardised and customised software was successfully implemented at all levels and became part of the day to day routine activities of health workers, statisticians and managers to undertake the data collection, analysis and reporting duties. Participatory design & development and practical implementation of the software across different levels of the health care system can also be considered as main learning mechanisms both at individual and group levels.

Technological capacity at Individual, group and Organizational levels:

According to the proposed organizational learning model, learning occurs at individual, group and organizational levels and they are linked with each other through intuiting, interpreting, integrating and institutionalizing. In this study, the process of cultivating technological capacity at individual, group and organizational levels using different learning mechanisms and approaches was evident both for HISP team members and health care domain experts. A good example of cultivating individual learning process was the step-by-step understanding and mastering of Java frameworks and some core technologies by some local team members of the HISP-Ethiopia team who were involved in DHIS 2.0 development and customization process. Through in-house training and learning by doing, some members of the local development and implementation team became familiar to Java technologies and other open source development core technologies (such as Maven, Hibernate). In the context of DHIS 1.3 implementation, the domain experts at facility, sub-city and regional levels improve their skills in using the functionalities of the system through formal training and through hands on exercise. In some instances, users requested for additional functionalities and features (such as personnel and pharmaceutical data management features) to be incorporated into the software.

Sahay and Robey (1996) argued that the “capability to absorb new technology is enhanced by members' prior experience, as affected by the deployment of similar technologies. Capability and spread of knowledge are thus interwoven in a process of continuous learning, enabling smooth transitions of related innovations.” As such, Past experience and learning simultaneously affects current and future learning in IS development and implementation. Past experiences could positively improve IS implementation and use if organizations consciously reflect and learn from it. Such positive outcomes of past experience to enhance IS implementation and use have been observed when the experiences of DHIS 1.3 customization and implementation process of the HISP-Addis Ababa team was used as the basis to expand the customization and implementation of the software in other regional health bureaus

including Oromia and Amhara. In addition to using the customised software and standardised data elements and reporting formats as a point of departure to start the customization process in other regions; best practices and knowledge were also communicated and shared among the HISP team members working in other pilot regions.

On the other hand past experiences may also contribute to competency traps that impede new learning and new approaches (Robey et al., 2000). Consistent with this argument, in this research, it has been observed that past learning and experiences of former HISP-Ethiopia team members on MS Access based DHIS versions (such as DHIS 1.3 and 1.4) contributed to poor performance in learning the new JAVA based technologies used in developing and customizing DHIS 2.0. Besides, poor prior experience and knowledge on Java and DHIS core technologies had significantly influenced local customization and development process and delayed the transition towards the new system.

The individual skills, competence and experience and the groups shared understandings, views, practices and actions will be institutionalized when they are transformed into the day to day routines of the organization in the form of artefacts, standards or procedures. Crossan et al. (1999) argued that if something (such as an artefact, standard, procedure etc.) is institutionalized at organizational level, it means that it had received a certain degree of consensus or shared understanding among the influential members of the organization. As such, the experience of successfully implementing DHIS 1.3 at all levels of the public health care system of the Addis Ababa city government with the consent and shared understanding of key actors (such as top managers, department heads, health workers, statisticians, and HISP team members) ensures the organizational level of learning to happen.

The lesson to be drawn from this study is that the process of IS development and implementation at a local level requires local knowledge and expertise in the form of technical competencies and skills. Besides, the already existing skills and knowledge should be systematically cultivated, developed and transformed to fit to new requirements through both formal training and informally through hands on exercise and practice. On the other hand, developers and implementers should always look forward and avoid any competency trap in a form of past knowledge and experience that may impede future action. The controversy and divergence in views on how to deal with the transition to DHIS 2.0 among the local team members had not only affected the individual and group learning process, but also, it resulted to a failure in fulfilling implementation deadlines set up with the health officials to implement DHIS 2.0 in Tigray and Benishangul regional states.

Organizational commitment and buy-in:

Organizational buy-in, support and commitment to an IS is an important factor for successful implementation and institutionalization of the system. It is also crucial to create opportunities for further learning among the domain experts and system developers through action and practice. Especially the buy-in from the top management gives the opportunity for further learning (both formal and informal) to happen. For example, in this study, it was the support and deep level commitment from top management at Addis Ababa regional health bureau that had created the opportunity for the successful implementation and further scaling of DHIS 1.3 across all levels of the regional health care system. It was the initial awareness, learning and deep level of commitment from top managers towards the system which had created a window of opportunity for others (lower level managers, health workers and statisticians) learn both formally and informally through standardization of data sets and reporting formats,

prototyping and software demonstration, discussions, hands on exercise etc. However, a similar level of organizational buy-in and learning process was not observed in DHIS 2.0 development and customization process since the software is not yet implemented in any health institution. In spite of formal agreements reached between two regional health bureaus and HISP-Ethiopia, it was not possible to carry out any of the issues agreed upon mainly due to the delay in the development and customization process. This obviously will have a negative impact in future efforts of creating organizational buy-in and commitment of top managers while implementing the system.

6. Concluding Remarks

This paper has tried to address the link between organizational learning and HIS development and implementation in the context of health care sector of developing countries. The intent was not to generalize the pattern of learning experience in all health care institutions in different settings and contexts, but it was rather intended to understand the dynamics of learning and the specific learning mechanisms at individual, group and organizational levels by adapting the 4I organizational learning framework of Crossan et al. (1999). The motivation for this paper was that while the notion of learning is applied in many HIS researches, the approaches used so far are primarily focusing on simply using the term to denote how local learning and best practices are shared and transferred across individuals and network of institutions without addressing the dynamics and the specific learning mechanisms employed at individual, group and organizational levels. As such, in this paper we tried to give practical examples on what is learnt, the learning dynamics and the specific learning mechanisms by using a comparative case study on the development, customization and implementation of two different versions of computerised HIS in the Ethiopian public health care system.

From the case description as well as the discussion made about individual, group and organizational level learning and the specific learning mechanisms employed; it can be concluded that, action is the best mechanism to facilitate the process of learning between different levels and across different domains. As it can be observed from the experiences of DHIS 1.3 customization, implementation and scaling in Addis Ababa, the practical action and implementation had played a significant role in speeding up a feed forward learning process by enabling individuals and groups from both the health and IS domains to learn from their day to day activities and actions. Besides, the mutual learning and shared understanding among IS people and the domain experts in customising the software, standardizing the data sets, and building local capacity of health workers and managers on the software contributed for coordinated action and the institutionalization of the system in to the day to day routines of all public health institutions of the Addis Ababa health bureau. This institutionalization of the system in turn invoked a feed back learning loop from which individuals and groups from the two domains start to learn from each others experiences through their personal hands on exercise on the system as well as through group discussion and shared understanding on the strengths, weaknesses, new requirements and functionalities of the system.

The mutual learning process which was established between developers (IS people) and the domain experts during DHIS 1.3 customization and implementation process had also enabled both parties to learn and understand basic issues in their respective domains and to create strong collaboration and partnership in dealing with problems and new challenges. For example, the IS people learn about the context (the public health domain) through user participation in a form of prototyping demonstration, standardization of data sets and reporting formats as well as informal discussions and conversations. The domain experts, on

the other hand, learn about the technology and the new system through formal training, workshops, demonstrations, and on hands on exercise. We argue that it is such a mutual learning process supported with action that contributed for successful implementation of the software at all levels of the public health care system in Addis.

However, on the other hand, in the case of DHIS 2.0 development and customization, due to lack of practical action in terms system implementation or reaching out the user organization, a similar level of mutual learning among health domain and IS experts can not be achieved so far. Although we can't deny the existing feed-forward learning process (in a form of exploration) going on among developers and IS people who are participating in the development and customization process across different nodes of the HISP network through various mechanisms (including formal training and sharing of experiences and developing mutual understanding about different technologies, standards, modules etc), the feed back learning process can't brought into the scene due to lack of action and user participation in the form of software demonstration, meetings, discussions as it was experienced in the process of DHIS 1.3 customization and implementation in Addis. Since the software is not yet implemented in any of the public health care institutions, developers couldn't get feedbacks on the weaknesses and strengths of the system.

References

- Aarts, J., V. Peel, et al. (1998). "Organizational Issue in Health Informatics: a Model Approach." International Journal of Medical informatics **52**: 235-242.
- Ang, K.-T., J. Y. I. Thong, et al. (1997). "IT Implementation Through the lens of Organizational Learning: A Case study of Insuror." International Conference on Information Systems Proceedings of the eighteenth international conference on Information systems 331-348.
- Argote, L., B. S., et al. (1990). "The persistence and transfer of learning in industrial settings." Management Science **36**: 140-154.
- Argyris, C. (1982). "Organizational Learning and management Information Systems." Data Base, Winter-Spring: 2-11.
- Argyris, C. and S. D. A. (1996). Organizational Learning II. Reading, MA, Addison-Wisely.
- Argyris, C. and S. D. (1978). Organizational learning: A theory of action perspective. Reading, MA, Addison Wesley.
- Attwell, P. (1992). "Technology Diffusion and Organizational Learning: The Case of Business Computing." Organizational Science **3**(1): 1-19.
- Berg, M. (1999). "Patient care Information systems and Health Care work: a Socio-technical Approach." International Journal of Medical Informatics **55**: 87-101.
- Bondarouk, T. and S. Klass (2003). Explaining Groupware Implementation through Group learning. proceedings of the 14th Information Resource Management Association International conference (IRMA), Philadelphia, MA, Idea group publishing.
- Bondarouk, T. V. (2006). "Action-oriented Group Learning in the Implementation of Information Technologies: Results from Three Case Studies." European Journal of Information Systems **15**: 42-53.
- Bondarouk, T. V. and H. J. M. Ruel (2002). Adopting New IT by Learning in Groups: Results of Discourse Analysis. Proceedings of the 36th Hawaii International conference on System sciences, Hawaii.
- Braa, J., O. Hanseth, et al. (2007). "Developing Health Information systems in Developing Countries: The Flexible Standards." MIS Quarterly, Special Issue on IT and development.
- Braa, J., E. Monteiro, et al. (1995). "Technology transfer vs. technological learning: IT-infrastructure and health care in developing countries." IT for Development, **6**(1): 15-23.
- Braa, J., E. Monteiro, et al. (2004). "Networks of Action: Sustainable Health Information systems Across Developing Countries." MIS Quarterly **28**(3): 337-362.
- Crossan, M. M., H. W. Lane, et al. (1999). "An Organizational Learning Framework: From Intuition to Institution." The Academy of Management Review **24**(3): 522-537.
- DiMaggio, P. J. (1988). Interest and agency in Institutional Theory. In L.G. Zucker (Ed.), Institutional Patterns and Organizations: Culture and Environment. Cambridge, MA, Ballinger.
- Engelstad, P. H. and B. Gustavsen (1993). "Swedish Network Development for Implementing National Work Reform Strategy." Human Relations **46**(2): 219-248.
- Floyd, C. (1989). "Out of Scandinavia: alternative approaches to software design and systems development." HUMAN-COMPUTER INTERACTION **4**: 253-350.
- Forsythe, D. E. (1996). "New Bottles, Old wine: Hidden Cultural assumptions in a Computerised Explanation System for Migraine sufferers." Medical Anthropology Quarterly **10**: 551-574.
- Garvin, D. A. (1993). "Building a Learning Organization." Harvard Business review **71**(4): 78-91.

- Huber, G. P. (1991). "Organizational learning: The Contributing Processes and the Literatures. ." Organizational Science **2**: 88-115.
- Huysman, M. (2000). "Rethinking Organizational Learning: Analyzing Learning Processes of Information Systems Designers." Accounting, Management and Information Technologies **10**: 81-99.
- Kim, D. M. (1993). "The link between Individual and Organizational Learning." Sloan Management Review, Fall(37-50).
- Lant, T. K. and S. J. Mezias (1992). "An Organizational Learning Model of Convergence and Reorientation." Organizational Science **3**(1): 47-71.
- Lawrence, T. B. (1999). "Institutional Strategy." Journal of Management **25**: 161-187.
- Lawrence, T. B. (2005). "The Politics of Organizational Learning: Integrating Power into the 4I Framework." Academy of Management Review **30**(1): 180-191.
- Levitt, B. and J. G. March (1988). "Organizational learning." American Review of Sociology **14**: 212-243.
- Lyytinen, K. and D. Robey (1999). "Learning Failure in Information systems Development." Information Systems Journal **9**: 85-101.
- March, J. G. (1991). "Exploration and Exploitation in Organizational Learning." Organizational Science **2**(1): 71-87.
- March, J. G. and J. P. Olsen (1975). Ambiguity and Choice in organizations. Bergen, Norway, Universitetsforlaget.
- Nonka, I. and T. H (1995). The knowledge Creating company. New York, Oxford university press.
- Ola, H. and M. Eric (1997). "Inscribing Behavior in Information Infrastructure standards." Accounting Management and Information Technology **7**: 183-211.
- Pentland, B. T. (1995). "Information System and Organizational Learning: The Social Epistemology of organizational Knowledge Systems." Accounting Management and Information Technology **5**(1): 1-21.
- Robey, D. and B. Marie-Claude (1999). "Accounting for the contradictory Organizational consequences of Information technology: Theoretical directions and Methodological Implications." Information Systems Research **10**(2): 167-186.
- Robey, D., B. Marie-Claude, et al. (2000). "Information Technology and Organizational Learning: A Review of Assessment of Research." Accounting, Management and Information Technologies **10**: 125-155.
- Robey, D., N. A. Wishart, et al. (1995). "Merging the Metaphors for Organizational Improvement: Business process Reengineering as a Component of organizational Learning." Accounting Management and Information Technology **5**(1): 23-39.
- Sahay, S. and D. Robey (1996). "Organizational Context, Social Interpretation, and the Implementation and consequences of Geographic Information systems." Accounting, Management & Information Technology **6**(4): 255-282.
- Scott, J. E. and I. Vessey (2000). "Implementing Enterprise Resource Planning Systems: The Role of Learning from Failure." Information Systems Froniers **2**(2): 213-232.
- Stein, E. W. and V. Zwass (1995). "Actualizing Organizational Memory with Information Systems." Information Systems Research **6**(2): 85-117.
- Aarts, J., V. Peel, et al. (1998). "Organizational Issue in Health Informatics: a Model Approach." International Journal of Medical informatics **52**: 235-242.

Appendix 1: Summary of HISP Implementation Activities Across Regions

Activity Region	Institutions covered	Software currently in Use	Date of implementation	Data Coverage	Capacity Building	Institutional Mechanism
Addis Ababa	10 out of 10 sub-cities 5 Hospitals 23 out of 28 public Health centres	DHIS ver 1.3 DHIS 2.0 is being customised for implementation	Since February 2004	Full data for two and half years from health facilities and sub-cities	On going training on DHIS 1.3 for more than 100 health workers and managers	HMIS committee, HISP researcher, & facilitator working on data quality, SW customization and technical support
Amhara	11 Zones	DHIS ver. 1.4	Since May 2006	10 months of data from all 11 zones	Training given to health workers from all the 11 zones	HMIS committee, HISP researcher and one facilitator working on data quality, SW customization and Technical support
Benishangul	3 zones 1 district	DHIS 1.4	Since November 2006	4 Months data from the three zones	Training on basics of computer and DHIS 1.4 functionalities given to health workers represented from all districts and zones	HMIS committee, HISP researcher, and one Msc student and one facilitators working on SW customization and implementation
Oromia	5 out of 17 zones 5 out of 17 zones	DHIS 1.3, since April, DHIS ver 1.4	From February 2004 to April 2006 From May 2006 onwards	One year data for one zone	On-going training for more than 150 staff from 17 zones	HMIS committee, one HISP researcher, two facilitators are working full time on data quality, SW customization, and technical support
Tigray	No Implementation so far. In 2004, DHIS 1.3 was piloted in two districts	Plan to implement DHIS 2.0 at regional level , one hospital and two pilot districts	None	None	Training was given for two districts health workers and managers	Regional HMIS committee, Two Masters students, and HISP researcher customising DHIS 2.0