REVISITING NETWORKING OF ACTIONS AND KNOWLEDGE TRANSFER:
AN OUTLINE OF PRACTICE AND COMMUNITY BASED DISTRIBUTED
APPROACH FOR OPEN SOURCE INFORMATION SYSTEMS
IMPLEMENTATION IN DEVELOPING COUNTRIES

Cases from Ethiopia

By

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Dissertation submitted as Partial Fulfillment to the Requirements of the
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To

Senni, Sarye, and Josi,

You gave me life!
Acknowledgement

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<th>Definition</th>
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<tbody>
<tr>
<td>AAHB</td>
<td>Addis Ababa Health Bureau</td>
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<tr>
<td>AAU</td>
<td>Addis Ababa University</td>
</tr>
<tr>
<td>AAUL</td>
<td>Addis Ababa University Library</td>
</tr>
<tr>
<td>AIDS</td>
<td>Acquired Immunodeficiency Syndrome</td>
</tr>
<tr>
<td>ART</td>
<td>Anti Retroviral Therapy</td>
</tr>
<tr>
<td>ARTIS</td>
<td>Anti Retroviral Therapy Information System</td>
</tr>
<tr>
<td>CBPP</td>
<td>Commons Based Peer Production</td>
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<tr>
<td>CoP</td>
<td>Communities of Practice</td>
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<tr>
<td>CoPT</td>
<td>Communities of Practice Theory</td>
</tr>
<tr>
<td>CTIT</td>
<td>College of Telecommunications and Information Technology</td>
</tr>
<tr>
<td>CTITL</td>
<td>College of Telecommunications and Information Technology Library</td>
</tr>
<tr>
<td>FMOH</td>
<td>Federal Ministry of Health</td>
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<tr>
<td>HISP</td>
<td>Health Information Program</td>
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<tr>
<td>HIV</td>
<td>Human Immune Deficiency Virus</td>
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<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
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<td>IS</td>
<td>Information Systems</td>
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<td>IT</td>
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<tr>
<td>OSIS</td>
<td>Open Source Software–based Information Systems</td>
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<td>OSS</td>
<td>Open Source Software</td>
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Preface

This dissertation entitled, "Revisiting networking of actions and knowledge transfer: An outline of practice and community based distributed approach for open source information systems implementation in developing countries: Cases from Ethiopia," is submitted as a partial fulfillment to the requirements of the degree of Doctor of Philosophy (PhD) at the Faculty of Mathematics and Natural Sciences, University of Oslo, Norway. The Norwegian Education Loan Fund, Lånekassen, and the Health Information Systems Program (HISP) generously supported this work by funding my subsistence, fieldwork, and conference participation expenses. This dissertation comprises an introductory paper, composed of six chapters, and five scientific papers that are appended at the end of the introductory paper as listed below.


1 The previous version of this paper was published in the proceedings of the 10th International Conference on Social Implications of Computers in Developing Countries "Assessing the Contribution of ICT for Development" (IFIP WG 9.4) Dubai, May 2009. Dubai School of Government http://ifip.dsg.ae/

2 The previous version of this paper was published in the proceedings of the 31st Information Systems Research Seminar in Scandinavia (IRIS 31st) “Public systems in the future – possibilities, challenges and pitfalls” Åre Sweden, August 10-13, 2008 http://www.iris31.se/
Abstract

Contemporary studies indicate that organizations are shifting away from traditional modes of organizing as dictated by changes in the operational context. The current operational context features the characteristics of interdependence across boundaries, a shift of focus away from material goods to informational goods, and horizontal collaboration of diverse groups rather than vertical chains of command. Similarly, the emergence of OSS, which has changed the philosophy and organization of software production and ownership, demands a new form of organization and organizing principles to make use of it. The actions and resources of globally distributed actors have become crucial to make use OSS-based IS (OSIS) especially in developing countries.

In line with this pressing need, this dissertation aims to outline an implementation approach that seeks to bring together the resources and actions of globally distributed actors into a situated implementation work practice thereby to circulate knowledge, and facilitate implementation and learning-in-working. To do so, it draws upon the notions of communities of practice (CoP) and network of practices (NoP) theories and delves into the micro-processes of OSIS implementation in public sector organizations in Ethiopia in an exploratory research designed as case study with underlying ontological and epistemological stances of the interpretative tradition.

Findings of the research show that the philosophy and practice of OSS have features that both promote and constrain OSIS implementation in developing countries. Code openness, free resources and services, and communal participation, for example, facilitate implementation, while concentration of attention on latest releases, lack of direct benefit of implementation from development knowledge, and lack of direct involvement of global practitioners in situated practices constrain implementation. The research identified shift of responsibility of implementation away from original developers to practitioners in developing countries as both an opportunity and a challenge. It is an opportunity because it triggers practice-based learning and it is a challenge because of the difficulty of implementation in a resource-constrained setting. The research also found out that co-location of practitioners, mutual engagement, socialization processes, legitimate access to implementation accounts, documentations, communications and sharing of source code, advice and solutions facilitate the emergence of a communal practice, the movement of knowledge, the social construction of meaning and identity. These conditions improve OSIS implementation as well as develop the competences of new practitioners.

Based upon findings, the dissertation outlines a community and practice based distributed collaborative implementation approach to both facilitate and conceptualize OSIS implementation in developing countries. By doing so, the dissertation extends the notions of the CoP and NoP theories to the practice OSIS implementation that has a different feature than canonical organizations, which the theories have been commonly applied. It introduces the notions of knowledge circulation, unlike transfer, and learning-in-implementation, and argues for networking globally dispersed actions and resources through notions of practice and communities. It also shows how the inherent characteristics of the ideals and practice of OSS and cultural traits in the implementation context could address some of the criticisms of the theories. The dissertation suggests and empirically shows that participation in OSIS implementation is the best vehicle for mastering technologies, developing techno-scientific competence, and act in the world in a socially recognized way.
Sammendrag

Virksomhetsstudier viser at tradisjonelle måter å organisere virksomheter utfordres som følge av endringer i operasjonelle omgivelserne. Dagens operasjonelle omgivelser kjennetegnes blant annet av gjensideig avhengighet på tvers av grenser, endring fra fokus på materiell produksjon til informasjon, og styrking av horisontalt samarbeid blant diverse grupper der tidligere praksis la større vekt på vertikal styring og kontroll. Fremveksten av åpen kildekode (open-source software, OSS) har bidratt til endringer i utvikling og eierskap av programvare, noe som på tilsvarende måte krever endringer med hensyn til organisasjonsutforming. Globale nettverk av aktører spiller en sentral rolle i handlingsplaner og ressursbruk for utvikling av OSS-baserte informasjonssystemer (open source information systems, OSIS), noe som gjør seg særlig gjeldende i utviklingsland.

Denne avhandlingen har som målsetting å skissere en fremgangsmåte for OSIS-realisering som søker å koordinere ressurser og handlinger i et globalt distribuert nettverk for å fremme situasjonsbestemt arbeidspraksis og derved bidra til sirkulering av kunnskap, forenkle systemrealisering og praktisk læring. For å bidra til dette tar avhandlingen utgangspunkt i teorier om arbeidsfellesskap (communities of practice, CoP) og arbeidsteknologier (networks of practice, NoP) og fordypser seg i detaljprosesser i OSIS-realiseringsarbeidet i offentlige virksomheter i Etiopia ved bruk av kartleggende forskningsmetoder utformet som case-studier med basis i en fortolkende vitenskapstradisjon.

Resultatene av forskningsarbeidet viser at observert tenkemåte og praksis for bruk av OSS både fremmer og hindrer OSIS-realisering i utviklingsland. For eksempel bidrar åpen kildekode, frie ressurser og samarbeid til å forenkle realiseringen, mens fokus på siste versjon av programvare, manglende evne til å omsette erfaringer fra utviklingen til umiddelbare realiseringsfordeler, samt mangel på direkte involvering av brukere hindrer realisering. Forskningen analyserer ansvarsskiftet vekk fra de opprinnelige utviklerne til brukere i u-landene som både en forbedringsmulighet og en utfordring. Det er en forbedringsmulighet da det bidrar til praksisbasert læring, og det er en utfordring på grunn av de praktiske vanskelighetene knyttet til systemutvikling av ressursfattige omgivelser. Forskningen peker også på betydningen av samlokalisering av brukere, gjensidig engasjement, sosialiseringsprosesser, legitim tilgang til systemutviklingsverktøy, dokumentasjon, kommunikasjon og deling av kildekode, råd og løsninger styrker arbeidsfellesskapet, flyt av kunnskap samt sosial konstruksjon av mening og identitet. Disse betingelsene forbedrer OSIS-realisering i tillegg til at det utvikler kompetansen hos de nye brukerne.

CHAPTER 1: INTRODUCTION

This chapter introduces the essence, scope, motivation, and structure of the dissertation in six sections. The first section presents the motivation for undertaking the research followed by a presentation of the problem domain in section 2. Section 3 discusses the research aims and questions. The expected contribution and theoretical focus of the dissertation are presented in section 4. Section 5 gives an overview of the empirical basis and the research approach. The chapter ends by providing an outline of the structure of the dissertation in section six.

1.1. Motivation

The motivation for undertaking the research reported in this dissertation emanates from three interrelated factors. Firstly, despite the importance, information systems implementation in developing countries has been challenging. Secondly, the change in the philosophy and practice of software production, ownership, and distribution, because of the emergence of open source software (OSS), has opened up unprecedented opportunities to developing countries. The changed phenomenon, in turn, requires developing countries to adjust themselves, and respond promptly and accordingly to convert envisaged benefits into a reality. The third factor is a personal interest associated to the need to contribute to the effort of addressing the challenges of IS implementation, and hence, utilization in the public sector of Ethiopia and in developing countries, in general.

IT plays a pivotal role in socio-economic development endeavors of developing countries in general (Sahay & Avgerou, 2002; Walsham, Robey, & Sahay, 2007), and in the context of Ethiopia in particular (Desta, 2003; GebreMichael, 2003; Mussa, 2003). It has a potential value across all sectors, in public and private enterprises, and at multiple levels, from software businesses in urban areas (GebreMichael, 2003), for example, to health delivery in rural villages (Desta, 2003; Walsham & Sahay, 2006).

The public sector of developing countries has been the largest consumer of IT (Ciborra, 2005); it is also the context where IS implementation has been proven to be challenging (Braa & Hedberg, 2002; Heeks, 2002; Heeks & Stanforth, 2007). The challenge emanates mainly from peculiarity of IS implementation in developing countries. IS implementation in
developing countries deals with successfully deploying and subsequently making use of systemic and context-sensitive technologies that are developed in the technologically advanced West, according to the Western context, and for the purpose of the West, in developing countries where the context is different, and resource and techno-scientific expertise are in a limited supply. So far, developing countries are from the consumer side of such systems. Studies point out that ISs are embedded with contextual elements during design and development according to the rationalization, assumption, morality, world view, etc of developers and sponsors who themselves are embedded in a certain social, political, economic, technological, and cultural contexts (Akrich, 1992; Avgerou, 2000; Heeks, 2002; Pollock, Williams, & D'Adderio, 2007).

Adaptation to use contexts is a requirement to make use of such systems; they cannot be just transferred and put in to use exactly as they are, and as a result, researchers have rejected the notion of technology transfer and argued in favor of technology translation instead (Braa, Monteiro, & Reinert, 1995; Nhampossa, 2005). The issues of knowledge transfer, best practice transfer, and learning have also been on the agenda despite conceptualization differences with regard to the possibility of transferring knowledge and best practices (Braa et al., 1995; Duguid, 2005; Orlikowski, 2002). IS implementation in developing countries, therefore, suffers from country context disparity, poor resources and techno-scientific capacity, complexity of the process, and other contextual elements. Developing countries would be further isolated and disadvantaged unless they make use of ICT and actively take part in the global environment. The challenge then is to tackle the difficulties and resolve them (Walsham, 2010; Walsham et al., 2007; Walsham & Sahay, 2006).

Many researchers have embraced OSS as an appropriate technology that would contribute to the alleviation of some of the challenges of IS implementation in developing countries, especially those related to acquisition, security, reliability, distribution, learning, freedom from vendor and espionage software, etc (Weber, 2003; Weerawarana & Weeratunge, 2004). Studies also show that free availability of a technology by itself and on its own could not deliver all the envisaged benefits (Odedra, 1992). Similarly, OSS by itself and on its own cannot guarantee the acclaimed benefits because of context dependent nature of technologies and resource limitations in developing countries. The fate of OSS would be similar to donated technologies that ended up in locked rooms or failed to be operational at all unless the techno-scientific capacity issue is addressed (Odedra, 1992).
Unlike other technologies, however, the very philosophy and practice of OSS lays down the foundation for the participation and involvement of globally dispersed actors in a situated OSS-based IS (OSIS) implementation work practice regardless of boundaries such as geography, organization, function, or time. The phenomenon demands beneficiaries to devise strategies that are appropriate to exploit the changed situation. Thus, organizations, in general, and those in developing countries, in particular, should respond to the changed phenomenon promptly and accordingly to make the best out of OSS. To this end, developing relevant strategy, investigating its relevance, and exploring the conditions of its emergence would be essential.

Moreover, communal practice, common belief, resource sharing, and a sense of community are the cornerstones of OSS production, and an implementation strategy that builds upon these cornerstones and consider the ideals of OSS could alleviate some of the challenges of IS implementation in developing countries. Some researchers also contest the notion of knowledge and best practice transfer, and argue in favor of practice as the only vehicle for circulating knowledge (both tacit and explicit) (Brown & Duguid, 2001; Duguid, 2005; Orlikowski, 2002). Similarly, OSS is practice and identity driven phenomenon. Therefore, investigating OSIS implementation in the eyes of practice-based theories that integrate working, learning, and innovating would be appropriate to deal with knowledge and its circulation. The dissertation argues that an implementation strategy that lays down the conditions necessary for the emergence of organizational forms that promote, make use of, and based upon communal practices would facilitate techno–scientific capacity development and knowledge circulation, address the challenges of implementation in developing countries, and exploit opportunities opened up by OSS.

1.2. Problem Area

Contemporary studies indicate that firms are shifting away from traditional modes of organizing as a result of changes in the operational context, to take advantage of technological advancements, and to meet the demands of flexibility, speed, and uncertainty (Kellogg, Orlikowski, & Yates, 2006; Orlikowski, 1996). The current operational context features the characteristics of interdependence across boundaries, a shift of focus away from material goods to informational goods, and horizontal collaboration of diverse groups rather than vertical chains of command (Kellogg, et al., 2006; Vaast, 2004). The changed context demands organizations to respond to and implement new collaboration,
coordination, and knowledge management mechanisms (Kellogg, et al., 2006; Orlikowski, 2002; Vaast & Walsham, 2009).

To this end, advances in communications and data processing technologies, and the Internet information infrastructure, with philosophical and ideological drive from the hacker community, have enabled and promoted the emergence of a software production system that crosses boundaries, and involves organizations and individuals (Benkler, 2002, 2006; Benkler & Nissenbaum, 2006; Raymond, 2000; von Hippel & von Krogh, 2003). The emergence of OSS has introduced a new form and organization of software production (Andreev, Feller, Finnegan, & Moretz, 2010), which would demand for a new form of organizing principles and organizational forms to make use of it.

The OSS phenomenon has challenged the well-established cathedral–based, top–down, organization–driven philosophy and practice of software production (Ducheneut, 2005; Elliott & Scacchi, 2008; Lakhani & von Hippel, 2003; G. Lee & Cole, 2003). The process, as some call it, private–collective (von Hippel & von Krogh, 2003), community–based (G. Lee & Cole, 2003), or commons–based (Benkler, 2002, 2006), invites and involves developers from around the globe, transcending geographic, organizational, functional, time, and cultural boundaries. Work has been planned, communicated, coordinated, and accomplished collaboratively using the Internet information infrastructure across various boundaries (Benkler, 2002; Benkler & Nissenbaum, 2006; Ducheneut, 2005). The OSS license dictates disclosure of source code, offers copyright owners the right to study, modify, use, and distribute software free of charge (Raymond, 2000; von Krogh, 2002).

The organizational form and production process of OSS are distributed, collaborative, individual–driven, and loosely coordinated (Andreev, et al., 2010; Benkler, 2002, 2004, 2006; Benkler & Nissenbaum, 2006; G. Lee & Cole, 2003). Individuals and firms have been participating in OSS production for various reasons and purposes. The motivational factors for individuals' participation could be different to different cultures and economies because of value differences, but in general, researches identify intrinsic (the need to share and learn), extrinsic (career concern and financial benefits), and internalized intrinsic (satisfying user needs) as motivational factors for individuals' participation (Andreev, et al., 2010; Ducheneut, 2005; Subramanyam & Xia, 2008).

The OSS literature gives much attention to software production than implementation and use (Waring & Maddocks, 2005). Software production and implementation are different but
related processes that face different challenges in different contexts. Development tends to de-contextualize, decompose, abstract, and model software artifacts, while organizational implementation deals with contextualization, integration, and organizational, technical, and social matters, in general (Heeks, 2002; Orlikowski & Barley, 2001). Implementation involves changing organizational practices as well as acquisition or construction of technology artifacts in organizations (Avgerou, 2003). It is a contextual, situated, and intensely political, social, technical, and organizational process (Hanseth & Monteiro, 1997; Kling, 1980; Markus, 1983; Monteiro & Hanseth, 1995; Myers & Young, 1997).

In principle, adoption of OSS brings many advantages to developing countries than proprietary software in terms of cost, security, knowledge advancement, ease of adaptation, etc (Câmara & Fonseca, 2007; Gallego, Luna, & Bueno, 2008; Waring & Maddocks, 2005; Weber, 2003). In practice, however, transferring technologies to developing countries in general, and implementation of ISs brought from the West, in particular, have been proven to be challenging (Heeks, 2002; Walsham, et al., 2007). Techno-scientific knowhow limitations and contextualization requirements have been the bottlenecks (Braa, et al., 1995; Heeks, 2002; Lungo, 2008; Nhampossa, 2005; Pollock, et al., 2007) and free availability of a technology, which is quite evident in the case of OSS, does not guarantee either smoother implementation or use (Odedra, 1992). The implementation and use of OSS in developing countries, in general, could suffer from challenges that other systemic and context-sensitive technologies have been facing. Of course, the main stream OSS production and use organizations (and the very philosophy of OSS) support user-to-user interaction and assistance rather than intermediaries (Lakhan & von Hippel, 2003). In the case of developing countries, it means that less skilled and less experienced experts are tasked with implementation activities.

For implementation to be successful, in addition to channeling global expertise and resources to situated practices, practitioners in developing countries are required to develop techno-scientific capacity and competence in managing and making use of globally distributed resources. The situation calls for understanding approaches that are relevant to facilitate and perpetuate learning, knowledge circulation and practice in the context of globally dispersed actors and resources. This dissertation deals with these issues in the eyes of practice-based theories that provide an integrated view to working, learning, and innovating such as the communities of practice and networks of practice theories in the
context of open source software–based information system (OSIS) implementation in Ethiopia.

According to practice–based theories, knowledge and best practices cannot be transferred, but circulate among practitioners that are engaged in communal and similar practices in situated and trans-situated contexts, respectively (Brown & Duguid, 2001; Duguid, 2005; Lave & Wenger, 1991; Orlikowski, 2002). The communities of practice theory (CoPT) considers organizations as constellations of small epistemic groups that are engaged in communal practices (Brown & Duguid, 2001; Vaast, 2004). The epistemic group, which is called communities of practice (CoP), is a situated work group that arises from the sharing of material, social, and historical contexts (Brown & Duguid, 1991; Lave & Wenger, 1991; Vaast, 2004). Communal practices and identity enact CoPs, and through mutual engagement, joint enterprise, and shared repertoire, CoPs collectively hold, reconstruct, and perpetuate knowledge, identity, and practice (Vaast, 2004). An epistemic group can have loose relationship to other epistemic groups to which it shares identity, practice, and knowledge, regardless of boundaries such as organization, function, culture, geography, or time. Such loose epistemic groups constitute network of practices (NoP) (Brown & Duguid, 2001). The NoP theory describes people that are not necessarily co-located and may never have met face to face but engaged in similar practices and have common identities.

Similar to the propositions of CoP and NoP theories, the core of OSS builds upon practice, learning, sharing, and innovation, and on a strong sense of community and identity. OSS is community–focused and practice–based phenomenon, which the communal actions and ideals of globally dispersed practitioners realize and perpetuate it. The global dispersion of actors and resources on the one hand, and situatedness of work practices, on the other, raise important questions. For example, in relation to 1) the meaning and essence of involvement of globally distributed actors in a situated practice; 2) the essence of learning, communal knowledge construction and reconstruction, and circulation of (tacit) knowledge (Brown & Duguid, 2001; Duguid, 2005)); and 3) mechanisms that foster cross–boundary participation and innovation. Answering these questions in the context of OSIS implementation would have special relevance to developing countries that have limited techno-scientific knowhow (Avgerou, 2008; Heeks, 2002).

The central concern of this study is, therefore, to explore the processes and mechanisms of knowledge circulation and situated practice improvement through the resources and
actions of globally distributed OSIS implementation practitioners. Although implementation is a situated practice, global and local actors could share knowledge, resource and practice, and collaboratively improve situated work practices using opportunities opened up by OSS and the Internet information infrastructure. These changes profoundly affect organizational forms and organizing principles as well as alleviate some of the challenges of IS implementation in developing countries. This research is a complement to the OSS literature that has dealt with various other aspects of OSS production and implementation in different contexts (cf. Fitzgerald & Kenny, 2004; Waring & Maddocks, 2005; Lungo, 2008; Braa, Monteiro, & Sahay, 2004).

1.3. Research Aims and Questions

The research presented in this dissertation aims:

To propose an implementation approach that seeks to bring together the resources and actions of globally distributed actors into a situated implementation practice and to shift the focus of attention to communities and practice as a means to circulate knowledge and facilitate innovation with IS.

The research seeks to answer the following interlinked questions:

**RQ1:** What are the affordances and constraints of the philosophy and practice of OSS towards OSIS implementation in developing countries?

**RQ2:** What are the conditions that advance a situated OSIS implementation work practice and the movement of knowledge among similar practices in the context of globally dispersed and loosely coordinated OSIS implementers?

**RQ3:** How can the actions and resources of globally distributed practitioner communities that are engaged in a similar OSIS implementation practice alleviate the challenges of IS implementation in developing countries?

The five papers appended at the end of this introductory paper contribute towards answering each of these questions. Specifically, papers 1, 2, 3, 4, and 5 answer the first question, papers 1, 2, and 5 answer question number two, and finally, papers 1, 2, and 5 answer the final question. The introductory paper consolidates the findings of each of the
papers, argues for, and outlines a distributed implementation approach based upon the notions of practice and communities of practitioners.

1.4. **Theoretical Focus and Expected Contribution**

The research implements the community of practice and network of practice theories that integrate working, learning, and innovating in situated and trans-situated environments, respectively. According to the CoP theory (CoPT), groups of practitioners engage in communal practices, hold and share collective knowledge, and innovate collectively. Through practice, the community perpetuates its identity, and circulates and reconstructs collective knowledge (Brown & Duguid, 2001). Such loose epistemic groups that are engaged in similar practices but dispersed across boundaries constitute network of practices (NoP) and create a common substrate. From the theories, the dissertation specifically deals with the notions of work practice, learning in working, knowledge circulation, communities of practices, and network of practices as explained in section 3.5.

This dissertation aspires to contribute theoretically and practically to the research domain of IS in developing countries. Specifically, it contributes to the study and practice of OSS in developing countries and resource constrained settings. By focusing on the implementation aspect of OSIS in the public sector of a developing country context, the dissertation

- Extends the notions of community of practice and network of practice to the practice of open source software implementation;
- Outlines an analytical perspective or implementation approach that builds upon practice, community, and temporal and spatial distribution of actors to facilitate the practice of OSIS implementation in developing countries;
- Proposes and analyzes an organizing principle and an organizational form that would facilitate the practice of IS implementation in developing countries;
- Provides rich insight into the micro-processes of collaboration, sharing and networking of actions among and between locally situated and globally dispersed actors in OSIS implementation;
- Outlines an empirically grounded approach for addressing techno-scientific capacity development problems; and
- Contributes to the debate of knowledge transfer, and hence, technology transfer conceptualizations.
1.5. Overview of Empirical Basis and Research Strategy

The empirical material for this dissertation comes from the public health care and higher education sectors in Ethiopia. In the public health care sector, the research targeted the development and implementation processes of an antiretroviral therapy (ART) information system – ARTIS – in ART Clinics in three selected regions of Ethiopia (Addis Ababa, Oromia and Amhara). So far, no medication is available to cure AIDS except to prolong and increase the quality of life of patients. Antiretroviral therapy is a lifelong treatment; it is the process of administering life-prolonging medications to AIDS patients. To get the envisaged benefits from the treatment, patients should adhere to medications at a precision of more than 99% with a close follow up from health care providers. Poor adherence could give rise to the development of drug resistant virus that affects not only the life of an individual patient but also the whole community, the nation, and the world in general. ART, therefore, requires reasonable care and precision.

To achieve the desired benefit, the Ethiopian health care system collects and processes large amounts of data per individual patient, implements various measures to follow up patients. The ever-increasing patient size in a resource-constrained environment, however, compromises data and service quality because of manual data collection, analysis, and reporting, i.e., data collection, analysis, evidence-based service provision, and follow up could become challenging and pose direct difficulty to realize envisaged benefits of the treatment because of manual operations, resource constraints, and ever-increasing patient size.

The health information system program (HISP) in collaboration with authorities in the Ethiopian healthcare system introduced ARTIS, a computer-based information system that computerizes data management, analysis, and reporting functions of ART Clinics. HISP is an international network of academics and health institutions that have been operating in a number of developing countries (see section 4.3.1 for further detail). The development, implementation, and roll out of ARTIS brought domain and IS experts together from both Ethiopia and other countries in the HISP network. These experts participated in local practices at various levels being present and absent in space and time. This research focuses on the collective practices of the development, implementation and rollout of ARTIS’s, and knowledge circulation, learning-in-working and communal innovation being present and absent in space and time.
Library system implementation in two public sector higher learning institutions – Addis Ababa University (AAU) and College of Telecommunications and Information Technology (CTIT) libraries – in Ethiopia is another source of empirical material for this dissertation. Although AAUL was the oldest and the largest research library in Ethiopia that serves mainly the AAU community, its services were manual until the introduction of an OSS-based library system called Koha in 2004. The library offered its services to patrons 100 percent manually with the aid of card catalogue, while the library staff uses some technologies to facilitate internal activities. As a result, searching and retrieving relevant books and other resources, and knowing what is available in another branch library were difficult to patrons. The library staff faced difficulty while processing items for purchase, cataloging and classifying materials, and circulating them, and producing various statistical reports including usage. Furthermore, the library spends huge share of the limited foreign currency to purchase catalogue cards and related materials. Simply, the library was in a challenging situation to operate and provide services in the 21st century. Before the introduction of Koha, AAUL attempted to purchase, develop in-house, and customize a library system for over a decade but did not succeed.

The state owned telecom monopoly, the Ethiopian telecommunication corporation established the CTIT in the first half of the 2000s to produce qualified work force in Information Technology, Telecommunications Engineering, and Software Engineering. The college in turn integrated the telecom-training institute, which was producing telecommunication technicians. The CTIT Library constitutes the training institute library and the college’s library. The library suffered from similar challenges as to the AAUL, but supported by its relative newness, the library attempted to partially implement an in-house developed library system and solve some of the problems. However, later it has switched to Koha.

Unlike ARTIS, the implementation processes of Koha in the two libraries feature the characteristics of mainstream OSS production, which has been characterized as communal, collective, open innovation, or commons-based peer production (Andreev, et al., 2010; Benkler, 2002; von Hippel & von Krogh, 2003). Awareness and knowledge of OSS among IT professionals in Ethiopia was limited until the formation of the Ethiopian Free and Open Source Software Network (EFOSSNet) in February 2005 (Chekol, 2007). However, collaboration between AAU and a professor (his students and an NGO) from the USA, which did not materialize the desired objective, introduced AAUL to the OSS phenomenon in the
end of 2004. AAUL started implementing Koha in the end of 2004 and managed to make use of some modules.

The implementation brought together IT experts from different departments within AAU, sought the participation of global actors in local practices, required detailed study of repositories (implementation accounts of Koha in another context), provided local solutions, circulated knowledge through practice, and improved services of the library. Thus, local communities of practitioners who were present in time and space as well as the communities of practitioners of Koha that were absent in time and space, circulated knowledge and other resources, engaged in communal practices, and collaborated in a local situated practice. The CTIT Library learned about OSS and the specific library system from AAU Library. It, then, followed a different trajectory than AAUL to implement and make use of the same software. Generally, the research reported in this dissertation focuses on the implementation trajectories and processes of Koha in these two libraries in the eyes of CoP and NoP.

As the research deals with context and situatedness, it adopted the qualitative research approach with the underlying epistemological and ontological notions of the interpretative philosophy, designed as a case study research and implemented multiple data collection techniques to collect data from multiple sources. The mode of analysis followed the procedure of iteratively reading and understanding data, identification of themes in relation to research questions and objectives with influences from theoretical concepts and personal interests, communicating results to colleagues and further improving results. The data analysis technique, in general, is an hermeneutics cycle inspired iterative mode. Chapter 4 elaborates on the adopted research methods and techniques further.

1.6. Structure of the Dissertation

This dissertation is divided into 6 related and logically organized chapters. Chapter 1, this chapter, introduces the research area, research aims and questions, expected contribution, motivation for undertaking the research exercise and gives an overview of the empirical material and the research strategy.

Chapter 2 discusses the research context focusing on social, political, economic, geographic, demographic, and IT infrastructure. It also highlights the historically constituted culture of
sharing and advancing communal interests in groups, and the specific research areas and its relationship with the overall context.

Chapter 3 presents a review of relevant literature on the essence of IS implementation, IS development, the nature of technology-based organization change, the scope and role of technology in organization, highlights the nature of implementation researches, and positions the study vis-à-vis the extant literature. As the study is about open source software-based information system (OSIS) implementation, it discusses the nature and characteristics of OSS, its aspired benefits to developing countries, and the unique characteristics of OSIS implementation, in general, and in the context of developing countries in particular. The chapter details the adopted analytical framework that draws upon the notions of community of practice (CoP) and network of practice (NoP), which are used to analyze the empirical findings presented in chapter 5.

Chapter 4 discusses the research philosophy, methods and techniques adopted in the study reported in this dissertation. The chapter details the ontological and epistemological stance of the study, the strategy of inquiry, data collection and data analysis techniques adopted in the study.

Chapter 5 presents the empirical findings of individual papers that comprise this dissertation. The chapter presents summary of the findings of each of the papers, synthesis of the findings in relation to the research aims and questions presented in chapter 1, and discussion of the findings in light of the analytical framework detailed in chapter 3.

Chapter 6 presents summary of the study presented in this dissertation, contribution of the research to both the theory and the practice of IS, OSS, and the theories of CoP and NoP, highlights limitations of the research, points out future directions and researches, and finally, provides a concluding remark.
CHAPTER 2: THE RESEARCH CONTEXT

The research reported in this dissertation was conducted in Ethiopia. This chapter therefore gives an overview of the research context in seven sections focusing on history, politics, geography, demography, socio-economy, health, and education aspects. The first section discusses the history and politics of Ethiopia. Section 2 gives an overview of the geographic and demographic contexts followed by a presentation on socio-economic aspects in section 3. Section 4 discusses historically constituted institutions and cultural traits that promote communal practices in Ethiopia. Section 5 highlights the education system and presents the library context. Section 6 presents the health care system and the HIV/AIDS context in Ethiopia. The chapter concludes with a presentation on the status of ICT in Ethiopia from penetration, institutional arrangement, capacity, policy and future direction perspectives in section 7.

2.1. History and Politics

Ethiopia is the oldest independent country located in East Africa, usually called the horn of Africa. It has never been colonized by a foreign power except a brief occupation by the Italian forces from 1936 to 1941 (Richard Pankhurst, 1998; Zewde, 2002). Due to its geographical location and access to sea route, Ethiopia enjoyed trade, religious, and other ties with North Africa, Middle East, Far East and Europe. The great rift valley of Ethiopia is the place where the oldest hominid was found, making Ethiopia to be the birth place of mankind (Richard Pankhurst, 1998). In the twentieth century, Ethiopia defeated the Italian invader force; the imperial era came to a conclusion giving way to a military dictatorship; modernization continued; and a state system that redefined sovereignty, nationality and federalism on the basis of ethnicity was introduced (Keller, 2002; Selassie, 2003). The beginning of the twentieth century was marked by advances in road and hospital construction, electricity and education, development of a central taxation system and foundation of the new capital, Addis Ababa (Richard Pankhurst, 1998; Zewde, 2002). The imperial era continued until a military junta called Derg overthrew the last Emperor and took control of state power in 1974. The military junta adopted the socialist ideology immediately after it took control of state power and waged a bloody battle with its own people for nearly two decades. The regime confiscated private properties, discouraged
private investment and the public sector became highly bureaucratic. Although the imperial system was down, Derg failed to deliver the expected social, economic and political reforms to the people of Ethiopia.

The military dictatorship came to a conclusion when the Ethiopian People Democratic Front (EPRDF) and its allies overthrew the Derg regime in 1991. An EPRDF led transitional government which was installed following the downfall of Derg introduced two important changes in the country’s history: Eritrea, which was the province of Ethiopia, became an independent state and a new constitution was introduced. The succession of Eritrea resulted in a landlocked Ethiopia and the new constitution redefined Ethiopia both administratively and politically, creating ethnically federated national and regional governments or states (Keller, 2002; Selasse, 2003). According to the constitution, the House of Peoples’ Representatives is the highest authority of the Federal Government and it is responsible to the People, while the State Council is the highest organ of State authority and it is responsible to the People of the State. Members are elected every five years for both to the parliament and the state council. Both the Federal Government and the States have legislative, executive and judicial powers.

The federal structure is composed of nine regional member states: Tigray, Afar, Amhara, Oromia, Somali, Benishangul Gumuz, Southern Nations Nationalities and Peoples (SNNP), Gambella and Harrari and two federally administered city-states (Addis Ababa and Dire Dawa). The States are demarcated and organized according to ethnicity, for example, the state Afar for the Afar ethnic group. The States and City-States are further divided into Woredas (611 in number). The Woredas are further divided into Kebeles (roughly 15,000) organized under peasant associations in rural areas (10,000 Kebeles) and urban dwellers associations (5,000 Kebeles) in towns.

The constitution accords each State with the political right to self-administration. In recent years, the country has been in the process of decentralizing administrative and political powers to a Woreda level. The decentralization targets at improving the effectiveness and efficiency of public services and minimizing bureaucracy. The country has been in the list of major recipients of aid and credit, from donor and credit agencies and countries such as, for example, the World Bank, USA, UK, Japan and China recently. The majority of development projects and initiatives, and in some case services (such as in the health care) are supported by donors. Often, these donors and creditors dictate certain policies and directions, for example as in the World Bank’s decentralization agenda, with the exception of China. The
country has also been in the process of reengineering business processes of each and every public sector organization since 2008. The reengineering aims at improving effectiveness and efficiency of services, and most of the organizations have already finished the study phase and are implementing the proposed change.

2.2. Geography and Demographics

Ethiopia is located in the North Eastern part of Africa, with a total area of around 1.1 million square kilometers. Ethiopia is one of the largest countries in the African continent, which is as large as France and Spain combined (Richard Pankhurst, 1998). It is situated almost centrally between the Tropic of Cancer and the Equator (Richard Pankhurst, 1998). The size of the Country and its location has accorded it with diverse topography, geographic and climatic zones and resources. High mountains in the Northern part tower more than 4,600 meters above sea level, giving way to flat low lands, with the Afar, or Danakil, depression sinking below it. The temperature ranges from the icy cold of the high mountains, with frost through the temperate highlands to the torrid lowlands (Richard Pankhurst, 1998). Figure 1 locates Ethiopia with respect to Africa and shows Regional States that constitute the country.

![Figure 1: Ethiopia with respect to Africa (Left) and Regional States of Ethiopia (Right)](image)

The population of Ethiopia has been growing at an average rate of 2.7% per annum since 2000 and the 2008 World Bank estimate puts the total population size to 80.7 million (World Bank, 2010). This figure brings Ethiopia to become the second most populous
country in African following Nigeria. The population aged 0 – 14, 15 – 64, and 65 and above constitute 43.86%, 52.99% and 3.15% of the total population, respectively (World Bank, 2010). The statistics shows that the working age population is more than half of the total population, which could give a good prospect to the development potential of the country, if proper investment is made on this fertile human capital and an environment conducive for making use of it is put in place.

2.3. Socio–economic Context

Ethiopia is one of the least developed countries in the world with an estimated gross national income per capita of US$ 280 in 2008 (World Bank, 2010). Ethiopia's economy is largely based on agriculture, accounting for half of the country's gross domestic product (GDP), 60% of exports, and 80% of total employment (Chekol, 2009). Poverty is pervasive with 44.2% of the population estimated to live below the poverty line (World Bank, 2010). Life expectancy at birth was 55 (in 2008) and the net enrollment ratio in primary, secondary and tertiary schools is low (World Bank, 2010).

The 2009 human development report of UNDP ranks Ethiopia 171 in human development index (HDI) out of 182 countries. The HDI value of Ethiopia was 0.414, which was below the Sub-Saharan average, putting the country under “low human development” category (UNDP, 2010). Table 1 shows the HDI value of Ethiopia in relation to other countries along with HDI measure in three dimensions of human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and gross enrolment in education) and having a decent standard of living (measured by purchasing power parity, PPP, income).

Various efforts have been put in place and measures have been taken by both the Government and other national and international partners to address socio-economic challenges of the country. The Government of Ethiopia has identified IT as a valuable resource and mechanism for addressing some of the socio-economic challenges and has been promoting and utilizing IT as a strategic tool and resource towards this end. Section 2.7 highlights some of the major initiatives that the nation has undertaken.
Table 1: Ethiopia's human development index 2007

<table>
<thead>
<tr>
<th>HDI value</th>
<th>Life expectancy at birth (years)</th>
<th>Adult literacy rate (% ages 15 and above)</th>
<th>Combined gross enrolment ratio (%)</th>
<th>GDP per capita (PPP US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Norway (0.971)</td>
<td>1. Japan (82.7)</td>
<td>1. Georgia (100.0)</td>
<td>1. Australia (114.2)</td>
<td>1. Liechtenstein (85,382)</td>
</tr>
<tr>
<td>169. Liberia (0.442)</td>
<td>149. Djibouti (55.1)</td>
<td>143. Benin (40.5)</td>
<td>157. Solomon Islands (49.7)</td>
<td>169. Mozambique (802)</td>
</tr>
<tr>
<td>170. Guinea (0.435)</td>
<td>150. Tanzania (55.0)</td>
<td>144. Sierra Leone (38.1)</td>
<td>158. Guinea (49.3)</td>
<td>170. Togo (788)</td>
</tr>
<tr>
<td>171. Ethiopia (0.414)</td>
<td>151. Ethiopia (54.7)</td>
<td>145. Ethiopia (35.9)</td>
<td>159. Ethiopia (49.0)</td>
<td>171. Ethiopia (779)</td>
</tr>
<tr>
<td>172. Mozambique (0.402)</td>
<td>152. Kenya (53.6)</td>
<td>146. Chad (31.8)</td>
<td>160. Burundi (49.0)</td>
<td>172. Malawi (761)</td>
</tr>
<tr>
<td>173. Guinea-Bissau (0.396)</td>
<td>153. Congo (53.5)</td>
<td>147. Guinea (29.5)</td>
<td>161. Congo (48.2)</td>
<td>173. Timor-Leste (717)</td>
</tr>
<tr>
<td>182. Niger (0.340)</td>
<td>176. Afghanistan (43.6)</td>
<td>151. Mali (26.2)</td>
<td>177. Djibouti (25.5)</td>
<td>181. Congo (298)</td>
</tr>
</tbody>
</table>

Source: UNDP: Human development report 2009

Any solution meant for addressing socio-economic problems and, for that matter, in order to properly address any local problem, considering local situations and practices in the design and administration of solutions are desirable. Similarly, IT solutions and strategies that are meant for addressing local problems should capitalize on the historically constituted socio-cultural practices and elements of the context. The following section gives an overview of the language and the widely practiced voluntary-based collaboration and cooperation among Ethiopians.

2.4. Language and Culture

Ethiopia is a multi-ethnic country, house to more than eighty ethnic groups with distinct languages that belong to four main linguistic groups: Semitic, Cushitic, Omotic, and Nilo-Saharan (Richard Pankhurst, 1998). The Semitic languages are currently located mainly in the northern and the center; the Cushitic in the south; the Omotic in the south-west; and the Nilo-Saharan on the western periphery. Each language has equal legal status in the country and States and local administrations use them in schools and public organizations. Amharic is the official language of the Federal Government of Ethiopia. The Amharic language has its own writing system and an alphabet, which is different from the Latin script. The country follows a different calendar than the Gregorian, the one which has been widely used in the
world. The Ethiopian calendar is nearly 7 years and 8 months behind that of the Gregorian calendar.

Some authors present some of the contextual matters, such as the use of so many local languages, the unique writing system and the script, as hindrances in IT implementation and utilization, while others cherish it. For example, Sauders (2007) mentions the challenges of designing an Amharic language keyboard and the hindrances of the use of local languages to making the best out of the Internet, the majority of the content of which is in English.

There has been a well-established culture of collaboration among Ethiopians. The communal nature of the society that has been constituted over the years along with the tradition of living together in an extended family structure create an environment conducive for collaboration and cooperation. Besides the extended family structure, there are historically constituted community-based indigenous institutions that promote collective practice and solution provision on a voluntary basis. The society sanctions involvement in communities; individuals prioritize the society than themselves; members also adhere to the unwritten rules and regulations of the society, and perpetuate the sense of communalism as well as the institutions through participation. The purposes of the community-based indigenous organizations could range from addressing religious/spiritual issues through recreation/refreshment to addressing social and economic challenges.

The indigenous institutions that are common across rural as well as urban Ethiopia include “Debo”, “Edir” and “Equib”. Debo is a labor exchange group; Edir is an association for mutual support in relation to deaths and funerals; and Equib is a rotating saving and credit group. The following section describes these community-based institutions at some detail.

2.4.1. Debo

Debo is an Amharic name given to the process of exchanging labor. The labor to be exchanged could vary from place to place and depends on situations; it could be to cook food in case of marriage both in urban and rural areas, harvest crops, build houses in rural areas or to do any other job that requires collaboration. For example, farming has been a challenging activity for most Ethiopian farmers, who are unable to implement mechanized farming systems. To overcome the challenge of farming they exchange labor at different stages of the farming process starting from tilling land to harvesting crops. Often, a farmer asks the labor of other farmers in his neighborhood and gets the demanded labor. Farmers
bring their own resources and provide all the necessary labor to the person who inquired the service free of charge knowing that they have a similar opportunity to do so in the future, if they did not do it before. For example, during crop harvesting season, farmers come together and harvest the crop of an individual farmer. What is required from the farmer who got the assistance is to provide refreshment such as food and drinks. He also understands that he has the obligation to provide the same assistance for others.

Marriage is another big social event in Ethiopia that requires the collaboration of families, relatives, friends, and the neighborhood. People exchange labor especially to cook food for guests which usually is a labor intensive activity. Ethiopians exchange labor in most events and activities that are normally beyond the capacity of an individual or those activities that can be done relatively easily and faster in collaboration. The culture of exchanging labor is common in Ethiopia regardless of location and education level but depends on the nature of the job and situations.

2.4.2. Equb

Equb is a rotating fund common in Ethiopia. It is an informal savings association of friends, acquaintances, neighbors, officemates, relatives, and peers. Individuals form a group for the purpose of contributing an agreed upon amount of money in a given frequency, usually weekly and monthly, and allot the collected money to one member at a time in a rotating order and on a lottery basis. For example, a group of 10 participants may contribute €5 weekly with total fund of €50 at the end of 10 weeks. After 10 weeks, each member would have received €50 when the cycle is complete. The purpose of participating in Equb is that members may not be capable of saving enough money to make necessary investments or they may need a given sum of money within a short period of time without the need to pay interests.

Equb is common among the Ethiopian society and it has been used at different levels including extending business, refurbishing house, or making other important investments. It is a communal activity meant for addressing financial challenges.
2.4.3. Edir

Edir is an Amharic name for small mutual insurance societies. The Edir collects funds from its members that are then used to provide some minimal social security, especially to cover expenses for funeral and mourning services. The majority of Ethiopians, it is possible to say almost all, especially those who have families participate in at least one Edir.

The leadership of Edir and Equib organizations is selected by the local people themselves and, they may have either written or oral rules defining procedures of their operation. In most urban areas, these organizations have written bylaws defining the conditions of membership, contribution and payment. In recent days, there have been attempts to modernize these organizations, facilitate their engagement in investment activities and take part in addressing socio-economic challenges of the country. IT initiatives could also benefit a lot if designed in a manner suitable to capitalize on these widely practiced notions of collaboration, voluntary service provision, and cooperation. Education is also key to socio-economic development as well as IT implementation and use in any nation. The following section highlights the education system in Ethiopia.

2.5. The Education System

The history of education in Ethiopia traces its origin back to the 4th century AD, along with the introduction and expansion of Christianity, which in turn, introduced a traditional education system meant for religious and intellectual reflections (Zewde, 2002). The Western education system began taking shape with the arrival of Western missionaries who set up educational facilities and schools in the second half of the 19th century (Zewde, 2002). Although the traditional education system was there for years, the government of Ethiopia opened the first public school and the first university in 1908 and 1950, respectively. Education has expanded since then while the system and the content kept changing to serve the needs of different regimes and interests. The most recent change was introduced in 1994, after the downfall of the Derg regime.

Prior to 1994, general education was divided into primary (1-6), junior secondary (7-8) and senior secondary (9-12) with national examinations given on completion of each level. The current system offers 10 years of general education consisting of 8 years of primary education and 2 years of general secondary education (9-10) with the second cycle of secondary education (11-12) which prepares students for continuing to higher education.
Primary education is divided into two cycles comprising grades 1 through 4 of basic education and second cycle of grades 5 through 8 of general primary education. Figure 2 shows the detail structure of the current education system in Ethiopia.

According to the education system, IT education in Ethiopia starts in Grade 11, during the second cycle of secondary education, and it is offered to those students who are attending preparatory education. The education system also offers IT as a vocational program to those who want an IT career starting from TVET level 3. The vocational program in IT was introduced in 2001/02 and has three levels: IT assistant technician, intermediate technician and technician. Students can go from lower level to the next upper level, from level 3 to level 4 for example, and join undergraduate programs in universities based upon their class performance, upon passing national accreditation examination, and offering related services for at least two years. The vocational program policy demands students to spend 30 percent on theory and the remaining 70 percent of the time on practice. The curriculum and its detailed guide were developed according to the 30 - 70 principle.

Figure 2: Structure of the Ethiopian education system
The current statistics of the government of Ethiopia (2008/09) indicates growth in major education indicators and points out the challenges ahead (FMOE – Ethiopia, 2010). Table 3 gives an overview of the Ethiopian education system along the lines of major indicators.

Table 2: The status of the Ethiopian education system at a glance

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Enrollment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0. KG</td>
<td>153,28</td>
<td>186,728</td>
<td>219,068</td>
<td>263,464</td>
<td>292,641</td>
<td>17.5</td>
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<tr>
<td>1. Primary education</td>
<td>11,448,641</td>
<td>13,474,674</td>
<td>14,014,276</td>
<td>15,340,788</td>
<td>15,549,524</td>
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<tr>
<td>2. Secondary education</td>
<td>953,217</td>
<td>1,190,106</td>
<td>1,398,881</td>
<td>1,502,133</td>
<td>1,589,207</td>
<td>13.6</td>
</tr>
<tr>
<td>3. TVET</td>
<td>106,336</td>
<td>123,557</td>
<td>191,151</td>
<td>229,252</td>
<td>308,501</td>
<td>30.5</td>
</tr>
<tr>
<td>4. Undergraduate</td>
<td>138,156</td>
<td>173,901</td>
<td>203,399</td>
<td>263,001</td>
<td>309,092</td>
<td>22.3</td>
</tr>
<tr>
<td>5. Postgraduate</td>
<td>3,604</td>
<td>6,385</td>
<td>7,057</td>
<td>7,355</td>
<td>10,125</td>
<td>29.5</td>
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<td>2. Teachers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0. KG</td>
<td>4,584</td>
<td>7,271</td>
<td>8,017</td>
<td>9,794</td>
<td>13,763</td>
<td>31.6</td>
</tr>
<tr>
<td>1. Primary education</td>
<td>171,079</td>
<td>203,039</td>
<td>225,319</td>
<td>253,629</td>
<td>268,693</td>
<td>11.9</td>
</tr>
<tr>
<td>2. Secondary education</td>
<td>17,641</td>
<td>20,795</td>
<td>28,183</td>
<td>33,736</td>
<td>38,357</td>
<td>21.4</td>
</tr>
<tr>
<td>3. TVET</td>
<td>4,957</td>
<td>6,134</td>
<td>7,083</td>
<td>9,01</td>
<td>9,052</td>
<td>16.2</td>
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<tr>
<td>4. Higher Education</td>
<td>4,847</td>
<td>4,848</td>
<td>8,355</td>
<td>8,355</td>
<td>11,028</td>
<td>22.8</td>
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<td>3. Schools</td>
<td></td>
<td></td>
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<tr>
<td>0. KG</td>
<td>1,497</td>
<td>1,794</td>
<td>2,313</td>
<td>2,74</td>
<td>3,865</td>
<td>26.8</td>
</tr>
<tr>
<td>1. Primary education</td>
<td>16,513</td>
<td>19,412</td>
<td>20,66</td>
<td>23,354</td>
<td>25,212</td>
<td>11.2</td>
</tr>
<tr>
<td>2. Secondary education</td>
<td>706</td>
<td>835</td>
<td>952</td>
<td>1,078</td>
<td>1,197</td>
<td>14.1</td>
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<td>4. Net Enrollment Ratios</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Primary education</td>
<td>68.5%</td>
<td>77.5%</td>
<td>79.1%</td>
<td>83.4%</td>
<td>83.0%</td>
<td>4.9</td>
</tr>
<tr>
<td>1.1 1st Cycle (1-4)</td>
<td>73.0%</td>
<td>79.9%</td>
<td>90.1%</td>
<td>88.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 2nd Cycle (5-8)</td>
<td>37.6%</td>
<td>39.4%</td>
<td>39.9%</td>
<td>46.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Secondary education</td>
<td>11.8%</td>
<td>13.2%</td>
<td>14.7%</td>
<td>13.8%</td>
<td>13.5%</td>
<td>3.4</td>
</tr>
<tr>
<td>2.1 1st Cycle (9-10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 2nd Cycle (11-12)</td>
<td>2.3%</td>
<td>3.0%</td>
<td>2.9%</td>
<td>2.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Pupil/Teacher ratio (Regular)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Primary education</td>
<td>66</td>
<td>61</td>
<td>59</td>
<td>57</td>
<td>57</td>
<td>3.6</td>
</tr>
<tr>
<td>2. Secondary education</td>
<td>51</td>
<td>54</td>
<td>48</td>
<td>43</td>
<td>43</td>
<td>4.2</td>
</tr>
</tbody>
</table>


³ AAGR stands for Average Annual Growth Rate
As indicated in the table, the enrollment ratio, for example, is low relative to the school age population, it further declines as the level of education increases and the student/teacher ratio is very high. The education budget and expenditure relative to the total government expenditure has been increasing since 2004/05. For example, it was 16.7% of the total government expenditure in 2004/05 and 23.6% in 2008/09 (FMOE – Ethiopia, 2010). There were 23 government universities (12 of them were newly opened in 2006/07) with a total of 9,496 teaching staff in 2008/09 academic year (AY). Collectively they enrolled 263,979 students in both undergraduate and graduate programs in 2008/09 AY. There were also 49 non-government owned colleges/universities with a total of 1532 teaching staff enrolling a total of 55,264 students in undergraduate and graduate programs in 2008/09 AY.

Libraries in higher education play a pivotal role in supporting and facilitating teaching, learning and research. With the advancement of technology, especially IT, libraries have been rendering services electronically to users without geographic and time limitations. Two of the sites in this study are libraries in two higher education institutions in Ethiopia, and the following section gives an overview of the library setting.

2.5.1. Libraries

The history of modern libraries in Ethiopia begins in 1930 with the opening of a public reading room (Gupta, 1995). Libraries began to emerge in 1930's in response to the needs of modern education encouraged by Emperor Haile Selassie and the growing number of foreign communities in Addis Ababa. It is commented that, although the reading room was beautiful, books and readers were scarce and even the librarian shows up occasionally (Gupta, 1995). Similar to other sectors, the five years (1936 – 1941) Italian occupation of Ethiopia halted the development of libraries in Ethiopia (Gupta, 1995; Rita Pankhurst, 1988). Although libraries have grown in number throughout the years, their collections and services were very limited (Gupta, 1995; Rita Pankhurst, 1988). Most of the collections of these libraries constitute individual and institutional donations with very limited financial resource to purchase books and journals. As a result, most of the collections of the libraries have been obsolete and had limited subscription to journals.

Only a handful of printed sources that deal about libraries in Ethiopia are available, and they talk about the history and challenges of libraries before the 1990s. The problem could be linked to the closure of the only Library Science program at Addis Ababa University in the 1990s and those trained librarians were also changed their careers. Generally, there are no
printed sources that give clear picture of the current status of libraries in Ethiopia. However, from my experience and exposure, I understand that the libraries in all of the higher learning institutions operate on a manual basis. It is the Addis Ababa University, the oldest and the largest one that has been utilizing IT to some extent in its backend activities and to provide some services to patrons.

Manual operations limit libraries to satisfy the needs of their users as required. Users could not be able to easily search for and fetch books and journals. The manual system could not allow searching for an item by combining keywords or subject headings. Even if the search was successful, it was not easy to know the status of a material, such as whether it is in circulation, on the shelf, out of circulation, etc. Manual systems require users to go further steps in order to get such information, and these processes consume time and energy. In case of large libraries that are organized into branches, users may require to visit other branch libraries to learn whether a material that they are in need of is available or not. The Library staff could also face difficulty in identifying what is available in the library, circulating books to users, compiling reports, etc.

The introduction of an integrated library system could improve services, alleviate drawbacks of the manual system, and facilitate interaction with similar libraries, which is not in existence presently. An integrated library system would automate the processes of acquisition of books and serials, cataloging and circulation functions, and facilitates the generation of various reports relatively easily and fast. Using OPAC (online public access catalog), users can easily interact with the Library, search library collections, and operate some circulation activities.

2.6. The Health Care System

Ethiopia has poor health status relative to other low-income countries, even within Sub Sahara Africa (SSA) (FMOH – Ethiopia, 2005b). The 2005 Health and Health Related Indicator of the FMOH indicates that malaria, helminthes, tuberculosis and bronchopneumonia infections are the major causes of outpatient visits at the health institutions accounting for 32.25% of all causes. The top 10 leading causes of outpatient visit accounts for 49.68% of all causes. Malaria, bronchopneumonia and tuberculosis are the major causes of death accounting for 51.67 % of all cause of deaths; and the top 10 leading causes of death accounts for 60.92% of all causes of deaths (FMOH – Ethiopia, 2005b). Widespread poverty along with general low income levels of the population, low education
levels (especially among women), inadequate access to clean water and sanitation facilities and poor access to health services have contributed to the high burden of ill-health in the country. The average life expectancy at birth is also relatively low at 55 years (53.8 for males and 56.7 for females) in 2008 and it is further expected to decline due to the HIV/AIDS pandemic (FMOH – Ethiopia, 2006; World Bank, 2010). The health expenditure per capita in 2008 was 9.18 USD and the total health expenditure in the same year was 3.79% of the GDP (World Bank, 2010).

Decision-making processes in the development and implementation of the health system are shared between the Federal Ministry of Health (FMOH), the Regional Health Bureaus (RHBs) and Woreda Health Offices. The FMOH and the RHBs function more on policy matters and technical support, while the Woreda health offices play pivotal roles of managing and coordinating the operation of the primary health care services at the Woreda levels. Donors also play important roles in the Ethiopian healthcare system ranging from financing specific health care program to human resource development and technical and policy development activities. The government has been operating to alleviate problems of the health sector by formulating health sector development program (HSDP) since 1997/98 (Desta, 2003), the latest being HSPD III. The third HSDP which was planned to be implemented from 2005/6 to 2009/10, aimed at improving maternal health, reducing child mortality and combating HIV/AIDS, malaria, TB and other diseases. HSDP III also gives better emphasis to Health Management Information System (HMIS) and Monitoring and Evaluation activities than the previous two. HSDP III states the following as the major objectives of HMIS subcomponent:

- Develop and implement a comprehensive and standardized national HMIS and ensure the use of information for evidence based planning and management of health services.
- To review and strengthen the existing HMIS at federal, regional, Woreda, health facility and community levels and ensure use of health information for decision-making at all levels.
- To achieve 80% completeness and timely submission of routine health and administrative reports.
- Achieve 75% of evidence based planning.

The health sector, specifically the HIV/AIDS domain, is one of the focus areas of the research reported in this dissertation. The next section gives detailed information on the status and prospect of HIV/AIDS in Ethiopia.
2.6.1. HIV/AIDS and Anti-Retroviral Therapy

HIV was first detected in Ethiopia in 1984 and the first two cases were reported to the MOH in 1986. The prevalence of HIV/AIDS has been increasing because of sexually transmitted infections (STIs), multiple sexual partners, and harmful traditional practices such as female genital mutilation, uvulectomy, bloodletting, skin cutting, and piercing practices. As a national response to the epidemic, a national HIV/AIDS task force was established in 1985 followed by the establishment of a National AIDS Control Program (NACP) at a Department level in the MOH in 1987. To create an enabling environment for HIV/AIDS prevention and control, the ministry formulated an HIV/AIDS policy which was adopted by the council of ministers in 1998. The policy guarantees rights for People Living with HIV/AIDS (PLWHA) and recommends the development of policies on the supply and use of antiretroviral (ARV) drugs.

The national AIDS control program was replaced by the HIV/AIDS Prevention and Control Office (HAPCO) which was established in 2002 directly under the Prime Minister's Office. HAPCO was responsible for resource mobilization, advocacy, and coordination of sectoral responses. As a national response, HAPCO developed the National Strategic Framework, and prioritized and implemented interventions. The intervention included education; condom promotion and distribution; voluntary counseling and testing (VCT); management of sexually transmitted infections (STI); blood safety; universal precaution; prevention of mother-to-child transmission of HIV (PMTCT); care and support to the infected and affected; legislation and human rights; surveillance; and research.

As indicated in Table 4, although the national adult prevalence has been gradually decreasing, it has already affected a large size of the population and impacted socio-economic development. For example, in 2010 the adult prevalence is estimated to be 2.8 (1.4 in rural and 9.3 in urban areas) with 1.44 million HIV positive population and 245 people dying of AIDS every day (FMOH – Ethiopia, 2006). For the same year, it was projected that there will be 143,826 HIV positive children aged 0-14 years, 965,967 AIDS orphans, 34,210 children need ART and 15,273 children would die of AIDS (FMOH – Ethiopia, 2006). It is also projected that the life expectancy of Ethiopians will decrease by 2.8 years in 2010 due to AIDS (FMOH – Ethiopia, 2006).

<table>
<thead>
<tr>
<th>ALL AGES</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult prevalence (%)</td>
<td>3.7</td>
<td>3.5</td>
<td>3.3</td>
<td>3.2</td>
<td>3.0</td>
<td>2.9</td>
<td>2.8</td>
</tr>
<tr>
<td>HIV-pos population</td>
<td>1,333,869</td>
<td>1,319,795</td>
<td>1,306,891</td>
<td>1,319,902</td>
<td>1,345,970</td>
<td>1,387,039</td>
<td>1,439,769</td>
</tr>
<tr>
<td>HIV-pos pregnant women</td>
<td>108,819</td>
<td>105,675</td>
<td>102,781</td>
<td>101,741</td>
<td>101,650</td>
<td>102,773</td>
<td>105,159</td>
</tr>
<tr>
<td>Annual HIV-Pos Birth</td>
<td>31,445</td>
<td>30,338</td>
<td>26,364</td>
<td>23,003</td>
<td>19,969</td>
<td>19,322</td>
<td>19,073</td>
</tr>
<tr>
<td>New HIV infections</td>
<td>127,760</td>
<td>128,922</td>
<td>129,907</td>
<td>132,154</td>
<td>134,936</td>
<td>139,867</td>
<td>144,737</td>
</tr>
<tr>
<td>Adult HIV incidence (%)</td>
<td>0.27</td>
<td>0.26</td>
<td>0.26</td>
<td>0.27</td>
<td>0.27</td>
<td>0.27</td>
<td>0.28</td>
</tr>
<tr>
<td>New AIDS cases</td>
<td>136,808</td>
<td>137,499</td>
<td>135,666</td>
<td>132,744</td>
<td>129,212</td>
<td>126,489</td>
<td>124,512</td>
</tr>
<tr>
<td>Annual AIDS deaths</td>
<td>131,812</td>
<td>134,450</td>
<td>111,200</td>
<td>101,180</td>
<td>89,904</td>
<td>83,161</td>
<td>89,225</td>
</tr>
<tr>
<td>Annual population increase</td>
<td>2,003,354</td>
<td>2,060,824</td>
<td>2,145,126</td>
<td>2,213,764</td>
<td>2,281,182</td>
<td>2,213,764</td>
<td>2,145,126</td>
</tr>
<tr>
<td>ART Needs</td>
<td>277,539</td>
<td>277,757</td>
<td>274,364</td>
<td>287,881</td>
<td>307,207</td>
<td>334,221</td>
<td>351,001</td>
</tr>
</tbody>
</table>


The impact of HIV/AIDS is all rounded encompassing all sectors and aspects of human endeavor. Since its first detection, HIV/AIDS has risked the life of millions of Ethiopians. The population lost to AIDS was about 1.3 million in 2005 and projected to reach 1.9 million by 2010 with 0.1 million annual increase if present trends continue. HIV/AIDS accounted for an estimated 32% of the 141,000 TB case incidences in 2005 (FMOH – Ethiopia, 2006). This proportion is expected to continue to rise in the coming years. The consequences of the co-infection of TB and HIV have resulted in major problems for the country’s health sector. It increases the number of TB patients, lowers cure rate of TB patients, increases mortality during treatment, maximizes the rate of adverse drug reactions leading to a high number of defaulters, maximizes the rate of TB recurrence and increases TB drug resistance. Adult (15-49 years) deaths due to AIDS are expected to rise tremendously, in the coming years and already account for about a third of all young adult deaths in the country. The loss of young adults in their most productive years of life is most likely to affect the overall economic output. The loss of trained professionals such as teachers, medical workers, engineers, development workers, etc, to AIDS would do the same and more as it will greatly affect the human resource development of the country. AIDS also increases the cost of medical care, drugs and funeral expenses, it has been estimated that the foreign exchange requirement for imported drugs would escalate to millions of dollars.
2.6.1.1. Anti-Retroviral therapy in Ethiopia

Anti-Retroviral Therapy (ART) is one among the efforts put in place to curb the HIV/AIDS pandemic in Ethiopia. ART is the administration of medications known as Anti-Retro Viral (ARV) drugs in order to suppress the replication of HIV. Successful use of ART suppresses HIV viral replication, consequently slowing down disease progression, improving immunity and delaying mortality. ART simply prolongs and enhances the quality of life of people infected with HIV and changes a uniformly fatal disease to a manageable chronic illness. As of February 2010, there were 532 operational ART treatment sites throughout Ethiopia (100, 20, and 26 public, private, and military hospitals respectively; and 1 military polyclinic, 383 health centers and 3 NGO clinics) (FMOH – Ethiopia, 2010). The following table shows the number of people enrolled into ART by age since the start of ART in Ethiopia.

Table 4: The number of people enrolled into ART by age as of February 2010

<table>
<thead>
<tr>
<th>Age category</th>
<th>New persons started in February</th>
<th>Cumulative ever started at end of February</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants &lt;18 months</td>
<td>57</td>
<td>1386</td>
</tr>
<tr>
<td>Children 19-59 months</td>
<td>89</td>
<td>4034</td>
</tr>
<tr>
<td>Children 5-14 years</td>
<td>176</td>
<td>8230</td>
</tr>
<tr>
<td>Non-pregnant females &gt;14 years</td>
<td>2246</td>
<td>125599</td>
</tr>
<tr>
<td>Pregnant females</td>
<td>108</td>
<td>3707</td>
</tr>
<tr>
<td>Males &gt;14 years</td>
<td>1542</td>
<td>100914</td>
</tr>
<tr>
<td>Unspecified</td>
<td>2477</td>
<td>246347</td>
</tr>
<tr>
<td>Total</td>
<td>4218</td>
<td>246347</td>
</tr>
</tbody>
</table>


Once ART is started, it has to be taken for life and is costly. The success of ART is closely linked to geographic coverage (100 % coverage is required) and patients’ adherence to regimens. An adherence level of more than 95% (missing no more than one dose per month) is required for patients to receive the therapy’s hoped-for benefit (FMOH–Ethiopia, 2005). ART is projected to decrease AIDS deaths and the number of AIDS orphans significantly (FMOH – Ethiopia, 2006). The administration of ART has unintended consequences such as the production of drug resistant viruses and increase of HIV prevalence (FMOH – Ethiopia, 2006). Poor adherence facilitates the development of drug-resistant viruses, harming not only an individual patient’s prospects, but also the
community’s as a whole, because transmission of a drug-resistant virus can ultimately lead to a superimposed epidemic of drug-resistant HIV. Since ART is supposed to be taken for life, provision of care and support for patients may be compromised as the size increases year after year.

The FMOH has set up policy and guidelines for the implementation and rollout of ART in Ethiopia specifying management and coordination structure, patient and data flows, and requirements (FMOH – Ethiopia, 2005a). It has also developed data collection and reporting forms, along with guidelines for how they should be filled out and by whom. The guidelines and forms dictate the collection of large amounts of data per individual patient, as well as duplication of them in different forms. These tasks were making accurate data collection, as well as the analysis and evidence-based service that follow from it, inordinately challenging. This became increasingly the case as the numbers of patients grew and the setting became more and more resource-constrained. Stakeholders of the service at different levels had difficulties getting accurate information on time, so they were unable to plan and make informed decisions. Patient follow up and report production was extremely difficult and resource consuming as a result. Misplacement of patient cards, for example, led to disappearance of medical detail of patients.

2.7. IT Infrastructure, Content, Initiatives and Directions

The use of IT for private and public consumption in Ethiopia is a recent phenomenon. The socialist agenda of the previous regime and the two decades long civil war contributed the lion share in devastating the country’s economy, killing competition and the private sector, isolating the country from the West, and as a result, from technological and scientific advancements especially those meant for individual and public consumptions. Since the second half of the 1990s, the IT sector has shown improvements. The country connected to the Internet in 1997 and introduced Mobile phone services in 1999, followed by the introduction of a prepaid mobile service in 2003. Since the beginning of the 2000s, the country invested huge amount of money in IT infrastructure development such as laid down fiber optics backbone network for data and voice communication, expanded data and communications services to rural communities, etc.

The current government has identified the potential of IT in accelerating socio-economic development, alleviating poverty, promoting transparency and democracy, facilitating maximum connectivity to the global information infrastructure and laying a foundation for
participation in the world marketplace, and embarked on infrastructure development and capacity building programs (Chekol, 2009). Studies commissioned by the Ministry of Capacity Building (MOCB), the government body responsible for IT capacity and infrastructure development, point out the need for embracing IT in the government’s socio-economic and national development plans (GebreMichael, 2003), the application of IT in different sectors (Desta, 2003; Diana, 2003; Gebreyesus, 2003; Mussa, 2003), and encourage the government to take actions in policy formulation and human resource capacity development (Demissie, 2003).

Following these calls, the government has undertaken various measures and initiatives that target at improving infrastructure, developing capacity, and setting out policies and directions. The following excerpt from the draft ICT for development action plan reflects the government’s position towards the role of ICT in Ethiopia:

Not only does the Government consider ICTs as an indispensable tool and means to alleviate … poverty but it also considers ICTs as a major tool for facilitating the on-going state transformation which is aimed at effective and efficient service delivery and at consolidating democratic values, governance, accountability and transparency. The Government therefore views ICTs within a wider context of its socio-economic development goals and objectives as well as the consolidation of democratic values and sound governance practices. The goal is to make Ethiopia an ICT-driven country able to function effectively in a networked global economy. (Dzidonu, 2004. P. 6)

ICT has become an integral part of Ethiopia’s development programs over the last decade, following initial indifference to the development of the sector (Adam, 2010).

2.7.1. Institutional Arrangements

The overall communication sector governance framework in Ethiopia comprises a number of players that influence the regulatory environment in different ways, but the key power rests with the prime minister (Adam, 2010). The main actors include:

- The Prime Minister, head of the government and ultimately responsible for decisions on policy and regulatory matters.
- The Council of Ministers, which approves communications regulations and sets the budget of the Ethiopian Telecommunications Authority (ETA).
The Ministry of Transport and Communications, which defines the policy framework, directs the regulator and oversees the activities of the incumbent operator. The Ministry appoints the General Manager of the ETA and the Chief Executive Officer of the Ethiopian Telecommunications Corporation (ETC).

The Ministry of Capacity Building, which defines ICT strategy for the public service, including education, health, agriculture and other sectors. The Ministry hosts the Ethiopian ICT Development Agency (EICTDA), which is responsible for the development and implementation of the national ICT policy.

The Government Communication Office, which deals with broadcasting sector and oversees the activities of the Ethiopian Broadcasting Agency (EBA), which has a parallel function to the ETA.

An ETC Board of Directors, which supervises the Ethiopian Telecommunications Corporation. The Board develops the telecommunications strategy for the country and appoints senior managers to the ETC.

The three institutions that compete for the regulation of the ICT sector are the EICTDA, ETA and EBA. The ETA and EICTDA have areas of ICT regulation that often overlaps, such as community access, content and legislations pertaining to online transactional content (Adam, 2010). The EBA and ETA overlap in the area of spectrum management and regulation of converged content.

The EICTDA was established to promote the use of ICTs in government agencies, education and in the private sector (Adam, 2010; Demissie, 2003). It deals with five themes: ICT for government; legal and regulatory frameworks including standards; human resources development; ICT applications in sector; private sector development and promotion of community access. The EICTDA has also been charged with the review of a national ICT policy.

The EBA was established in 2000 following a proclamation for its establishment in 1999. It has not been effective for quite a long period due to a protracted debate over opening the broadcasting sector for private investment. The EBA works closely with the Ethiopian Telecommunications Agency and responsible for the management of the broadcast radio frequency spectrum.
2.7.2. Infrastructure

The IT infrastructure in Ethiopia is among the least developed in the world (Adam, 2010; Demeke, 2003), however, current statistics indicate growth in major indicators such as telephone density (fixed-line and mobile), Internet penetration, access to television and radio, and broadband access, etc (Adam, 2010; Dzidonu, 2004; Takeuchi, 2008). For example, fixed-line telephone capacity has tripled, from 649,593 in 2003 to 1,769,024 in 2009 (Adam, 2010). The percentage of digital lines to analogue has grown from 89.64% in 2003 to 99.87% in 2009. The number of Internet subscribers has doubled in 2009 from 34,110 in 2008 to 71,059 in 2009 (Adam, 2010). The estimated Internet users are about 500,000 in 2009 and the bandwidth has been improved over the years. In 2009 there were 3498 broadband subscriptions for example (Adam, 2010). By 2014 the number of fixed line subscribers in Ethiopia is expected to increase to 4.4 million, representing an annual average growth rate of 38% p.a. The number of mobile subscribers is expected to grow at 43% per year over the period, reaching almost 20 million by 2014.

Ethiopia has been building a national backbone, 10,000km fiber network, fanning out from the capital Addis Ababa in seven directions (Adam, 2010). Furthermore, the country has undertaking WoredaNet and SchoolNet projects that target at deploying ICT networking infrastructure in more than 500 Woredas and nearly 700 schools, respectively. WoredaNet aims at delivering Web Service, Voice-over IP Service, Directory Service, Messaging, Video Conferencing services at the federal, regional and Woreda levels of government. The SchoolNet is designed to develop a wide area network linking all schools in the country and making Internet and online education accessible to them. The country also embarked on an E-Government project in 2004.

2.7.3. Content

Applications and local contents are very limited in Ethiopia (Diana, 2003). However efforts and directions have been put in place towards the same end. Various applications development initiatives are being carried out in government Ministries and Agencies. The ICT for Development action plan besides articulating the required interventions, tends to integrate the fragmented previous initiatives (Dzidonu, 2004). Language translation, keyboard standardization, etc have been undertaken to use ICT in local languages. As an output of the effort, Microsoft released the first office package, MS Office 2007, in Amharic in
April 2010. Microsoft also developed an Amharic keyboard in Windows 7 and it made possible to compose in Amharic and exchange documents in a similar platform.

Although the majority of medium and large scale systems have been imported from overseas, the number of local software companies is increasing. These companies serve as subsidiaries to foreign firms and engage in small-scale software development and support activities (GebreMichael, 2003).

2.7.4. Human Capacity

The number of qualified people in the IT sector is still very limited compared to the demand, although the number of higher learning institutions teaching ICT related programs has been increased in parallel with increasing the intake capacity of existing programs in all public universities (Adam, 2010). The private sector has also been producing a number of qualified personnel and ICT training in technical and vocational training schools were introduced throughout the country (Demeke, 2003).

2.7.5. Policy and Direction

ICT is one of the major components of the Sustainable Development and Poverty Reduction Program (SDPRP) of the Ethiopian government (Adam, 2010; Dzidonu, 2004). The most consolidated and recent policy framework is the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) that runs between 2005 and 2010. Five major initiatives were designed with regard to the ICT sector development in the PASDEP document:

- promoting human resource development in the ICT field;
- mainstreaming the use of ICT in all sectors of the economy, in the administration of government, and in the education system;
- developing the necessary telecommunications infrastructure;
- promoting research and development through ICT; and
- creating enabling legal and regulatory framework.

The broad ICT sector policy of the Ethiopian government that derives from PASDEP, was developed in 2006 by the Ethiopian ICT Development Agency (EICTDA) (Adam, 2010; Dzidonu, 2004). The policy aims to:
develop ICT as a globally competitive industry, and as an engine of national growth; create the necessary conditions for the rapid development of ICT within the economy and society to accelerate Ethiopia’s socio-economic development process; promote and facilitate an extensive use of ICT in support of key sectors of the economy including agriculture, industry and the services sectors; transform Ethiopia into a knowledge and information-based society and economy; and promote the use of ICT for modernising the civil and public service to enhance its efficiency and effectiveness for service delivery, to promote good governance and reduce wastage of scarce resources.

The country has drafted an ICT policy back in 2002 but it has not been yet ratified and the state does not preferentially benefit the ICT sector. In fact, computer hardware and software are taxed heavily (Demeke, 2003). Although the policy documents theoretically create an environment conducive for the development of the ICT sector, facts on the ground prove otherwise (Adam, 2010). For example, the Ethiopian Telecommunication Corporation (ETC), a state owned corporation, has been the only Internet and telecommunications service provider and the regulatory body until 1996, until a government proclamation separated the regulatory power. The monopoly did not facilitate competition and growth in the area. Of course, some critics attribute the low rate of telecom density, IT infrastructure, Internet penetration, and poor connection and service to the monopoly characteristics (Adam, 2010). The following table, adapted from Adam (2010) indicates prevailing policies of Ethiopia in the IT sector.

**Table 5: Prevailing policy in the Ethiopian communications sector**

<table>
<thead>
<tr>
<th>Telecommunication services</th>
<th>Market</th>
<th>Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed-Line (Domestic and International)</td>
<td>Monopoly</td>
<td>ETC is the sole provider of international and domestic fixed-line services.</td>
</tr>
<tr>
<td>Mobile service</td>
<td>Monopoly</td>
<td>ETC is the sole provider of mobile service</td>
</tr>
<tr>
<td>International gateway</td>
<td>Monopoly</td>
<td>ETC controls the international gateway</td>
</tr>
<tr>
<td>Internet services</td>
<td>Monopoly</td>
<td>ETC is the sole provider of Internet service</td>
</tr>
<tr>
<td>Domain names</td>
<td>Monopoly</td>
<td>ETC is the manager of the domain name and responsible for web hosting under “.et” domain.</td>
</tr>
<tr>
<td>Telecommunication services</td>
<td>Market</td>
<td>Policy</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>Content services</td>
<td>Monopoly</td>
<td>Web hosting under .et domain a monopoly of ETC</td>
</tr>
<tr>
<td>VSAT</td>
<td>Monopoly and case by case</td>
<td>Individuals and enterprises are not allowed to own VSATs and bypass the national gateway. International organizations are allowed to own VSAT with payment of traffic compensation or “landing right” fees on case-by-case basis.</td>
</tr>
<tr>
<td>Call centre, cyber café and messaging services</td>
<td>Competition</td>
<td>Downstream value-added services such as call centers, pay phones, cyber cafés and messaging services are allowed for competition.</td>
</tr>
<tr>
<td>Call back and use modern technologies (e.g. VOIP)</td>
<td>Barred</td>
<td>Call back or use of modern technology like VOIP is not allowed.</td>
</tr>
<tr>
<td>Telecommunications equipment</td>
<td>Competition</td>
<td>Sale of mobile and telephone handsets is allowed.</td>
</tr>
</tbody>
</table>

### 2.7.6. Open Source Software

Awareness and knowledge about OSS among IT professionals in Ethiopia was limited until the formation of an Ethiopian Free and Open Source Software Network (EFOSSNet) in February 2005 (Chekol, 2007). EFOSSNet is a non-governmental professional network established by a group of interested ICT professionals and individuals. It aims to facilitate the use of OSS in the country through awareness-raising, training and fostering partnerships with the private, non-profit and public sectors (Chekol, 2007). A workshop which was organized by EFOSSNet and the Ethiopian IT Professionals Association (EITPA) on 27 December 2008, reveals the immaturity of the OSS idea even among IT professionals three years after the establishment of EFOSSNet. There is little mention of OSS in the ICT policy and the ICT4D action plan documents (Dzidonu, 2004; Ethiopian ICT Development Authority, 2002).
CHAPTER 3: COLLABORATIVE IS IMPLEMENTATION IN DEVELOPING COUNTRIES

This chapter presents an overview of theoretical perspectives that influenced data collection and analysis, and outlines tenets of the analytical framework used to address the research questions presented in chapter one. The chapter is organized into six sections. Section 1 presents an overview of IS implementation focusing on how it has been conceptualized, viewpoints on technology-based organization change and the role of IS in organizations, and discusses the nature of implementation researches. The section concludes by summarizing the viewpoints and indicating the adopted perspectives. The OSS phenomenon has been considered an opportunity to developing countries in their attempt to increase IT utilization, thereby bridging the existing digital divide. Section 2 discusses the essence of the OSS phenomenon, its organization and production processes, and the implications of the production organization on implementation. Section 3 discusses the unique characteristics, challenges and opportunities of IS implementation in developing countries. Section 4 discusses the unique opportunities and challenges of OSS focusing on implementation, open innovation and human capital development. Section 5 presents the CoP and NoP theories, and concludes with a presentation on the proposed distributed collaborative implementation approach.

3.1. Conceptualizing IS Implementation and Organization Change

The concept ‘implementation’ has been used in the IS literature to refer to different things at different times, it is black boxed in most of the cases. The majority of implementation articles just mention the concept without unpacking its constituent elements or giving an explicit definition (see for example (Doolin, 2004; Lapointe & Rivard, 2005; Orlikowski, 1993, 1996; Plant & Willcocks, 2006; Sahay, 1997; Sahay & Robey, 1996; Scott & Wagner, 2003; Yetton, Sharma, & Southon, 1999). Traditionally, implementation is regarded as a technical activity that comes before the maintenance phase in the system development life cycle (Ilivari, 1986; Kautz & Nielsen, 2004; Land, 1992). The system development life cycle, the process of developing software systems, has five distinct phases – systems analysis, design, implementation, testing, and operations and maintenance. Implementation, in this case, refers to the process of ensuring system development is completed and that the system
functions adequately in a technical sense; it involves procurement and installation of hardware and software, building of files and programs, user training, system handover, etc (Iivari, 1986; Koskinen, 2006; Land, 1992; Walsham, 1993). This technology-oriented conceptualization has to do more with information system development, which deals with the ways in which information systems are conceived, analyzed, designed and implemented usually following the traditional system development life cycle with slight variations from methodology to methodology (Avison & Fitzgerald, 2006). Information system development begins with identification of system requirements and leads to the implementation and maintenance of an IS product. The notion of implementation in information system development, as manifested in standard methodologies mean no more than system's testing and hand-over (Land, 1992).

Implementation has also been broadly defined to include the entire system development process from original suggestion through feasibility study, systems analysis and design, programming, training, conversion to installation (Iivari, 1986; Kim & Pan, 2006). Implementation sometimes refers to human and social aspects, such as that the frequency of use of a system by organizational members or that it is considered valuable to them in their personal work activities or co-ordination with others (Walsham, 1993). It is also defined as an organizational effort directed toward diffusing appropriate information technology within a user community (Cooper & Zmud, 1990).

Some studies treat IS development and organizational implementation as separate phenomena (Koskinen, 2006). Information system development, as discussed above, is concerned mainly with production, while organizational implementation is concerned with the introduction of a new IS product in an organization and managing the organizational and social effects of the introduction (Koskinen, 2006). Organizational implementation begins with initiation and adoption, and ends up with use and incorporation; it involves installation, configuration, contextualization and integration of an IS product in an implementation setting and dealing with social and organizational matters (Koskinen, 2006). The notion of implementation, in this case is a continuous socio-technical change process (Koskinen, 2006; Orlikowski, 1996). However, it does not mean that organizational implementation and information systems development are mutually exclusive. Both involve similar activities such as analysis, design, coding, changing, etc, but for different purposes in different settings.
Today most ISs are developed outside the organization that actually implements them, giving a rare opportunity to affecting the actual system development and leaving little room for making use of social and contextual elements identified during implementation into the development process (Koskinen, 2006). The notion of implementation in information system development has also a narrow focus on technological, organizational, and social aspects (Avison & Fitzgerald, 2006; Land, 1992; Walsham, 1993). Furthermore, organizational implementation by itself is a complex process that involves a continuous interplay among technological, organizational and institutional, social and personal spheres, and deserves separate treatment (Koskinen, 2006).

The bulk of IS implementation studies, although did not explicitly state it, adopt the organizational implementation perspective in their endeavors (see for example (Alvarez, 2004; Gal & Berente, 2008; Kim & Pan, 2006; Markus, 1983; Orlikowski, 1992b; Zhang, Lee, Zhang, & Banerjee, 2002). Some researchers consider this type of organizational IS implementation as innovation, as it involves not only technological development but also social and organizational changes that lead to a new technology-mediated practice and socio-technical order (Avgerou, 2003, 2008; Swanson & Ramiller, 2004; Tatnall, 2009; Yetton, et al., 1999). For example, Avgerou (2008, p. 134) chose the term innovation "to convey the notion of novelty and open-endedness of the effort and experience of IS implementation and of the associated changes within the hosting organization and beyond it".

There is a clear distinction between production and implementation when firms are involved in these processes. Specialized software firms, normally, produce software systems in their labs and implement them somewhere else where they could be utilized. The kinds of challenges and problems that they face and address during production and implementation could not be the same. The development mainly focuses on building a technical system that would inscribe aspirations, worldviews, morality, procedures, modes of operation, etc as imagined by designers under the influence of the context surrounding them (Akrich, 1992; Orlikowski & Barley, 2001). Design and development are tasked with inscribing visions and imaginations of designers and sponsors as

all technologies represent a particular set of choices made by specific designers

.... Some are the result of physical considerations, others reflect the designers' assumptions and images of users, still others reflect traditions of the design
community, and yet others reflect taken-for-granted understandings of how the world is organized (Orlikowski and Barley, 2001, p. 149).

Implementation on the other hand deals with contextualization, integration, organizational and social matters, systems functionalities, users acceptance, etc in a specific context (Heeks, 2002; Orlikowski & Barley, 2001). It involves changing organizational practices as well as the acquisition or construction of technology artifacts (Avgerou, 2003). Because of contextual processes and situated actions of users, implementation of similar technologies could result in different outcomes in different contexts. In this regard, Orlikowski and Barley state that

... because most technologies can be used in multiple ways, users shape the implications of technologies as they integrate them into everyday practice ..... Similar technologies can, therefore, be embedded into different social systems in different ways, occasioning different social outcomes. (2001, p. 149)

IS implementation in organization is, therefore, contextual and situated; it is a complex and challenging process as well, due to the involvement of different actors both human and nonhuman that range from installed base, social actors with varied objectives and interests, diverse rationalizations, to complex structures that may demand restructuring and which would spark disagreements. In general, IS implementation is intensely political, social, technical and organizational process that requires the attention of all of those dimensions (Kling, 1980; Markus, 1983).

This study is concerned with organizational implementation of OSS. It conceptualizes implementation as a dynamic organizational innovation process that involves initiation, adoption and adaptation, use and incorporation. These change processes are continuous, dynamic; displace some aspects of actors and involve complex interactions among technological, organizational and institutional, social, and personal elements in a specific place in time. IS implementation is a complex socio-technical process that is concerned with bringing technology-based change in an organization, and involves a multitude of technical and nontechnical elements and a complex interaction among the elements.

The IS implementation literature conceptualizes technology-based organization change as continuous, evolving, and incremental, and as episodic, discontinuous, and intermittent. Furthermore, whether it is explicitly addressed by IS researchers in their work, or not, all of the IS studies reflect a particular position on the relationship between technology and
organizations (Orlikowski, 2005). It is a fundamental question in IS research although the existing literature does not support reliable generalizations. These different conceptualizations have divergent effects on the study and practice of IS implementation. The succeeding sections highlight these points and position the study at hand vis-à-vis the existing literature on technology-based organization change, the relationship between technology and organization, and the research category. In this dissertation technology is synonymous with IS and IT unless explained otherwise, and IT and ICT are used interchangeably without meaning and scope difference.

3.1.1. Technology–based organization change

IS implementation in organization triggers change; it dictates organizations to depart from the status quo or from smooth trends (Huber & Glick, 1993). It enables new types and patterns of communication and work flows, and may also trigger previously unplanned organizational shifts (Nance, 1996). There are diverse conceptualizations to making sense of these shifts. The organization science literature disagrees on the meaning of organization, organization change and how to study it (Tsoukas & Chia, 2002; Van de Ven & Poole, 2005). Organizations have been viewed as consisting of either things or processes following the argument what constitutes reality. On the one hand, there are viewpoints and associated theories that presuppose that an organization is a social entity or structure (a thing or a noun) that retains its identity while changing from one state to another over time. In this view, an organization is always something in some particular state or phase of a process; there is always something out there. On the other hand, there is a viewpoint and associated theories that presuppose that organizations are composed solely of organizing processes. According to this view, an organization is "simply a reification of a set of processes that maintain the organization by continuously structuring it and maintaining its boundaries in a field of other processes that are continuously breaking down the organization and its boundaries” (Van de Ven and Poole 2005, p. 1380). Tsoukas and Chia (2002) also note that ontologically change precedes organization; organization is the result of change processes; and organization is a place where change takes place on a continuous basis.

Following these arguments, organization change research makes distinction between change that is episodic, discontinuous and intermittent, and change that is continuous, evolving, and incremental (Porras & Silvers, 1991; Weick & Quinn, 1999). The first model privileges stability, routine, and order and treat organizational change as exceptional rather than natural. The second model promotes the idea that in the contemporary world where
flexibility, customization, and learning are the watchwords, change is endemic to the practice of organizing and it is enacted through ongoing situated practices of actors. These distinctions emanates from the level of analysis of change, i.e., perspectives of the observer either at a distance (macro level) or a closer (micro level) (Weick & Quinn, 1999). At a macro level, the primary focus is on the flow of events that constitute organizing and researches of this perspective examine what looks like repetitive action, routine, and inertia dotted with occasional episodes of revolutionary change. A closer look at change suggests ongoing adaptation and adjustment that are frequent and continuous across units. These adaptations and adjustments are capable of altering structure and strategy and some researchers consider it to be the essence of organization change (Orlikowski, 1996; Weick & Quinn, 1999).

Change has predominately been approached from the perspective of synoptic accounts (the stage model of change, following the classic “unfreezing-moving-refreezing” model), which views change “as an accomplished event whose key features and variations, and causal antecedents and consequences, need to be explored and described” (Tsoukas and Chia 2002, p. 570). This perspective approaches change from the outside and treats entities that undergo change to have distinct states at different points in time. Despite its importance, the synoptic approach fails to account for the open-ended micro processes that underlie the trajectories organizations follow; it does not quite capture the distinguishing feature of change such as its fluidity, pervasiveness, open-endedness, and indivisibility; and guides reality to appear more stable than it actually is (Feldman, 2000; Tsoukas & Chia, 2002; Weick & Quinn, 1999). It is not a good idea to try to understand change by transforming it into a succession of points/states because the change itself goes on between them. According to Tsoukas and Chia (2002) the stage model of change cannot deal with change per se, except by conceiving of it as a series of immobilities; “it makes sense of change by denying change!” (p. 571)

The stage model is not adequate to making sense of change in the current altered organizational stage where change is a way of organizational life (Orlikowski, 1996) and falls short of explaining the subtle changes happening in everyday life of organizations (Tsoukas & Chia, 2002). The organizational thinking and practice engaged in a discourse dominated by questions of stability are not helpful to make sense of micro-processes of change; and change must be seen in its own terms rather than as a special case of stability and routine (J. Ford & Ford, 1995; R. Ford, 2008; Orlikowski, 1996; Tsoukas & Chia, 2002).
There is a need to bringing change to the forefront instead of stability because change is “inherent in everyday practice and (...) [it is] inseparable from the ongoing and situated actions of organizational members” (Orlikowski, 1996, p. 67).

Approaching organization change from an ongoing process viewpoint enable researchers to obtain a more complete understanding of the micro-processes of change at work including the nonlinear processes, the dynamics, and ramifications and implications of change beyond those initially imagined or planned. It also helps to know enough about how change is actually accomplished such as how plans were translated into action and how they were modified, adapted, and changed; and helps to overcome the implementation problems of change programs reported in the literature (see Tsoukas and Chia, 2002 for further detail). Viewed from process perspective, organization change is continuous, evolving and incremental (R. Ford, 2008; Orlikowski, 1996, 2000; Porras & Silvers, 1991; Weick, 1993; Weick & Quinn, 1999).

To make statement about what changes and what remains stable one has to refer to the level of analysis or the logical types. For example, at the level of organizational routines, a synoptic account highlights the routine's self-contained, thing-like, and stable character. While at an individual action and interaction level a process-oriented perspective would show that routines keep changing, depending on the dynamic between ideals, action, and outcomes (Feldman, 2000; Tsoukas & Chia, 2002). Similarly, the propositions “the acrobat maintains her balance” and “the acrobat constantly adjusts her posture” at the levels of the body and parts of the body, respectively, are true. Both the “synoptic” and the “performative” accounts of organizational change are necessary as they serve different needs. The synoptic account enables us notice patterns at different points in time that normally escape our perceptions, while a performative account offers us insights into the actual emergence and accomplishment of change because of its focus on situated human agency unfolding in time (Tsoukas & Chia, 2002). Performative accounts are more directly connected to practitioners' lived experiences and actions than synoptic accounts.

In order to account for the micro-processes of change and the mutual recursive interaction between the social and the technical (or the socio-technical change), the research reported in this dissertation considers the process perspective. If change is eminent due to the implementation of an IS, it is essential to understand the role of agency and address the following questions.
Can we expect the development or acquisition of new ICT systems to drive, and necessitate the working out of, specific new organizational practices and structures, such as customer-oriented practices or network structures? Is it the other way round, that is, effective take up of ICTs require specific structural characteristics and established modes of work practice? Or is there a different way of understanding the relationship between ICT and organizations that does not assume one is determined by the other? (Avgerou 2003, p.142)

The succeeding section answers the above questions by elaborating on the three dominant perspectives on the relationship between ICT and organizations; it also highlights the viewpoint adopted in this research.

3.1.2. *The roles of IS in organizations*

The current state of knowledge about the role of technology in organization offers three divergent perspectives – the technology imperative, the organization imperative and the emergent perspective (Hanseth, 2005; Holmström, 2005; Orlikowski, 1992a, 1996; Rose, Jones, & Truex, 2005a, 2005b; Walsham, 2005). The technology imperative research conceives technology as the primary and relatively autonomous material cause or driver of organization change with a deterministic effect. The adoption of a technology, according to this viewpoint, creates predictable changes in organizations’ structures, work routines, information flows, and performance (Orlikowski, 1996; Orlikowski & Barley, 2001). This conceptualization ignores the role of human agency in shaping the design, development and use of technology, as well as the proactive role of human agency in organization change (Orlikowski, 1992a, 1996; Orlikowski & Barley, 2001).

The organizational imperatives, on the other hand, assume almost unlimited choice over technological options and almost unlimited control over the consequences to human action. It suggests that technology is not an external object, but a product of ongoing human action, design, and appropriation; sees technology more as a product of shared interpretations or interventions of humans (Markus & Robey, 1988; Orlikowski, 1992a). This perspective holds that human actors design information systems to satisfy organizational needs for information and assumes that system designers can manage the impacts of information systems by attending to both technical and social concerns (Markus & Robey, 1988). This set of research is criticized for (1) giving more emphasis to human agency, (2) denying the
material affordances and constraints of technology, and (3) due to the notion that only managers or technology designers have the authority and means of shaping a technology.

The emergent perspective, the third viewpoint, is relatively the latest one for making sense of the role of technology in organizations and it seeks a middle ground between socio-constructivist and technology deterministic viewpoints. It questions the viability of the constructionist and materialist perspectives in light of the current organizational discourses that emphasize emergence, flexibility, and self-organization (Orlikowski, 1996). Conceiving technology as the primary and relatively autonomous material cause or driver of organization change with a deterministic effect, and rendering almost unlimited choice over technological options and almost unlimited control over consequences to human action have proven to be problematic (Monteiro, 2000; Orlikowski, 1996). Hence, the emergent perspective proposes the idea that neither a strictly constructionist nor a strictly materialist stance are adequate for studying technologies in the workplace. It holds that the use and consequence of information technology emerge unpredictably from complex interactions (Ciborra & Hanseth, 2000; Cordella, 2006; Markus & Robey, 1988; Orlikowski, 1992a; Orlikowski & Barley, 2001). This view posits technology as an external force having impacts but where these impacts are moderated by human actors and organizational contexts. This is true because both technologies and organizations are undergoing dramatic changes in form and function, and new and unprecedented forms and functions are becoming evident (Orlikowski, 2000). In the contemporary world, the notion of emergence is particularly relevant because, writes Orlikowski (1996:65), “unprecedented environmental, technological, and organizational developments facilitate patterns of organizing which cannot be explained or prescribed by appealing to *a priori* plans and intentions” (emphasis in the original). Changes also emerge because of the situated actions of actors and these changes cannot be anticipated or planned ahead of time (Orlikowski, 1996). Avgerou also states that

the construction or the configuration of new technology artefacts and the working out of organizational arrangements unfold by a mix of technical/rational tasks, institutionalized enactments and improvisational action, as people make sense of the potential of ICTs in their work context and seek to appropriate it. (2003, p. 142)

Therefore, IS implementation or technological change is not something that can be arranged ahead of time as a drama so that it results in a predicted output, or it does not follow the
deterministic logic but emerges out of the complex interactions between technical and nontechnical elements in a specific context. The research reported in this dissertation conceptualizes the relationship between technology and organization along the emergent line of argument; it conceptualizations IS implementation as an emergent property of the unpredictably complex interaction between technological, social, and organizational elements over time.

3.1.3. The characteristics of implementation researches

The IS research has looked into various aspects of implementation including the process through which technology is introduced, the role of social context in shaping the introduction and use of technology (Markus, 1983), the centrality of players' deliberate, knowledgeable, and reflective action in shaping and appropriating technology (DeSanctis & Poole, 1994; Orlikowski & Robey, 1991), the effect of interpretation differences (Davidson, 2002; Orlikowski & Gash, 1994), politics (Doolin, 2004; Keen, 1981; Peszynski & Corbitt, 2006; Spicer, 2005), learning (Ang, Thong, & Yap, 1997; Bondarouk, 2006; Robey, Boudreau, & Rose, 2000), organizational change (Keen, 1981; Orlikowski, 1993, 1996; Robey & Boudreau, 1999), critical success factor identification (Ehikhamenor, 2002; Markus & Robey, 1988; Plant & Willcocks, 2006; Zhang, et al., 2002), etc. These researchers can be broadly classified in to factor-based and process-focused approaches based on their logical structures, i.e., the time span of theory (static versus dynamic) and hypothesized relationships between antecedents and outcomes (Iivari, 1986; Kim & Pan, 2006; Peszynski & Corbitt, 2006).

The factor-based approach focuses on identifying factors that lead to successful implementation of systems in organizations such as for example the presence or absence of top management support, clear goals and objectives, positive attitudes toward information systems, project team competence, and education and training (Peszynski & Corbitt, 2006; Plant & Willcocks, 2006). The research in this category has identified various critical success factors and established a ‘precursor or cause’ and ‘outcome’ relationship wherein the precursor is posited as a necessary and sufficient condition for the outcome (Markus & Robey, 1988; Peszynski & Corbitt, 2006). Although the factor research serves the purpose of identifying factors and explaining the direct effect of each on IS success, it gives a snapshot view of the phenomenon and it is limited in showing interactions among the factors and the process of IS implementation (Markus & Robey, 1988; Peszynski & Corbitt, 2006). Process approaches, on the other hand, give time and interaction dimension to the implementation
research (Kim & Pan, 2006). As stated above, implementation is a social action that involves the interaction of multiple actors within several related social environments and therefore, making sense of it requires consideration of a variety of factors and interrelationships among factors over time (Kim & Pan, 2006; Markus & Robey, 1988). Process theory focuses on the order and sequences of events (or states) over time to explain why and how particular outcomes are reached (Markus & Robey, 1988; Van de Ven & Poole, 1995). The majority of contemporary IS researches embrace the process perspective than the factor-based approach as it helps to understand the dynamics of a phenomenon over time and place (Markus & Robey, 1988; Tsoukas, 2005). Likewise, the research reported in this dissertation adopts the process perspective in order to account for the various social, technological and organizational factors and their interactions over time to explain the implementation of an OSIS.

Different theoretical perspectives illuminate the ontological and epistemological stances of change, the relationship between technology and organization, and the nature of implementation research discussed above. The following section highlights the theoretical perspective adopted in this dissertation, summarizes the conceptual constructs discussed so far and indicates the points of departure of this study.

3.1.4. IS implementation and organization change as conceptualized in this dissertation

The above discussion shows that IS implementation is a complex socio-technical process, which involves both changing as well as constructing technology in an organization. The following table, table 6, summarizes the conceptual constructs, their variations as discussed above, and those that are adopted in this dissertation.

This dissertation conceptualizes IS implementation as an organizational innovation process, where the focus is on building technology as well as changing an organization. The innovation changes social and technical elements, and their interrelationships. It results in a change that emerges out the complex socio-technical interactions, and it is continuous, evolving, and incremental. Innovation with IS is a complex socio-technical process where both the social and the technical evolve together.
Table 6: Summary of conceptual constructs adopted in this dissertation

<table>
<thead>
<tr>
<th>Concept</th>
<th>Alternative Conceptualization</th>
<th>Adopted Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS implementation</td>
<td>As a stage in systems development lifecycle.</td>
<td>IS implementation as organizational innovation process.</td>
</tr>
<tr>
<td>Implementation research</td>
<td>Factor-based where the concern is to identify critical success factors.</td>
<td>Process approach where the focus is to consider a variety of factors and their interrelationships over time.</td>
</tr>
<tr>
<td>The role of IS in organization</td>
<td>Technology or social deterministic perspectives.</td>
<td>Use and consequence of IT emerge unpredictably from complex socio-technical interactions.</td>
</tr>
<tr>
<td>Organization change</td>
<td>Change is episodic, discontinuous, and intermittent.</td>
<td>Change is continuous, evolving, and incremental.</td>
</tr>
</tbody>
</table>

The IS research implements a number of theories⁴ to explain implementation from different perspectives, building up on the conceptual constructs discussed above. Many of these theories are adapted from other disciplines. The focus of earlier IS implementation theories and researches were on a rational–economic interpretation of organizational processes and a positivist philosophy, however, attention was shifted to interpretivism in the 1990s (Bondarouk, 2006; Sahay, 1997; Walsham, 1993). Interpretivism advocates for understanding the context, the process, the technology, and influences among them to explicate IS implementation by using social construction and socio-technical ideas and by seeing implementation as an enacted, dynamic, changeable and situated process (Bondarouk, 2006; Sahay & Robey, 1996).

Along the interpretivism line of thought, the focus of this study is to explain the processes in which continuous, evolving and incremental technology-based organization change evolves in the context of a developing country in a specific mode of implementation. The specific mode of implementation, in this case, is the open source–based IS (OSIS) implementation, a boundary spanning process, which involves a multitude of actors and which is different

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⁴The following wiki, an associate of the Association for Information Systems (AISWorld), lists a number of theories that have been in use in IS research
http://www.fscyorku.ca/york/istheory/wiki/index.php/Main_Page

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from traditional modes of implementation as discussed below. The study also examines the viability of this specific mode of implementation in the context of developing countries in their attempt to increase and sustain ICT utilization.

3.2. The Organization of Open Source Software Production

Open source software is a phenomenon that has changed the philosophy and practice of software production and ownership (Feller, Fitzgerald, Hissam, & Lakhani, 2005; Raymond, 2000; von Hippel & von Krogh, 2003). Because of OSS, the production of software changed from closing to opening source code and it became more of individual-driven than organization–based. The phenomenon challenged the established copyright protection of software products as well as the process and organization of software production. This section explains the basics of OSS, organizations of its production process, and highlights the implications of the changed philosophy and practice of licensing and the organization of software production on implementation.

3.2.1. The core of open source software

The establishment of the Free Software Foundation in 1985 by Richard Stallman marked the beginning of an organized challenge to preserve free access to software developed by hackers (von Hippel & von Krogh, 2003). Stallman developed the General Public License or GPL (sometimes referred to as "copyleft") license to implement the idea of “free software”. The license grants, to those possessing a copy of free software, the right to use it at no cost, to study its source code, to modify it, and to distribute modified or unmodified versions to others at no cost (von Hippel & von Krogh, 2003).

The new perspective challenges the dominant existing model of software production in which source code is proprietary and secret and a software product is only available as ‘object’ code – available for sale and use but closed to inspection and modification (Dalle, David, Besten, & Steinmueller, 2008). The idea of “free” software was not favorably welcomed especially by the industry, and as a result, a need arose to make it appealing to the whole community. As a response, the “open source” software movement was established to promote the practical benefits of such licensing rather than focusing on "issues regarding the moral rightness and importance of granting users the freedoms offered by both free and open source software” (von Hippel & von Krogh, 2003, p. 210). The term "open source" has
been in use to refer to free or open source software (von Hippel & von Krogh, 2003), and the same is true in this dissertation.

**Figure 3: Open source software production in context**

The emergence of OSS has changed not only software license but also the philosophy and practice of software development (Raymond, 2000; von Hippel & von Krogh, 2003). OSS development relies mainly upon individuals making choices to volunteer their time, skills, and resources to a production activity organized in a loosely coordinated distributed environment – a bazaar style (Raymond, 2000) – transcending geography, organization, culture and time barriers (Dalle, et al., 2008; Mockus, Fielding, & Herbsleb, 2005; von Hippel & von Krogh, 2003). Figure 3 illustrates a community-based OSS production phenomenon in brief. The license dictates disclosure and dissemination of source code so that anyone with proper programming skills and motivations could use, modify and distribute any OSS written by anyone (Ducheneut, 2005; Neumann, 2005; von Hippel & von Krogh, 2003; Waring & Maddocks, 2005). OSS developers/contributors coordinate activities, deliver products, and offer field support using the Internet usually without the need for an
intermediary or a vendor and face–to–face communication (Lakhani & von Hippel, 2003; Mockus, et al., 2005; von Hippel, 2002, 2005).

OSS development, as a process, follows a specific pattern, which is different from the traditional software engineering principles and theories, as discussed above. The proprietary software development is a carefully planned process while the OSS development is a more chaotic interaction of participants of an oriental bazaar (Raymond, 2000). The following table, adapted from (Evers, 2000), summarizes the difference between open source and proprietary software productions.

Table 7: The difference between open source and proprietary software productions

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Proprietary Software</th>
<th>Open Source Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization model</td>
<td>Cathedral</td>
<td>Bazaar</td>
</tr>
<tr>
<td>Resources</td>
<td>Known</td>
<td>Unknown</td>
</tr>
<tr>
<td>Period of Planning</td>
<td>Whole project</td>
<td>Step by step</td>
</tr>
<tr>
<td>User</td>
<td>Paying customer</td>
<td>Co–developer</td>
</tr>
<tr>
<td>Objective</td>
<td>Fulfill contract/specification</td>
<td>Solve problem</td>
</tr>
<tr>
<td>Enforcement</td>
<td>Strong</td>
<td>Weak</td>
</tr>
<tr>
<td>Progress</td>
<td>Private</td>
<td>Public</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Face to face</td>
<td>Via the Internet</td>
</tr>
<tr>
<td>Quality assurance</td>
<td>Management</td>
<td>Competition, peer review</td>
</tr>
</tbody>
</table>

OSS has become not only a means of production but also a social organization and a political or cultural statement (Dalle, et al., 2008). Dalle and associates write that

Individuals who, implicitly or explicitly, recognise the expansible and non-rival nature of information goods, may hold the political belief that the form of property created by the commercial secret of source code or the use of copyright to prevent access is wrong or hold the cultural view that denying access to human creations diminishes humankind (2008, p. 301).

The OSS phenomenon is, therefore, beyond organization and software production. Of course, Benkler and Nissenbaum (2006), argue that such a commons-based production system serve as a context for positive character formation such as moral and political virtues.
The size OSS development projects as well as the market share of OSS products have been steadily increasing from time to time, simultaneously increasing user and developer bases (Wheeler, 2007). In terms of quality, reliability, security, and performance, in principle (in some cases, proved that) software products produced through peer collaboration outweigh closed code software produced by firms. For example, the OSS–based backend applications such as in web server technology (Apache), server operating system (Linux), mail server (Sendmail), and database (MySQL), and in frontend applications Mozilla and Firefox, web browser software, are among the successful OSS products that have been competing with, and in some cases dominated the respective market share. The domain specific frontend applications has also been following the successes of backend applications (Lungo, 2008; Waring & Maddocks, 2005; Wheeler, 2007).

Studies show that individuals as well as firms take part in OSS projects for different reasons (Andreev, et al., 2010; Dahlander & Magnusson, 2005). Motivations for individuals' participations have been found to range from the need to solve problems to gaining reputation benefits and career opportunities. Research indicates that intrinsic (the need to share and learn), extrinsic (career concern and financial benefits), and internalized intrinsic (the need to satisfy user needs) drive individuals to participate in OSS projects (Subramanyam & Xia, 2008). The motivational factors could be different to different cultures and economies because of value differences across contexts (Andreev, et al., 2010; Ducheneut, 2005; Subramanyam & Xia, 2008).

### 3.2.2. The organization of open source software production

The digitally networked environment, with the facilitation of the technical infrastructure of the Internet, gave rise to the emergence of a new socio–economic system of production as discussed above (Andreev, et al., 2010; Benkler, 2002, 2004, 2006; Benkler & Nissenbaum, 2006). The new form of production is different from the dominant modes such as the contract– and market–based, and managerial–firm based and state–based production systems in many respects. Yochai Benkler (Benkler, 2002, 2004, 2006) named the network–based peer production as commons–based peer production (CBPP), while other have gave it a different name (Andreev, et al., 2010; G. Lee & Cole, 2003). Despite name differences each of them references to communal practices, open participation, open innovation, loose coordination, and boundary spanning organization (Ducheneut, 2005; Elliott & Scacchi, 2008; Lakhani & von Hippel, 2003; G. Lee & Cole, 2003). The following table, adopted from
Lee and Cole (2003), differentiates between firm-based and commons-based knowledge creation.

**Table 8: The community-based model vs the firm-based model of knowledge creation**

<table>
<thead>
<tr>
<th>Organizing Principles</th>
<th>The Firm-Based Model</th>
<th>The Community-Based Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intellectual Property Ownership</td>
<td>Knowledge is private and owned by the firm.</td>
<td>Knowledge is public but can be owned by members who contribute it as long as they share it.</td>
</tr>
<tr>
<td>Membership Restriction</td>
<td>Membership is based on selection, so the size of the firm is constrained by the number of employees hired.</td>
<td>Membership is open, so the scale of the community is not constrained.</td>
</tr>
<tr>
<td>Authority and Incentives</td>
<td>Members of the firm are employees who receive salaries in exchange for their work.</td>
<td>Members of the community are volunteers who do not receive salaries in exchange for their work.</td>
</tr>
<tr>
<td>Knowledge Distribution Across Organizational and Geographical Boundaries</td>
<td>Distribution is limited by the boundary of the firm.</td>
<td>Distribution extends beyond the boundary of the firm.</td>
</tr>
<tr>
<td>Dominant Mode of Communications</td>
<td>Face-to-face interaction is the dominant mode of communication</td>
<td>Technology-mediated interaction is the dominant mode of communication.</td>
</tr>
</tbody>
</table>

A spectrum of models of production can be drawn in between the commons-based production on one end and a firm-based proprietary production on the other. For example, firm employees could participate in OSS production on a payment basis, firms could control the production of an OSS, etc (Andreev, et al., 2010; Mehra, Dewan, & Freimer, 2011). The commons-based production and the firm-based OSS production are of interest to this research. Unlike firms that produce closed source software, organizations can produce OSS and engage in implementation activities in a different manner than traditional implementation. The only difference between organization-based and commons-based
production, in this case, would be the involvement of payment and control of participants and activities.

As explained in section 3.1, software production mainly deals with inscribing visions and plans into software artifacts. An inscription needs to be translated into a use context through an implementation process, the tenet of which is discussed in section 3.1. The implementation could not be the same as the production activity. The new implementation model that could arise based on the commons-based production model does not involve intermediaries such as vendors, the service of which could range from software adaptation, configuration to implementation, training, and maintenance. For example, vendors provide technical and operational support and training to clients. Their services could continue for a certain period depending on the nature of an agreement, as it is customary. Such situated arrangements and service level agreements concerning technical and operational support and knowledge sharing do not exist in a commons-based model. The practical activities of making use of OSS has become more and more dependent on end users, socio-technical ensembles in use contexts, and on developer and user communities of a particular software in the commons-based model than in any other arrangement. Implementation in such a model features situated practices, trans-situated practitioners, over time socially constructed peculiar implementation accounts, collective learning, identity formation, and innovation. Similar to production, implementation of OSS could be communal and grass root-based. This form of implementation is different from firm-based closed source (and proprietary) software implementation. This dissertation considers the changed form of implementation in the context of developing countries. The following section discusses the nature, focus and challenges of IS implementation in developing countries and the promises of the new form of software production and implementation in the attempt to increase ICT utilization in developing countries.

3.3. The Challenges of IS Implementation in Developing Countries

Studies attest to the importance of ICT to facilitate socio-economic developments in developing countries (see for example, (Avgerou, 1998; Bollou, 2006; Heeks, 2002; Meso, Musa, Straub, & Mbarika, 2009; Sahay & Avgerou, 2002; Saunders, 2007; Urquhart, Liyanage, & Kah, 2008; Walsham, et al., 2007; Walsham & Sahay, 2006). Some go as far as suggesting the possibility for developing countries to leapfrog and catch up with the development levels of their developed counterparts through ICT. However, let alone
leapfrogging, gradual realization of the envisaged benefits proved to be challenging. The implementation of ISs, which is an aspect of increasing ICT utilization, has been problematic and the rate of failure could be higher than what has been recorded in developed countries (Heeks, 2002). Studies also show that developing countries could be further disadvantaged and isolated unless successfully involved in the global environment and make use of ICT (Walsham, et al., 2007).

The challenges of ICT implementation and utilization emanate not only from the complexity of implementation itself but also from peculiarity of the process in the context of developing countries. Implementation in developing countries aims at successfully deploying and subsequently making use of systems that are produced in and for the technologically advanced West. The process suffers from several drawbacks such as conceptualization, context disparity, and the challenges thereof, and the nature and complexity of information systems, the intricate nature of IS implementation, and impediments in developing countries. Section 3.1 has presented the complexity of IS implementation in general. The succeeding sections discuss the rest of the challenges as follows.

3.3.1. The problems of technology transfer conceptualization

The issue of appropriate technology transfer in the context of developing countries came to light in the 1980s. The focus was on selectively transferring technologies that were deemed relevant to developing countries. The technology adoption and technology acceptance models have been in use to explain such a phenomenon (Avgerou, 2008; Nhampossa, 2005). Despite relevance of the notions in explaining and supporting activities related to the processes of transferring discrete technologies and artifacts, it suffers from many drawbacks in the context of systemic and context-sensitive technologies, such as ISs.

Transferring context sensitive systemic technologies would be relatively complex and challenging because of the requirement to adapt them to use contexts and transfer associated knowledge and skill that enable appropriate use of an artifact in addition to transferring the physical artifact (Odedra, 1992). For example, software engineering principles that focus on decomposition, isolation, or de-contextualization of tasks could easily be transferred unlike systems implementation that focuses on mutual learning processes and adaptations. The challenge increases as the need for integration and communication among related systems and work processes arise. In the contemporary world where IT is ubiquitous and an integral part of organizations (Doherty & King, 2005),
the requirement for integration and communication among units of an organization and between organizations are imminent. In the public healthcare sector, for example, various health programs require to interact with each other to share data and facilitate the production of an integrated view of functions and services across programs for various actions.

In addition, context-sensitive systemic technologies require adaptation to use contexts. The adaptation is required as the physical thing never fully determines the full aspects of its use because of the difficulty to entirely determine an artifact’s patterns of use during design (Bijker & Law, 1992) and the dependency of use on social, cultural and economic contexts of use (Braa, et al., 1995). Empirical evidences show that users shape and adapt artifacts in ways which were not planned during design (Akrich, 1992; Bijker & Law, 1992). In the context of IS, the assumptions and worldviews inscribed into a design need to be translated into the specific conditions and situations of use (Heeks, 2002; Nhampossa, 2005). Because of the involvement of human agency at the time of development and use, technologies embody human interests and, the technology itself could influence its trajectories of use (Orlikowski & Barley, 2001). As a result they demand appropriation and translation into use contexts as part of the effort to put them into use (Heeks, 2002). Translation affects the implementation context as well as the technology; it displaces some aspects of both the use context and the technology. In the case of developing countries, where there are production and use context disparities, adaptation is a requirement (Braa, et al., 1995; Heeks, 2002; Nhampossa, 2005). Adaptation targets at minimizing the gap between IS presumptions and actual work practices by changing the IS or the work practice or both (Bada, 2002; Heeks, 2002; Lungo, 2008; Pollock, et al., 2007).

The major drawbacks of the technology transfer conceptualization lie on the notion of knowledge transfer and the assumption that a transferred technology would be used as is regardless of social and cultural context of use (Braa, et al., 1995; Nhampossa, 2005). As a result, some authors refute the notion of technology transfer and talk about technology translation instead (Braa, et al., 1995; Heeks, 2002; Nhampossa, 2005). Scholars that focus on practice-based learning and knowledge circulation refute the notion of knowledge and practice transfer without practice (Brown & Duguid, 2001; Duguid, 2005; Orlikowski, 2002).

Implementation projects, activities, and researches that focus on bridging the digital divide with technology transfer notion could suffer from the drawbacks discussed above. Technology has to be learnt and mastered rather than transferred (Braa, et al., 1995). IS
innovation in developing countries is also about “constructing new techno–organizational structures within a given local social context and places” (Avgerou, 2008, p. 135), so emphasis should be placed on exploring local meanings and working out locally appropriate techno–organizational structures. IS innovation and organizational change are socially embedded actions, which could be studied through social constructionist and situated research perspectives (Avgerou, 2008). Furthermore, technology-based development is a socioeconomic improvement through locally situated action (Avgerou, 2008, 2010).

3.3.2. Country context disparity and associated incongruence

Disparity between development and implementation country contexts that would lead to the development of systems that are embedded with rationalizations, assumptions, and world views different from that of the implementation context (Akrich, 1992; Avgerou, 2000; Heeks, 2002; Orlikowski & Barley, 2001) poses difficulty to IS implementation. The majority or almost all of IS development projects and products have been based in the West. Hence, their production process, purpose, and the end product itself consider the Western context, similar to other technologies (Akrich, 1992; Heeks, 2002). As a result, the gap between the design of an IS artifact and realities in implementation contexts could be huge and affect implementation accordingly (see Heeks, 2002, 2006 for a detailed discussion on design/reality gap). The higher the design–reality gap, the higher the change and the chance of failure.

3.3.3. Impediments in developing countries

Impediments in developing countries such as lack of resources (financial, infrastructural, etc) and techno–scientific capabilities are the bottlenecks of ICT utilization (Avgerou, 1998, 2000, 2008; Heeks, 2002; Meso, et al., 2009; Odedra, 1992). These are the very obstacles that made developing countries to be consumers of technologies as well as posed difficulties, even, not to properly consume them. Various channels of technology transfer (Hoekman, Maskus, & Saggi, 2005) such as acquisition of equipment, technical assistance, education and training, and direct foreign investment did not make developing countries able to utilize and sustain technologies (Odedra, 1992). Western experts also failed to deliver expected outputs due to cultural and language barriers (Odedra, 1992; Saunders, 2007) and country context gaps (Heeks, 2002), for example. Brain drain has further dwarfed developing countries, in general, and the public sector, in particular. Although progress has
been made so far, there have been challenges as well (Avgerou, 2008; Walsham, 2010; Walsham, et al., 2007).

3.3.4. **Fragmented top-down solutions**

Donor initiated top-down projects have limitations in making use of ICT and sustaining benefits thereof in developing countries (Baark & Heeks, 1999; Braa, Monteiro, & Sahay, 2004). The major problems of such projects are linked to the very nature of projects and aid packages such as, for example, limited time periods of an aid package, inadequate focus on local expertise, and focus on pilot sites which results in unused and unsustainable pilot projects (Baark & Heeks, 1999; Braa, et al., 2004). The aid package sometimes requires expensive Western experts and importing technologies despite availability of local technologies or alternatives. For example, the aid package that aims to fight against Malaria requires importing mosquito net from donor countries or associates despite availability of a similar product in the local market (Moyo, 2009). Often, experts from donor countries develop systems and import specific technology depending on the nature of the aid package.

Studies also indicate that technologies transferred to developing countries through the channels of donation and procurement ended up in locked rooms or failed to be operational (Odedra, 1992). Odedra indicates how ICTs donated by the West to some developing countries failed to be operational because of lack of local skilled personnel, cultural barriers and communication difficulty between local and Western consultants, and ineffective local capacity development strategies. The studies attest to the fact that receiving a technology by itself does not guarantee use. Furthermore, copyright protection (and the distribution of object code as a result) compromises capacity development and contextualization process and Western experts are very expensive compared to local experts. OSS could solve some of these problems.

The emergence of OSS has changed the concept of time, location and collaborative action, sharing, and learning. OSS facilitates learning and software development and coordination of activities in a loosely coordinated distributed environment (Hossain & Zhu, 2009; von Krogh, 2002). Studies indicate that networking among actors of aligned interests assists learning and IS implementation (Braa, et al., 2004; Heeks & Stanforth, 2007). For example, by using local/global network model, Heeks and Stanforth (2007) explain that in e-Government implementation projects in developing countries there are a ‘global’ set of resource providers and a ‘local’ set of implementers, and the degree and balance of
participation in this network determines success. In order for local intervention to be robust and sustainable, “skill is required to be transferred” from where success is achieved to new sites, which could be possible through networking and formation of alliances. Braa, Monteiro, and Sahay explain, “[e]stablishing networks creates opportunities for sharing experience, knowledge, technology, and value between the various nodes of the experience” (2004, p. 341). The networking is not about growing the size to reach the level of critical mass but to facilitate the necessary learning process, which they say, is pre-requisite to sustainability. The advent of OSS offers new ways of networking, sharing and collaboration, in a different organizational form and principle as presented in the next section.

3.4. The Potential Benefit of Open Source Software to Developing Countries

The advent of OSS has created a unique window of opportunity for developing countries to increase ICT utilization (Li, Lin, & Xia, 2004; Weber, 2003; Weerawarana & Weeratunge, 2004). In principle, adoption of OSS reduces license cost and total cost of ownership (Waring & Maddocks, 2005); promotes indigenous technological development (Weber, 2003; Weerawarana & Weeratunge, 2004); avoids being hostage to proprietary software and vendors (Weber, 2003); guarantees against buried “espionage software” (Weber, 2003); advances knowledge more quickly (Câmara & Fonseca, 2007); promotes adaptation to changing organizational environments (Gallego, et al., 2008); and helps to set up an information economy (Weber, 2003; Weerawarana & Weeratunge, 2004). In practice, however, technology transfer in general, and implementation of ISs brought from the West, in particular, have been challenging with a very high failure rate (Heeks, 2002; Walsham, et al., 2007) as discussed in section 3.3. It could have a similar implication to OSS unless organizations in developing countries respond differently and effectively. The potential advantage of OSS to developing countries depends on the effectiveness of the response to accommodate the unique feature of OSIS implementation such as, for example, the response to the call for an organizational form that transcends boundaries and a new capacity development opportunity.

Some developing countries have already set up programs and legislations prioritizing OSS in the public sector while others are following a similar suite (bridges.org, 2005; Chan, 2007; Waring & Maddocks, 2005; Weerawarana & Weeratunge, 2004). For example, the governments of China, India, Peru, and Brazil have set up programs and regulations to encourage the growth of OSS through distribution of OSS, education, and government
procurement preferences and tax benefits for OSS firms (Chan, 2007; Li, et al., 2004; Subramanyam & Xia, 2008). In Africa, countries such as Angola, Benin, Djibouti, Kenya, Senegal, South Africa, Tanzania, Uganda and Zambia have formulated OSS specific policies or reference to OSS or open standards in publicly available documents (bridges.org, 2005).

So far, the majority of OSS development projects are based in the West and the participation of developing countries is limited to using systems at a modest level. Although the OSS license facilitates software acquisition and offers the freedom to study, utilize and redistribute any OSS, it does not guarantee the acclaimed potential benefits on its own and by itself, especially to developing countries. To make matters worse, the public sector requires domain specific applications (such as health information systems and Library systems), on top of backend and middleware applications (such as operating systems, server software, middleware, etc). Often, IT professionals are the primary users of backend applications and they are able to understand and change source codes. Development and use of such systems would be like “scratching own itch” as stated by Raymond (2000). In the case of frontend applications, however, users may not be computer experts, and hence, could not be able to configure and use systems by themselves (Ducheneut, 2005). Such systems require expertise that mediates users’ requirements, systems capabilities and local circumstances. Such an expertise is either lacking or in a limited supply in developing countries. Therefore, it means that only those with relevant techno-scientific expertise and resources could make the best out of OSS, while others like developing countries struggle.

HISP is one of the organizations actively involved in promoting OSS in developing countries, especially focusing on the public health sector. It has been involved in an action research project encompassing OSIS development and implementation, capacity building and research. Systems development and implementation in HISP is a collaborative activity that involves the actions and resources of members in the network and other interested participants. New practitioners pass through a formal process of learning that blends classroom learning and participation in real life project. HISP follows the political agenda of boosting users’ capacities and sustaining implementation through networking actions within and across developing countries, as well as between the developing and developed worlds, of iterative incremental development and implementation processes, of OSS-use, etc. (Braa, et al., 2004). HISP has contributed a lot towards increasing ICT utilization in developing countries by developing and implementing systems, seeking scientific solutions
to problems, developing techno-scientific capacity and networking among different implementation sites (visit the HISP website for further information).

In this respect, the very philosophy and practice of OSS opens up new opportunities to develop expertise, collaboratively improve practice, and sustain implementation. The implementation of OSS could be realized through the actions and resources of individuals and communities that are physically present and absent in time and space. The globally dispersed communities of OSS practitioners share resources and engage in similar practices across settings. This form of collaboration paves the way for improving practice as well as expertise in a given setting. Sharing beliefs, values, communications, artifacts and tools among OSS developers/users enables not only cooperation, but also provides a basis for shared experience, camaraderie, and learning (Scacchi, 2005).

As discussed so far, OSS is a phenomenon that is based upon communal practice, common belief, resource sharing, identity formation and perpetuation, and a strong sense of community. It is a practice- and community-based phenomenon. In order to understand the intricacies of the implementation work practice and learning-in-working, it would be appropriate to adopt practice-based and community-focused theories. Such theories offer language and mechanism to understand work practices, knowledge, knowing, and the transfer of best practices and knowledge across sites focusing on practice and community. The communities of practice and the networks of practice theories are especially relevant to explain work practices, sharing, learning, knowledge circulation, and network that exists among globally dispersed actors in the context of OSIS implementation. Accordingly, the dissertation draws upon the communities of practice and the networks of practice theories to understand the social construction of OSIS implementation, the processes of learning (knowledge circulation), and the social construction and perpetuation of individual and group knowledge and identity as discussed below.
3.5. **The Communities of Practice Theory**

Working, learning, and innovating are closely related forms of human activity (Brown & Duguid, 1991, p. 40).

The communities of practice theory (CoPT) has developed a remarkably wide following since its first appearance in 1990/91 (Duguid, 2005; Lave & Wenger, 1991). The theory adopts an integrated perspective towards working, learning, and innovating, and considers them as interrelated, compatible, and even complementary, not conflicting (Brown & Duguid, 1991). The CoPT is a situated practice theory that captures work practices, knowledge sharing and innovations of people who share occupational interests, work together, and interact face–to–face (Brown & Duguid, 2001; Vaast, 2004; Vaast & Walsham, 2009). Brown and Duguid (2001) latter introduced the concept of a “network of practice” (NoP) to describe people that are not necessarily co-located and may never have met face to face but engaged in similar practices. The following sections elaborate on the two theories focusing on work practices, learning in working, communities of practices, knowledge and its circulation, and network of practices, and relate them to the case at hand, the practices of OSIS implementation work practice.

3.5.1. **Work practice**

..... [T]he ways people actually work usually differ fundamentally from the ways organizations describe that work in manuals, training programs, organizational charts, and job descriptions (Brown & Duguid, 1991, p. 40).

Work practices are complex, plural and situated than abstracted in job descriptions and operational manuals. The abstractions are detached descriptions of practice and, distort or obscure intricacies of that practice, since actual practices involve tricky interpolations between abstract accounts and situated demands (Brown & Duguid, 1991). The analogy with reference to a journey as actually carried out on the ground and as seen on a map clearly resembles the distinction between abstractions of work and actual practices. The map inevitably smoothes over the myriad decisions made with regard to changing conditions such as road works, diversions, Memorial Day parades, earthquakes, personal fatigue, conflicting opinions, wrong–headed instructions, relations of authority, inaccuracies on the map, and the like. The map, though potentially useful, by itself provides little insight into how ad hoc decisions presented by changing conditions can be resolved (and, of course,
each resolved decision changes the conditions once more) (Brown & Duguid, 1991). As a journey becomes more complex, the map increasingly conceals what is actually needed to make the journey. Thick description, by contrast, ascends from the abstraction to the concrete circumstances of actual practice, reconnecting the map and the mapped.

According to Brown and Duguid, the thick descriptions of the work practices of the photocopy repair technicians (reps) that Orr has studied represent three interrelated core features that are separated only for discussion purposes such as narration, collaboration, and social construction, which could be generalized to work practices in general (Brown & Duguid, 1991). The first aspect of the reps work constituted the practice of creating and exchanging stories that served to both diagnose a state of a troublesome machine as well as preserve accumulated wisdom. Stories and their telling can reflect the complex social web within which work takes place and the relationship of the narrative, narrator, and audience to the specific events of practice. The stories have a flexible generality that makes them both adaptable and particular. Each new situation could be interpreted in light of accumulated wisdom and constantly changing circumstances. The second most important aspect of reps’ work was that it is communal and thereby collaborative. The analysis shows both the reps and specialists went through a collective, not individual process. The insight accumulated is not a private substance, but socially constructed and distributed. The reps preferred to work together and to discuss problems in groups. The learning in this case is inseparable from working and individual learning from collective learning.

The third important aspect involves social construction, which has two parts in itself. The first part is about the construction of shared understanding out of conflicting and confusing data. The constructed understanding reflects the reps’ view of the world and the machine in a specific context, which was different from the models represented by trainers. The stories of the reps’ feature generalities about a particular model of a photocopy machine as well as specify peculiarities about a specific machine in a specific site. Such an approach is highly situated and highly improvisational (Brown & Duguid, 1991). The second feature of social construction, as stated by Brown and Dugid relates to the construction and perpetuation of individual and group identity. They note that in telling these stories an individual rep contributes to the construction and development of his or her own identity as a rep and reciprocally to the construction and development of the community of reps in which he or she works. In doing the work, telling stories, and defining own perspective, the reps simultaneously and interdependently contribute to the construction and evolution of a
community through which the shared means for interpreting complex activity get formed, transformed, and transmitted (Brown & Duguid, 1991).

3.5.2. Learning in working

What is learned is profoundly connected to the conditions in which it is learned (Brown & Duguid, 1991, p. 48).

Learning has long been the province of psychological theory until the idea of organizational learning opened it up to theories of all kinds (Fox, 2000). The situated learning theory, which was introduced by Lave and Wenger (1991) is a version of a social learning theory that has got prominence (Duguid, 2005). It explains learning in terms of social groups, situated contexts and work practices (Lave & Wenger, 1991). The theory relates learning to practice, what is learned to the conditions in which it is learned, and brings the social construction and collective nature of learning to light (Brown & Duguid, 2001; Duguid, 2005).

Brown and Duguid (1991) note that conventional learning theories value abstract knowledge than actual practices and, as a result, separate learning from working and the context of work, and learners from workers. The canonical training is “thought of as the transmission of explicit, abstract knowledge from the head of someone who knows to the head of someone who does not …. The setting for learning is simply assumed not to matter.” (Brown & Duguid, 1991, p. 47) (italics in the original). Organizational learning theorists have rejected this model of learning, which essentially tends to transfer knowledge by codifying and isolating it from practice (Brown & Duguid, 1991; Lave & Wenger, 1991). Furthermore, organizational researchers, Tsoukas and Chia (2002, p. 567), argue that change is the reweaving of actors’ webs of beliefs and habits of action to accommodate new experiences obtained through interactions. Insofar as this is an ongoing process, that is to the extent actors try to make sense of and act coherently in the world, change is inherent in human action....

New habits and experiences are obtained as actors engage the world in practice every day to get their work done (Orlikowski, 2002). Orlikowski notes that .... individuals are understood to act knowledgeable as a routine part of their everyday activity. They are seen to be purposive and reflexive, continually and
routinely monitoring the ongoing flow of action—their own and that of others—and the social and physical contexts in which their activities are constituted. (2002, p. 249)

The situated leaning theory accounts for such kind of continuous and evolving learning and knowledgeability that takes place in everyday life, including in work place. The learning process, in this case, is tied to ongoing activities and practices (Fox, 2000), and these activities and practices are carried out by communities of practitioners through social interaction. It is a social and collective process according to Brown and Duguid (2001).

The apprenticeship like theory of making sense of learning, the legitimate peripheral participation (LPP), integrates learning and working, and connects learners and workers, and captures the essence of learning in practice (Lave & Wenger, 1991). Learning in LPP is a situated process, which is embedded in the specificities of the context of work (Vaast & Walsham, 2009).

Learning, from the viewpoint of LPP, essentially involves becoming an "insider." Learners do not receive or even construct abstract, "objective," individual knowledge; rather, they learn to function in a community – be it a community of nuclear physicists, cabinet makers, high school classmates, street-corner society, or, ..., service technicians. They acquire that particular community's subjective viewpoint and learn to speak its language. In short, they are enculturated. (Brown & Duguid, 200, p. 48)

Newcomers learn both tacit and explicit knowledge from old timers as well as build identity similar to the community by engaging in a communal practice and accessing repositories (Brown & Duguid, 1991, 2001; Duguid, 2005). According to Brown and Duguid, workplace learning is best understood in terms of the communities being formed or joined and personal identities being changed (Brown & Duguid, 1991). The central issue in learning in this case is about becoming a practitioner not learning about a practice. To become an insider, learners need to have legitimate access to the periphery of communication, repository, war stories, practices, etc so that they can pick up invaluable "know how" – not just information. In order to foster learning–in–working, therefore, legitimacy, periphery and participation are important.

Learning is not only about the acquisition of knowledge but also about forming an identity, about acquiring the ability to act in the world in socially recognized ways (Brown & Duguid,
Brown and Duguid (2001) state that ‘it is not enough to claim to be a physicist or a carpenter; people, particularly other physicists or carpenters, have to recognize you as such’. In order to become a manager, for example, modeling on managers is not enough. One has to gain the acceptance and recognition of managers. Therefore, learning involves acquiring an identity that reflect both how a learner sees the world and how the world sees the learner (Brown & Duguid, 2001). Because of the situated nature of practice, the practice–based learning always and inevitably reflects the social context in which it takes place.

This notion of learning underpins practice as a successful circulator of knowledge both tacit and explicit, and represents the fluid evolution of learning through practice (Brown & Duguid, 2001; Duguid, 2005; Orlikowski, 2002). Practice also creates unique epistemic communities (Brown & Duguid, 2001). Knowledge and practice are reciprocally constitutive and it does not make sense to talk about either knowledge or practice without the other (Orlikowski, 2002). The succeeding section discusses knowledge and its circulation from the perspective of practice–based theories.

3.5.3. Knowledge circulation

... knowing is not a static embedded capability or stable disposition of actors, but rather an ongoing social accomplishment, constituted and reconstituted as actors engage the world in practice (Orlikowski, 2002, p. 249).

Researchers have approached organizational knowledge from two perspectives: the first set makes distinction between the types of organizational knowledge, while the other set provides an integrated view (Orlikowski, 2002; Tsoukas, 1996). The latter understands the nature of organizational knowledge through making analogies between organizations and human brains on the one hand, and organizations and individual minds on the other (Tsoukas, 1996). They model organizations on human brains or on individual minds. The human brain functions by connecting millions of neurons together at the time of action. Similarly, the connectionist approach value the distributed knowledge of individuals in enacting collective and individual knowledge (Tsoukas, 1996). According to this perspective, individuals that are distributed throughout a team hold an organizational knowledge, and the connection of which makes possible to carry out an activity (see Tsoukas, 1996 for further elaboration).
The first category, the taxonomic perspective, as termed by Tsoukas (1996), suggests the existence of different types of knowledge in organizations. It proposes that the success of an organization for developing and implementing effective means for generating, sharing, and managing knowledge depends on identifying and examining the different types of knowledge (Orlikowski, 2002). There are different dichotomies of organizational knowledge that originate from the tacit and explicit distinction made by Polani (1946, cited by Orlikowski, 2002), for example, local vs. universal, codified vs. uncodified, canonical vs. noncanonical, procedural vs. declarative, and know–how vs. know–what (Orlikowski, 2002). Tsoukas (1996) lists a number of such categories.

The taxonomic category is criticized for its tendency to reify knowledge by treating it as a stock or set of discrete elements (Orlikowski, 2002; Tsoukas, 1996). Furthermore, according to Tsoukas (1996, p. 14), the perspective does not recognize that “tacit and explicit knowledge are mutually constituted . . . [and they are] inseparable.” He further states that tacit knowledge “is the necessary component of all knowledge; it is not made up of discrete beans which may be ground, lost or reconstituted.” As a result, various researchers argue in favour of “an integrated approach that affords a view of organizational knowledge as processual, dispersed, and “inherently indeterminate”” (Orlikowski, 2002, p.250).

This research draws upon the “know how” and “know that” dichotomy of organizational knowledge as discussed by Brown and Duguid (Brown & Duguid, 1991, 1998, 2001; Duguid, 2005). Although the perspective distinguishes between types of knowledge, it shares the views of Tsoukas as discussed above. Brown and Duguid discuss organizational knowledge building upon knowing what and knowing how, and tacit and explicit distinctions made by Ryle and Polanyi, respectively. The distinction between know how and know that emanates from the famous quote “[w]e know more than we can tell” (Polanyi 1966, p. 4, cited in Brown and Duguid, 2001), which also go in line with the tacit and explicit distinction of Polanyi. Know that and know how are not independent types of knowledge. “They are interdependent and cannot be reduced to one another…. [and] [a]cquiring know that does not lead to being able to use it” (Brown & Duguid, 2001, p., 204). They give the example of chess playing to elaborate the distinction. Knowing the rules of a chess does not tell you how to play chess.

Organizational knowledge, similarly, is constituted from know that, an explicit knowledge, and know how, an implicit knowledge – the particular ability to put know–that into practice (Brown & Duguid, 1998; Duguid, 2005). The two aspects of knowledge are complementary,
know how helps to make know that actionable (Duguid, 2005). Know that is explicit and free moving, while know how is implicit, embedded in collective work practice and hard to spread, coordinate, benchmark, or change (Brown & Duguid, 1998).

Therefore, knowledge is two dimensional, one depends on the other, acquiring explicit knowledge only doesn't make the receiver actionable, and only practice successfully circulate knowledge (Brown & Duguid, 2001; Duguid, 2005; Orlikowski, 2002). The succeeding section discusses the nature of practitioners engaged in communal practices and its relationship to learning and knowledge sharing.

3.5.4. Communities of practices

The idea of a community of practice refers to a group of people that are involved in a shared practice. Communities of practitioners collectively engage in practices, and hold and share collective knowledge. The communities are more fluid and interpenetrative than bounded, often crossing the restrictive boundaries of the organization to incorporate people from outside (Brown & Duguid, 1991, 2001; Vaast & Walsham, 2009). Such communities are called communities of practice (CoP).

CoPs are situated work groups that arise from the sharing of material, social, and historical contexts (Brown & Duguid, 1991; Vaast, 2004). Communal practices and identities enact CoPs. Practice is a temporally, materially, and socially situated action, and it unifies and gives coherence and significance to CoPs, while identity gives shared meaning and interpretive consistency to the community (Vaast, 2004). Members of a CoP experience close practices, interact frequently, and share knowledge and close concerns. Identity has to do with shared meaning and interpretive consistency of the community. It arises from direct, repeated encounters and implicit learning on the job and it ensures that members of the community feel part of a group, which gives meaning to their job. The identity of the community relies on both the internal image (what members of the group consider themselves to be) and the external image (how they think other people, who do not belong to the community, perceive the community) of the group’ (Vaast, 2004). The community sustains itself partly because its members value their participation in a group that provides them with a prized professional identity. Identity and practice are the founding blocks of CoPs while mutual engagement, joint enterprise, and shared repertoire characterize them (Vaast, 2004).
• Mutual engagement: People join the CoP by committing themselves to actions whose meaning is mutually negotiated. Members of a CoP are complementary and linked through their mutual engagement in social practices.

• Joint enterprise: Socialization processes and operations in the community aim at achieving a joint enterprise, which results from the constant process of negotiation that reflects the dynamics of mutual engagement.

• Shared repertoire: The shared repertoire has gradually been constituted and regenerated through engagement in practices and maintains the social construction of meaning. It may be material and concrete (e.g., files and forms) or more intangible (e.g., routines, symbols, and specific idioms).

Through a communal practice, practitioners share know how or tacit knowledge. As the CoPs are defined by their communal practice, they are likely to have communal know how developed from practice (Brown & Duguid, 2001). Newcomers to a CoP learn to be unlike learning about in a face-to-face interaction (Duguid, 2005). Tacit knowledge is either displayed or exemplified in a face-to-face interaction, but not transmitted. As noted by Duguid (2205), the CoP’s knowledge, in tacit or explicit form, is distributed across the collective and their shared artifacts rather than held by or divisible among individuals. The distribution could be uneven, and within the CoP the knowing how of the community, not merely of an individual, is on display. Epistemic communities created around a practice could exist in different contexts and every practice may not be local (Duguid, 2005). The following section discusses practice and knowledge in a distributed context.

3.5.5. Networks of practices

Studies apply the CoPT in a distributed international environment, including in the analysis of open source software phenomenon (Hildreth, Kimble, & Wrigh, 2000). Such moves, however, are criticized for unnecessarily extending the theory (Vaast & Walsham, 2009). The situated learning theory and the associated CoP analytical device capture the learning dynamics among people engaged in similar practices and have frequent occasions to interact with each other often face to face (Brown & Duguid, 2001; Vaast & Walsham, 2009).

People can engage in similar practices but many not be necessarily co-located and many never have met face to face, like for instance, in the case of scientific communities (Brown & Duguid, 2001). The emergence of IT, particularly the Internet, facilitates “the acquisition and generation of new knowledge and competence based on similar practices and experiences,
and beyond the confines of shared locations or of institutionalized educational settings”
(Vaast and Walsham 2009: p. 547). It also enables the distribution of work across geography
and involvement of actors in local practices despite organizational, functional and
geographic barriers.

To account for such a distributed phenomenon, Brown and Duguid introduced the concept
of a “network of practice” (NoP) (Brown & Duguid, 2001; Duguid, 2005; Vaast, 2004). It
describes people that are not necessarily co-located and may never have met face-to-face
but engaged in similar practices. NoPs may arise from CoPs that are geographically separate
but that are characterized by close practices and identification processes. Relations among
network members could be significantly looser in NoP than within a CoP; practice may not
be coordinated within a NoP as it is a CoP; control and coordination of the reproduction of a
group and its practice are different; and newcomers enter the network through a local
community (Brown & Duguid, 2001; Duguid, 2006).

To explain the circulation of knowledge across an NoP, Brown and Duguid use leaky and
sticky notions, and adopt “disembedding” and “reembedding” concepts from Anthony
Giddens (Brown & Duguid, 2001; Duguid, 2005). The stickiness discussion focus on the
challenge of moving knowledge inherent in best practices inside an organization, while the
leakiness discussion focuses on the external and undesirable flow or loss of knowledge
across the boundaries of the firm to competitors (Brown & Duguid, 2001). Unlike other
researchers that relate declarative knowledge to leakiness and performative knowledge to
stickiness, Brown and Duguid explain that exactly the same knowledge can be both sticky
and leaky (Brown & Duguid, 2001). They state that “[i]deas, insights, inventions, and
practices that are unable to travel within the organization can prove to be quite capable of
travelling to competitors.” (p. 199). Therefore, instead of addressing the inertia of
knowledge in terms of inherent properties of knowledge itself or using socio-cultural
accounts, they propose to focus on practice (Brown & Duguid, 2001). To do so, they adopt
the notions of “disembedding” and “reembedding” knowledge that Giddens has introduced
to address the challenge of workplace communication and coordination across boundaries
(Brown & Duguid, 2001).

According to Giddens (1990), technologies allow people to communicate across space and
time, and knowledge is disembedded in one place to be reembedded in another for the
purpose; however, success depends on the degree to which the embedding conditions at
both ends of the communication are similar. Communication and coordination would be
successful if the embedding conditions are similar and would likely breakdown otherwise. Brown and Duguid (2001) suggest for the existence of a similar challenge of communication and coordination across different communities that are developed around practices as different practices create distinct embedding circumstances. Therefore, they say that, understanding where and why practices and embedding circumstances are common would help to explain where knowledge flows and where it sticks.

As discussed above, CoPs have communal know how developed from communal practices, and shared know how makes it possible to share know that or explicit knowledge effectively. Sharing common embedding circumstances are effective at circulating explicit knowledge. Knowledge flows (leaks) in the direction of shared practices; it sticks where practice is not shared. Therefore, members of an NoP share practices and hence knowledge flows with in an NoP relatively easily, although there could be different embedding conditions in different CoPs. Newly emerging knowledge is hard to circulate until the practice underlying it becomes common beyond its generating community. Knowledge circulates in an NoP following routes prepared by practice and it will often leak to the extent that common practice has prepared the way (Brown & Duguid, 2001).

The CoP and NoP theories are not without criticism; they are criticized for lack of due explanation on the effects of power relation within a CoP towards success, trust and predisposition (see for example, (Fox, 2000; Roberts, 2006). The OSIS implementation work practice features the characteristics of CoPs and NoPs, and an implementation approach that builds upon the CoP and NoP theories would help to focus on practice, communities and learning-in-working; it also helps to facilitate the practice and alleviate the challenges of IS implementation in developing countries. Therefore, for the same purpose, this dissertation argues for and outlines a practice-based and community-focused distributed implementation approach. The following section elaborates on the proposed approach.

3.6. Distributed Collaborative Implementation Approach

As elaborated earlier, IS implementation is an organizational innovation process, the focus of which is on building technology as well as changing an organization. It is a complex situated socio–technical process meant for changing both social and technical elements as well as their interrelationships. The process results in a property that emerges out of the complex interaction between the social and the technical, and it is continuous, evolving, and incremental. In a successful innovation, the social and the technical evolve together.
The emergence of OSS has changed implementation from the exclusive practice of firms to the hands of globally distributed actors. It has become more of a collaborative practice of globally distributed actors. The ideals and practices of globally distributed proponents of OSS develop and perpetuate a community of practitioners around an OSIS regardless of barriers such as geography, organization, culture, time, and function, with the aid of the Internet information infrastructure.

The organization of an OSIS implementation work practice is a distributed one – individual practitioner community operates independently simultaneously interconnecting with others. In technical terms, a distributed system is a collection of loosely coupled independent components that communicate by explicit message passing. The components are intrinsically concurrent and their states may be known only through communication. We cannot determine the exact global state of a distributed system, we can only approximate it. The OSIS implementation features such characteristics because of the global distribution of actors and openness of the process to any interested individual. The following section explains the distributed OSIS implementation from the perspectives of networking of actions and actors, involvement of globally distributed actors in a situated practice, and knowing and knowledge circulation evident in the due course.

3.6.1. Networking of actions and actors

Different studies emphasize the importance of networking of actions and actors to facilitate movement of resources, best practices, and skills from where success is achieved to new sites so as to facilitate and sustain IS implementation in developing countries (cf. (Braa, et al., 2004; Heeks & Stanforth, 2007)). The very philosophy and practice of OSIS support and make possible the emergence of a communal practice in a given setting and networking of practices across sites regardless of barriers.

By downloading and making use of software, practitioners join an OSIS implementation community; i.e., legitimacy is automatic, and through practice, newcomers ascend to the center, i.e., acquire explicit and implicit knowledge of a practitioner community. Practitioners share implementation stories, problems, and solutions to get a work done thereby accumulating data. They construct meaning out of the accumulated data in a manner suitable to new situations and through practice and over time, they construct and perpetuate individual and group identity as OSS champions.
An OSIS implementation, in general, features the notions of work practice, sharing and learning evident in CoPs and NoPs, as discussed above. Local communities of practitioners, who interact face-to-face and that are engaged in implementation activities together, can be understood as CoPs. The group is distinct and constitutes an epistemic community. These practitioner groups share identity, practice and resources with other groups within a given geographic area and with those dispersed across the globe. Such loosely related communities of practitioners constitute an NoP. Figure 4 below visualizes the distribution of local and global CoPs and NoPs, and the degree of connectedness among local CoPs and the connection between local CoPs and the global NoP.

Figure 4: Interaction between local and global communities of practices

Collocation of actors, face-to-face interaction, legitimate access to periphery of a practice and repositories, and mutual engagement in a CoP create an ideal situation for the movement of knowledge embedded in best practices, and the construction of meaning and communal identity (Brown & Duguid, 1991). A local practitioner community participates in a situated implementation practice simultaneously seeking partnership with similar local
communities. Establishing and strengthening local networks of practice pave way for the movement of knowledge because of the relative advantages of similarity in knowledge embedding conditions. The implementation of an OSIS in a given site creates an epistemic community, and can have loose coupling with related communities in a given geography. Although different, these epistemic communities feature relatively similar knowledge embedding conditions because of similarity in value, norm, education, etc. This feature makes practice based knowledge generated at a given local site to easily leak to other local sites.

These situated communities can also access the resources of global communities of practitioners that are engaged in similar practices. Access to resources of a global NoPs could be through accessing implementation accounts, posting questions, or through mutual engagement in local practices. Global actors can engage in a communal practice and share software, code snippet, guidance, best practices, advice, value, norm, information, etc. This form of association facilitates for the movement of knowledge embedded in best practices from successful sites to new ones. Degree of association in Figure 4 refers to such richness of a communication for the movement of resources and knowledge rather than infrastructural connection (Figure 5 and the next section explain it in detail). The networking could also serve as a means for sustaining implementation practices across settings and for CoPs to share local implementation accounts to global communities.

An ideal situation can be identified by combining the degree of attachment of actors in global network, degree of mobilization of local network actors, and the degree of richness of communication media (ranging from electronic repository consultation to presence in time and space). In the context of developing countries, the success of an OSIS implementation and reaping potential benefits of OSS depends on the strength of association that can be established locally among different groups of practitioners and, with the global pool of resources. A spectrum of involvement or association can be drawn among the different OSIS communities of practitioners as discussed below.

### 3.6.2. Involvement of actors in a situated work practice

Participation of global actors in local practices ranges from indirect, in cases where members of a CoP construct meaning out of information repositories, through active participation in technology mediated interaction to presence in time and space. In OSIS implementation, therefore, a spectrum of involvement of actors in situated practices can be
drawn between a mere access to software and related documentations on the one side to collocation, mutual engagement, socialization processes and face-to-face interaction on the other side, as indicated in Figure 5. Practitioners in a given site have the right to access source code; communications, problems and solution archives; designs and manuals; news, events, stories; etc because of the philosophy of OSS and legal mechanisms that protect access and distribution. Practitioners construct meaning out of the accumulated data and interpret new situations in the light of the accumulated data. Furthermore, help lines in source codes communicate purpose, organization, and relationship to other code snippet. Further to accessing resources of other CoPs or globally held information repositories, local practitioners could seek solutions from another epistemic communities engaged in a similar practice. Lastly, as depicted in the wider end of Figure 5, members of a global epistemic community could engage in a mutual practice. The degree of connection within local CoPs and, between local and global CoPs could affect knowledge circulation and, hence, implementation.

Figure 5: Involvement of actors in local OSIS implementation practices

3.6.3. Knowing in practice and knowledge circulation

If communal practices and relationships among epistemic communities circulate knowledge, engagement in an OSIS implementation practice should also open up the possibility for practice–based techno–scientific knowhow development, evolvement of social and technical elements, and circulation of knowledge. Knowledge acquisition, which is core at changing
individual and group behavior, identity, and action is a continuous, evolving and incremental everyday process, which is constituted and reconstituted as actors engage the world in practice (Orlikowski, 2002; Tsoukas & Chia, 2002). Action is central to knowledgeability and practice and knowledge are mutually constituted (Orlikowski, 2002; Tsoukas, 1996).

Implementation of an OSIS triggers practice-based learning and circulation of knowledge among communities engaged in similar software implementation practices. As indicated above, knowledge flows in the direction of shared practice and it sticks where practice is not shared. The OSIS implementation is a shared phenomenon among communities that are dispersed across the globe. Therefore, there is a high possibility for knowledge embedded in best practices to circulate relatively easily among communities of practitioners. The similarity of OSIS implementation practice across settings facilitates for the movement of knowledge, although embedding conditions might be different in different contexts.

Acquisition of knowledge changes the action, behavior and identity of a practitioner. An individual's knowledgeability is reflected in the action he/she does, and the action and interaction in turn affect knowledgeability. It is a continuous recursive process. Learning, in this case, is not just about acquiring facts about implementation; it is also about being a full-fledged practitioner, gaining recognition, and constructing and perpetuating own identity within and outside of a group. Through practice, practitioners construct an individual identity as well as perpetuate a group identity.

### 3.6.4. The distributed approach and IS implementation conceptual constructs

The distributed approach for OSIS implementation, as presented above, explains collaboration, sharing, learning, and knowledge circulation. It focuses on collaboration, sharing, and networking of actions as a means to develop techno-scientific competence, and improve and sustain implementation in developing countries. The dissertation argues that, in order to alleviate some of the challenges of IS implementation in developing countries, organizations should lay down conditions necessary for the emergence of a communal practice across settings and sites in addition to focusing on the construction of a technology and dealing with related changes in an organization separately.

A distributed organization does not exist out there but enacted through the actions of globally distributed actors. It is a pattern that is constituted, shaped, and emerges from
collaboration, sharing and learning processes during an OSIS implementation. Therefore, the distributed organization is composed solely of organizing processes. As discussed in section 3.1, change is the way of organizational life; it is continuous, evolving, and incremental; and enacted through the ongoing situated practices of actors. The notions adopted in the distributed approach build upon and support such kind of continuous, evolving, and incremental socio-technical change in an organization. The research also adopted the notion that the use and consequences of a technology emerges out of the complex interaction between technical and nontechnical elements. The notion adopted in the proposed approach considers the emergent perspective and lays down mechanisms for overcoming challenges.

Studies show that a technological solution meant for addressing problems of developing countries would be beneficial if its purpose arises from local problematizations and its course is determined by the way local actors make sense of it and accommodate it in their lives (Avgerou, 2008). The proposed distributed approach allows for the emergence of such a socially and locally embedded technological development. Furthermore, as indicated in chapter 2, Ethiopians have cultural traits and grass-root institutions that promote voluntary service, sharing, and collaboration similar to that of the ideals promoted by OSS proponents. An implementation strategy that considers and integrates the ideals of OSS and the cultural traits of Ethiopians together could solve the challenge of IS implementation, especially those related to resource and expertise limitations.
CHAPTER 4: RESEARCH DESIGN AND METHODS

This chapter provides an account of the research methods and techniques used in this research. It describes the adopted research design and situates it amongst the existing research traditions in information systems research. To this end, the chapter constitutes five sections. Section 1 details the ontological and epistemological stances of the research followed by a presentation on the preferred research methods in section 2. Section 3 discusses the selected cases, case selection processes, styles of involvement and mechanisms of access to data. Section 4 presents data sources and data collection techniques adopted in the research. Section 5 details data analysis technique and the role of theory and other influences in data collection and analysis.

4.1. Ontological and Epistemological Stances: The interpretative tradition

This research adopted the qualitative research approach (Silverman, 1998, 2005) with the underlying epistemological and ontological notions of the interpretive philosophy. Qualitative research in IS can be classified into positivist, interpretive, or critical based on researchers’ assumptions about the essence of the phenomena under investigation (ontology) and the criteria by which valid knowledge about a phenomenon may be constructed and evaluated (epistemology) (Myers & Avison, 2002; Orlikowski & Baroudi, 1991; Walsham, 1995b). Positivists generally assume that “reality is objectively given and can be described by measurable properties which are independent of the observer (researcher) and his or her instruments” (Myers & Avison, 2002, p. 6). The research in the positivist tradition focuses on theory testing with the aim to increasing predictive understanding of phenomena (Myers & Avison, 2002; Orlikowski & Baroudi, 1991). Critical researchers on the other hand, assume that “social reality is historically constituted and that it is produced and reproduced by people” (Myers & Avison, 2002, p. 11). Critical researchers recognize that even if people have the ability to consciously act to change their social and economic circumstances, they are constrained by various forms of social, cultural and political domination. The research in this category is best known for its critical stand towards the conditions of the status quo and on its focus on bringing to light the causes of alienation and domination (Myers & Avison, 2002; Orlikowski & Baroudi, 1991; Walsham, 1993). Critical researchers emphasize on values and emancipation of the individual.
The interpretive tradition, the third category, presumes a social constructionist perspective on reality and the construction of knowledge; it rejects the possibility of an ‘objective’ or ‘factual’ account of events and situations independent of the observer. Orlikowski and Baroudi note the following concerning the interpretive tradition:

Interpretivism asserts that reality, as well as our knowledge thereof, are social products and hence incapable of being understood independent of the social actors (including the researchers) that construct and make sense of that reality. … The aim of all interpretive research is to understand how members of a social group, through their participation in social processes, enact their particular realities and endow them with meaning, and to show how these meanings, beliefs and intentions of the members help to constitute their social action. (1991, p. 13)

Although the positivist perspective has been the dominant epistemology in IS research in terms of quantity of researches (Orlikowski & Baroudi, 1991), the interpretive tradition has also got momentum in the last two decades (Klein & Myers, 1999; Walsham, 1993, 1995a, 1995b). Of course, Walsham claims that the interpretive stance is "a valuable approach to studying IS in organizations, or … a better method than positivism for this purpose" (1995b, p. 378). The interpretative approach becomes more interesting and relevant as the focus of IS research shifts from being purely technological to the one that includes behavioral and organizational aspects, consequently when more interest is placed on the interaction between context and innovation (Benbasat, Goldstein, & Mead, 2002; Galliers & Land, 2002). Interpretive research in IS helps the researcher “to understand human thought and action in social and organizational contexts; it has the potential to produce deep insights into information systems phenomena” (Klein & Myers, 1999, p., 67). The aim of an interpretative research is to produce “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). Orlikowski and Baroudi classify researches under the interpretive category if it has an evidence of

… a nondeterministic perspective where the intent of the research was to increase understanding of the phenomenon within cultural and contextual situations; where the phenomenon of interest was examined in its natural setting and from the perspective of the participants; and where researchers did not impose their outsiders’ a priori understanding on the situation. (1991, p. 5)
The interpretative approach buys to the notion that the researcher can never assume a value-neutral stance, and is always implicated in the phenomena being studied. Researchers' prior assumptions, beliefs, values, and interests always intervene to shape their investigations (Orlikowski & Baroudi, 1991).

Likewise, this research adopted the interpretative philosophy because of the intent of the research, and the importance of examining the phenomenon in its natural setting, and from the perspective of the social actors. The research intends to increase our understanding of OSIS implementation from the perspectives of learning, working, and innovating, all of which are context dependent. Organizational implementation deals about technology construction and bringing about change in a given context hence implementation cannot be explained separate from the natural setting. Furthermore, work practices, learning, actions, and the formation and perpetuation of communities are socially constructed realities, which cannot be explained independent of the social actors (Brown & Duguid, 1991). As such, the research was guided by the belief that the social world is produced and reinforced by humans through their actions and interactions, and believes in interpretation of the social reality than ‘discovering’ an objective social reality.

4.2. The Case Study Research Method

There are different strategies of inquiry that move from the underlying philosophical assumptions to research design and data collection. Of course, a range of approaches are available in IS but they have their own strengths and weaknesses making them more or less applicable in different circumstances (Benbasat, et al., 2002; Galliers & Land, 2002). The case study research, action research, ethnography and grounded theory are the common research methods in IS (Myers & Avison, 2002). However, they may not be suitable to every situation and type of inquiry. Therefore, choosing the right method is essential and the choice should take account of the nature of the subject matter, complexity of the real world, and goals of the researcher (Benbasat, et al., 2002; Galliers & Land, 2002).

In this respect, field studies are regarded to be the appropriate methods for generating valid interpretative knowledge from the examination of subjects within their (natural) social settings (Orlikowski & Baroudi, 1991; Walsham, 1995b, 2006). Ethnography and case study researches are the two types of field studies common in IS research (Klein & Myers, 1999). There is no hard and fast distinction between the two methods, except the length of time that the investigator is required to spend in the field and the extent to which the researcher
immerses himself or herself in the life of the social group under study (Klein & Myers, 1999).

Case study research is viable in IS because it facilitates the study of IS in a natural setting; allows the researcher to answer ‘how’ and ‘why’ questions; helps to understand the nature and complexity of the process taking place; and it is an appropriate approach to research an area in which few previous studies have been carried out (Benbasat, et al., 2002). Although there is no standard definition of a case study, this research, adopted the following more inclusive definition given by Benbasat, Goldstein, and Mead:

A case study examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or a few entities (people, groups, or organizations). The boundaries of the phenomenon are not clearly evident at the outset of the research and no experimental control or manipulation is used. (2002, p. 81)

A case study research can be positivist, interpretative or critical, depending upon the underlying philosophical assumptions of the researcher (Myers & Avison, 2002). Interpretative case studies can help to develop concepts, generate theory, draw specific implications in a domain of action, and contribute rich insight (Walsham, 1995b).

The study adopted the ontological and epistemological stances of the interpretative philosophy, as discussed above, and the case study research method. The method helps to generate valid interpretative knowledge from examination of social actors and their actions, and implementation processes in their natural organizational settings using multiple methods of data collection (Flyvbjerg, 2006; A. Lee, 1989; Myers & Avison, 2002). The study also aims to draw specific implication to open source software-based IS implementation in the public sector of a developing country context concerning knowledge circulation, learning and innovation. The design and execution of the research were mainly influenced by Walsham and Klein and Myers (Klein & Myers, 1999; Walsham, 1993, 1995b, 2006).

4.3. Case Selection, Style of Involvement and Access to Data

Similar to other researches, case selection, style of involvement and gaining and maintaining access to data are important in case study researches (Flyvbjerg, 2006; Walsham, 2006; Yin, 2003). This research studied three cases in two different settings – public healthcare and public higher education. These cases were selected based on opportunity and judgment
(Flyvbjerg, 2006; Yin, 2003). The following sections elaborate my style of involvement and the processes and mechanisms of gaining and maintain access to data in each case.

4.3.1. **Anti-Retroviral Therapy System Implementation**

My involvement as a researcher in the development and implementation of ARTIS traces my role as coordinator of the HISP project in Ethiopia, HISP Ethiopia for short. HISP is an international network of academics and health institutions operating in a number of developing countries (Braa, Hanseth, Mohammed, Heywood, & Shaw, 2006). The primary goal of HISP is to design, implement, and sustain HIS following a participatory approach to support local management of health care delivery and information flows in selected health facilities, districts, and provinces, and its further spread within and across developing countries (Braa, et al., 2004). HISP included Ethiopia in 2002 through a university to university collaboration and by enrolling PhD and masters students in information systems at the University of Oslo (Braa, et al., 2006). Subsequently, HISP Ethiopia initiated an action research project in five regions; the major effort being to implement a district based routine health data management and reporting system called DHIS. HISP has achieved a lot in terms of improving practice and contributing to understanding health information system implementation (cf. (Braa, et al., 2006; Damtew & Gebreyesus, 2005; Lagebo & Mekonnen, 2005; Mengiste, 2010; Wondim & Nega, 2009).

The coordinator role introduced me to the details of the Ethiopian health care system, its stakeholders, activities of HISP, and after all, interested me pursue research in the area. While coordinating the project, I met and discussed with diverse stakeholders about the Ethiopian healthcare system focusing on health information system implementation, open source software, collaboration between the academy and the industry, and activities of HISP and Addis Ababa University (the organization where I belonged and where HISP was based) in this regard. I have met with people in the Ethiopian government system ranging from Deputy Prime Minister, Deputy Minister of the Ministry of Health, Regional Health Bureau Heads to Nurses and Data Clerks in ART Clinics) and donors such as the Center for Disease Control (CDC) and the UNDP. I used to regularly discuss every issue that a real world project encounters with HISP coordinators, and project members, who were actually implementing DHIS, and offering trainings and conducting researches. I had a chance to inaugurate and participate in some of the workshops that were meant for introducing the operations of DHIS to users, which were organized by HISP in collaboration with Regional Health Bureaus.
I had visited implementation sites in 5 regions where the project was running, and paid regular visits to implementation sites in Addis Ababa.

These encounters gave me better opportunities to understand the nature of the Ethiopian health care system, and among others, the challenges of systems development and implementation in the sector. I was also very much attracted to the action-based research of HISP (Braa, et al., 2004) and appreciated the expertise that each researcher has developed from cases and the real life problems that they addressed (Damtew & Gebreyesus, 2005; Lagebo & Mekonnen, 2005). I also understood the value of context dependent knowledge in the study of human affairs and technologies (Akrich, 1992; Flyvbjerg, 2006; Suchman, 2007).

As a result of my experience and review of literature on IT in Ethiopian health care system (Desta, 2003; Mussa, 2003), I figured out the importance of focusing on the development and implementation of electronic health record system in a pilot site in Addis Ababa. I started the PhD journey with a focus on electronic health record development and implementation, although it was not materialized due to political instability following the 2005 election in Ethiopia. Then, I shifted my attention to the implementation of ARTIS.

ARTIS is also the product of HISP. HISP initiated the ARTIS project in 2006 to primarily implement it in ART clinics in Addis Ababa, the capital of Ethiopia, and then to enroll it out to other parts of the country. Two Ethiopian students who were attending M.Sc. in Information Systems at the University of Oslo, who were also members of HISP, led the development and implementation efforts. As part of the curriculum, the students were required to attend courses on the theory and practice of open source software, and write dissertation based on empirical material. This arrangement facilitated for the two students to choose the HIV/AIDS area in consultation with their professors. Through the already established network because of the DHIS, HISP problematized the ART service to the Addis Ababa Health Bureau and proposed ARTIS as a solution. The person in charge of ART in Addis Ababa Health Bureau welcomed the proposed solution reiterating on the challenges of they were facing. An agreement between Addis Ababa Health Bureau and HISP Ethiopia was concluded in 2006 to develop ARTIS in a pilot ART Clinic. The development and implementation of ARTIS was carried out with the financial, material, technical, and human resource support from HISP. Although HISP concluded an agreement with Addis Ababa Health Bureau, a U.S.-based university had the mandate to technically support ART in the
Region. The Federal government of Ethiopia gave mandate to four U.S-based universities to technically support ART in Ethiopia.

The development and implementation process brought different actors together, including me as a researcher and practitioner. I was involved in the development process by evaluating the system from technical and functional perspectives, discussing with developers, and leading meetings and discussions with donors and health officials in the Ethiopian health care system ranging from officials in the FMOH through Regional Health Bureau officials to Data Clerks in facilities. The discussions were aimed at seeking mechanisms of cooperation and gaining the will of stakeholders to introduce ARTIS. I also closely worked with and visited implementation sites in Addis Ababa, Oromiya, and Amhara Regional states.

As of July 2009, ARTIS was implemented in more than 27 clinics in Addis Ababa and the effort to scale it up in terms of geography and function was going on. The research concerning ARTIS was conducted as an inside observer (Walsham, 2006) and gained and maintained access to data as a result of my association with the HISP project.

4.3.2. Library System Implementation

As indicated earlier, the research reported in this dissertation considered additional two settings in the public higher education sector – the Addis Ababa University Library (AAUL) and the College of Telecommunications and IT College Library (CTITL). The cases and my involvement are discussed below.

4.3.2.1. Addis Ababa University Library

AAUL was founded in 1950 along with its parent organization, the AAU. Although, it is the oldest and the largest research library in the country, its services and activities were manual except in the production of card catalogues which was semi automated until the end of 2004, until it started customizing an OSS-based library system, Koha. The research context section in paper 3 details the challenges and attempts of AAUL with regard to IT utilization.

I was employee of AAUL from 1996 to the end of 2002, until I joined a teaching department, the Department of Information Science, in the same university. I joined the Library as a systems librarian with the main duty of facilitating IT utilization. During this period, I was actively involved in the process to acquire and implement an integrated system, to "automate services of the library" as it was called. The Library established a Computer
Center in 1988 to facilitate automation, however, shortage of work force led to the establishment an automation committee composed of experts within the Library that would be responsible for the automation effort. The committee at different times and circumstances suggested purchase, in-house development, purchase, and customization of an open source software between the years 1996 and 2004 in such an order. Lack of political will, organizational politics, and financial and expertise limitations were the bottlenecks. I was actively involved in these processes especially since 2000, and served as chairman of the committee from August 2001 – August 2004.

My role in the automation process gave me the opportunity to better understand challenges; share them with donors, project members, university officials, librarians, related project members, etc; and look for solutions, and deal with uncertainties. I firsthand witnessed the challenges of staff turnover, organizational politics, and the effects of financial and expertise limitations in system development and implementation endeavors because of this project. The various attempts to curb the problem including looking for foreign funding agencies, bringing together IT expertise from departments that offer IT courses such as Computer Science, Electrical and Computer Engineering, and Information Science departments were challenged. The final attempt was to customize an OSS in collaboration with a University in the USA (a professor and his students) and an NGO (co-established by the professor). To promote sharing of knowledge and experience, the international arrangement mixed local and global members together in groups and started the project but did not go further the planning stage. Despite its failure to deliver the expected product, the arrangement introduced the local team to the world of OSS.

Although the implementation of Koha was started after I left the project as a manager, I was involved in the selection and gap analysis phases as a member. As a researcher, my membership in the process facilitated for understanding previous efforts, and to access documents, identify key players, and communicate with them relatively easily. During the data collection process, respondents refer to my previous involvement with the phrase “as you are aware of”. Therefore, generally, I was involved in the last phase in a limited fashion, and hence, a limited involved observer (Walsham, 2006).

4.3.2.2. Telecommunications and Information Technology Library

The College of Telecommunications and Information Technology (CTIT) was established in the first half of the 2000s with the sponsorship of the state owned telecom monopoly
Ethiopian Telecommunication Corporation. The CTIT Library (CTITL), which was established together with the college, has two branches - the graduate school and telecommunications training libraries. The libraries serve about 1000 users composed of students, faculty and employees. It had a collection of around 100,000 materials composed of books, journals and others. The library also suffered from the challenges of manual operations and services similar to AAU. However, tried to develop and implement an in-house library system in the main library based on the UNESCO sponsored free software, the CDS/ISIS.

The Library turned its eye to OSS and Koha because of the AAU Library. The Head Librarian, who is Librarian and IT expert by training, discussed with the Koha project members in AAUL about OSS in general and the specific software, Koha. Following the conversation, he started the implementation of Koha in the CTIT Library.

I identified CTIT Library as one of my cases due to my conversations with the AAU Library during the data collection process. Both the project people and users of Koha were mentioning CTIT Library as a success story. Compelled with the views of respondents and my intention to understand about the penetration of OSS in the Ethiopian market, I tried to investigate the existence of other projects. Although, I did not find other libraries fully implementing Koha, I identified the attempts of other University Libraries but they were in preliminary stages. Of course, the penetration of OSS as an idea was limited at the time let alone the practice. Therefore, I did not have involvement in the implementation of Koha in CTIT Library and hence, the research was conducted as external observer (Walsham, 2006). My friendship with the Librarian, other members of the Library, and members of the College including the Dean allowed me to access data relatively smoothly and easily.

4.3.3. Characteristics of Selected Cases

Despite organization size, implementation trajectories, and differences in adopted software system, the three organizations attempted to adopt OSS-based information systems. The following table summarizes the similarity and differences of the cases.
Table 9: Similarity and differences of the chosen cases

<table>
<thead>
<tr>
<th>Characteristics/Feature</th>
<th>ARTIS in the Health Care</th>
<th>Koha in AAU Library</th>
<th>Koha in CTIT Library</th>
</tr>
</thead>
</table>
| **Development Related** | • Developed from scratch with financial, political, work force, and technical support from HISP.  
• The novice developers benefited from formal education and the practice-based support from HISP members.  
• The system lacked documentation.  
• More of a controlled nature | • Downloaded Koha from the Internet  
• Developers were novice to the technologies and technical operational environment of Koha.  
• Locally organized group briefly trained developers through practice.  
• Koha’s documentation was not complete  
• Contextualization of Koha according to AAUL was a requirement.  
• Active developer and user communities. | • Downloaded Koha from the Internet.  
• The developer had some expertise with some of the technical operational environment and technologies of Koha.  
• Koha’s documentation was not complete  
• Contextualization of Koha according to the CTITL was a requirement.  
• Active developer and user communities. |
| **Implementation Related** | • The initiative and funding were from an external source, HISP.  
• The environment was highly politicized and competitive.  
• Although decentralized, the FMOH has authority in most local matters.  
• Regional health bureaus and Clinics were supportive of the implementation.  
• The HISP network involved the process at different levels. | • The Library/University initiated the implementation.  
• The project manager was member of the Library Administration.  
• Library reform project has been going on and working closely with the project team.  
• There was neither technical nor financial support from external sources.  
• Made use of the Koha’s developer and user communities throughout the process. | • The Library initiated the implementation with a full support from the College.  
• The person responsible for the development was also head of the library.  
• There was neither technical nor financial support from external sources.  
• Made use of the Koha’s developer and user communities throughout the process. |
| **Implementation Approach** | • Organization–driven | • Commons–based | • Commons–based |
| **Global Actors participation** | • Blurred the local/global dichotomy | • Electronic communication, repository, documentation | • Electronic communication, repository, documentation |
| **Researcher’s Role** | • Insider | • Partially insider | • Outsider |
4.4. Data Collection

The case study method suggests data collection through multiple mechanisms from multiple sources such as documents, archival records, interviews, direct observation, participant observation, and physical artifacts (Benbasat, et al., 2002; Yin, 2003). Walsham (1995b) also argues in favor of the interview as the primary data source with respect to interpretative case studies as an outside observer.

"it is through [interview] that the researcher can best access the interpretations that participants have regarding the actions and events which have or are taking place, and the views and aspirations of themselves and other participants. Even in the case of interpretive case studies being carried out as a participant observer or action researcher, it can be argued that interviews are still an important data source, since they enable researchers to step back and examine the interpretations of their fellow participants in some detail. (Walsham, 1995b, p. 78)

This study also used multiple data sources and implemented a combination of data collection techniques over a period of time. The field work for the research was carried out during the following periods: March–August 2006, February–April 2007, and November 2007–February 2008, and September–December 2008. During these periods, I have conducted semi-structured interviews, observed work practices, held discussions, analyzed the technical and functional aspects and documentation of both Koha and ARTIS, studied email exchanges (email list archives), participated and led national and international conferences and workshops, and reviewed minutes, reports, memos and related publications as discussed below. Generally, the research adopted the research approach and design illustrated in Figure 7.
4.4.1. Review of Documentation

I have reviewed documentations in order to understand the HIV/AIDS domain and the detail work processes, coordination mechanisms, plans, actions, improvements, challenges, decisions, ambitions, frustrations, successes, perceptions, etc. For this purpose, I have reviewed publications of the Ministry of Health, WHO, reports, minutes (AAUL), project documents, and memos.

4.4.2. Interview

During the field work periods indicated above, I interviewed respondents mentioned in table 8 below in three Regional Administrations, Addis Ababa, Oromiya and Amhara, in the case of ARTIS and in two libraries in the case of Koha. The respondents were either users of the system or managers and technologists who directly influenced the implementation of the two systems. All of the interviews were conducted in the respondents’ offices except in one occasion, when the session was arranged out of office hour in a different location. The interviews were semi-structured in a sense that respondents were asked a question and given an opportunity to reflect on it, followed by a follow up question until an issue was
clarified. The respondents were expressing their feelings in a relaxed mood. In most of the instances I was regarded as an insider who is there to solve their problems. The interviews in ART Clinics and Health Bureaus were full of interruptions. In some instances, patients interrupt the session, or either Physicians or Nurses demanded information while interviewing Data Clerks. During these fieldwork periods, altogether, I have conducted 81 interviews with respondents in the three settings as indicated in table 8.

Table 10: Respondents by responsibility and frequency

<table>
<thead>
<tr>
<th>Context</th>
<th>Respondents’ Specialization/Responsibility</th>
<th>Number of Respondents</th>
<th>Number of Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public healthcare system – Antiretroviral Information Systems Development and Implementation</td>
<td>ART coordinators</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Physicians</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Nurses</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Data Clerks</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Pharmacist/ Druggist</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Laboratory Technician</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Developers</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Project Management</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Technologists</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Catalogers/Users of the system</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>81</strong></td>
<td></td>
</tr>
</tbody>
</table>

I have recorded some of the interviews, 17 of them and have taken detailed notes during the rest of the sessions. I have summarized main points immediately after the interview, occasionally presented results to respondents, and in some cases, presented summarized reports to other actors. I have also used artifacts of the Unified Modeling Language (UML) especially activity diagrams to model work practices, understand local changes, and facilitate communication with respondents, especially in ART area. I have also presented summary of the interview and the draft of my papers to some of the respondents in AAU Library.
4.4.3. **Observation**

I have paid visits to research sites during several occasions, particularly paid attention to subjects (Cataloguers, Data Clerks, and Technologists) while performing usual duties in the natural setting, in the main library and two branches in AAU Library and the CTIT Library. In some cases, my presence made them uncomfortable and in most of the cases they tend to reflect on their activities and different aspects of the new system such as, including but not limited to, improvements in work practices, challenges, overall perceptions, etc. In general, I have surveyed and observed the work processes of ART clinics in five hospitals (Armed Forces and Military General Hospital, Tikur Anbesa Teaching Hospital, Zewditu Memorial Hospital, Federal Police Hospital, and Federal Prison Health Center), and work practices in the two libraries.

4.4.4. **Discussions and Meetings**

I have made several meetings and discussions with relevant stakeholders, as indicated in table 9. The meetings and discussions were aimed at seeking mechanisms of collaboration and coordination of work practices pertaining to the implementation of ARTIS. I usually took detailed notes during each session and circulated summarized reports in the HISP network.

<table>
<thead>
<tr>
<th>Context</th>
<th>Respondents’ Specialization/Responsibility</th>
<th>Number of Respondents</th>
<th>Number of Informal discussions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public healthcare system – Antiretroviral Information Systems Development and Implementation</td>
<td>ART coordinators</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Regional health bureau officials</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>U.S.-based universities representatives</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>National HAPCO</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

I have also held several informal discussions with the respondents in the two libraries over lunch and tea breaks. During these informal discussions, respondents were keen to talk about their day-to-day encounters and their overall assessment of the new system from the perspective of its significance and the social and technological challenges and consequences. The respondents also talked about opportunities that OSS opened up not only to their specific library but also to all libraries in the country.
4.4.5. Conferences and Workshops

I have participated and chaired national and international workshops and conferences that specifically focused on open source software and ARTIS in Ethiopia. Workshop participants included members in the HISP network, ART Coordinators, Data Clerks, representatives from the Addis Ababa Health Bureau and the Federal Ministry of Health, and donors. It was an interesting occasion to learn about the views of these participants towards ARTIS and activities of HISP in Ethiopia.

4.4.6. Email Archive

The Koha communities maintain mailing lists one for developers and another for users. I have identified and collected all the emails exchanged between local developers in the two libraries and the Koha community between December 2004 and February 2010. December 2004 was the time when the AAU Library started to implement Koha.

Examination of email exchanges helped me to understand the practical problems and challenges that the local team faced, the type of answers, advices, referrals, codes, and other solutions provided to them, the dispersion of global actors, and some of unanswered questions and unaddressed issues.

4.4.7. Artifact Examination

I have collected data by analyzing the technical and functional aspects of both systems – Koha and ARTIS – at different times to understand changes and improvements. The analysis also helped me to understand the level of cooperation and common practice that can be facilitated through the provision of help lines and advises in the source code. The source code of Koha features detail help lines as to the intent of the code and how it is organized. Analysis of ARTIS overtime allowed me to understand the design changes that were made to translate the interests of new environments for the sake of scaling up the system geographically and hence, increases collaboration.

4.5. Data Analysis

A clear distinction between data gathering and data analysis is problematic for many qualitative researchers (Myers & Avison, 2002). In fact, Myres and Avison prefer to speak of ‘modes of analysis’ rather than ‘data analysis’ as the analysis affects the data and the data affects the analysis in significant ways. In addition, in certain modes of analysis such as the
hermeneutics, the researcher's presuppositions affect the gathering of the data (Myers & Avison, 2002). A theory can also be used as part of an iterative process of data collection as well as analysis in an interpretative research (Walsham, 1995b, 2006). Furthermore, as indicated above, researchers' prior assumptions, beliefs, values, and interests always intervene to shape their investigations all the way from data collection through analysis. This research therefore could not be immune to my prior assumptions, beliefs, values, and interests and the influences of theories throughout the research. Of course, as interpretative researchers state what is reported in this dissertation is my own construction of the interpretation of others (Flyvbjerg, 2006; Orlikowski & Baroudi, 1991; Walsham, 1995a).

The mode of analysis focused on iteratively reading the collected data, spacing it throughout timelines, extracting themes in line with research objectives and theoretical concepts, and sharing results with colleagues. There were continuous iteration between the whole and parts, featuring the hermeneutics cycle (Klein & Myers, 1999). As Walsham (2006) notes, the researcher's mind supplemented by the minds of others is the best tool for analysis, and this research relied mainly on the minds of the researcher supplemented by colleagues. Specifically, the analysis focused on iteratively reading data and findings reported in the five papers, spacing it throughout timelines, and relating them to the constructs of the CoP and NoP theories.
CHAPTER 5: ANALYSIS AND DISCUSSION OF FINDINGS

This chapter presents the empirical findings of the study drawing upon the five papers appended in this dissertation, synthesizes findings in relation to the research aims and questions, and discusses them in relation to the theoretical framework presented in chapter 3. The chapter is divided into four sections. The first section presents summary of the findings of each of the papers followed by a presentation on summary of key findings in section 2. Section 3 presents synthesis of the findings in relation to the research questions of the dissertation. Section 4 presents the discussion.

5.1. Summary of the Papers

5.1.1. Paper 1


The paper explores the development, implementation, and roll out of ARTIS from a network of relations perspective. It conceptualizes IS implementation as a complex process of establishing, expanding, and sustaining network of relations among aligned interests, and shows the process drawing upon the notions of translation and inscription from Actor–Network Theory (ANT). Specifically, it uses the four moments of translation such as problematization, interessement, enrolment, and mobilization, and inscription to explain the process in which a socio–technical network around the development, implementation, and rollout of ARTIS came into being, constructed, maintained, competed with other networks, and made durable. HISP was the focal actor that defined the problem, proposed ARTIS as an obligatory point of passage and played a pivotal role in the construction, maintenance, and durability of a network of relations that included social and technical actors.

The research suggests that IS implementation is not just a technical problem solving exercise but a complex socio–technical process where various circumstances and events
The nature of ARTIS and its development and implementation strategies played significant roles in reinforcing the construction, expansion, strength, and durability of the ARTIS actor network. The open source ideology of ARTIS brought resource constrained beneficiary organizations aboard the network, limited the competition power of competitors, and enhanced the acceptance of HISP and ARTIS. Openness of ARTIS attracted other local and international actors as well. The local association of IT experts organized to promote OSS in the country, the Ethiopian Free and Open Source Software Network (EFOSSNet), and member countries in the HISP network were interested to join the network and further develop ARTIS.

The implementation strategy, which was built upon the OSS feature of ARTIS, blurred the distinction between global and local actors creating a community of practitioners that was collaboratively carried out technical, social, organizational, and political matters. The less experienced practitioners were introduced to the principles of OSS, IS development and implementation through a formal classroom setting and essentially through participation in practices. They were legitimate participants of the development and implementation practices along with the international partners in the local setting. The group engaged in mutual activities, socialization processes, and held joint repertoire in a form of report, research products, etc. Participated meetings, workshops, and conferences; discussed challenges, plans, problems, solutions, etc with other HISP members in a face-to-face interaction and using electronic means, especially email communications and telephone conversations whenever possible. Therefore, they socialized through the practice of
implementation and developed an identity – OSS implementers and a sense of community (group identity as HISP implementers). The local practitioners became promoters of OSS in the country and the global practitioners shared their knowledge and best practices to the locals through practice.

The practitioners didn’t learn the principles of systems implementation rather they learned to be implementers, being able to deal with not only technical matters but also social, political, and organizational issues. The local practitioners later scaled up ARTIS geographically and functionally, occasionally meeting electronically with their international partners.

5.1.2. Paper 2


This article explores the trajectories of the design of ARTIS over time and location to understand the interests of actors that are embedded in the material and functional forms of ARTIS and on the wider socio–technical arrangement, their translation, and negotiation in the course of socio–technical order formation and sustainability in a resource constrained setting where competition and politics were paramount. The research was a continuation of the research reported in paper 1, and it was designed as qualitative interpretative case study.

The findings of the study show that ISs inscribe contextual matters that are only relevant to gaining the support of other actors despite their problems, and leave others aside regardless of their advantages in facilitating work practices. Not only the resulting system but also the wider socio–technical arrangement that can be established around an IS could embed the ideology, strategy, and interests of one of the actors, which could be considered as dominant

5 The previous version of this paper was published in the proceedings of the 10th International Conference on Social Implications of Computers in Developing Countries "Assessing the Contribution of ICT for Development" (IFIP WG 9.4) Dubai, May 2009. Dubai School of Government http://ifip.dsg.ae/
and powerful. The dominant and the powerful actor in this case is the one that defines both the problem and the solution, and produces and achieves collective goals.

The capacity development strategy and the OSS ideology that were embedded in the ARTIS socio-technical arrangement are of interest here. The choice of the OSS ideology was according to the interests of the beneficiary organization which had financial and other resource limitations to introduce computer-based systems, although the idea was not mature enough in Ethiopia.

To develop and sustain local capacity, HISP has chosen to base the development of ARTIS in the local environment, endow local developers and users with knowledge and skill through formal and informal education, and establish local and international networks so that developers could share expertise and resources. Furthermore, HISP blurred the local/global actor dichotomy by facilitating partners to engage in local activities at various capacities. The ARTIS socio-technical network thus embedded the political agenda of the dominant and powerful actor, which was boosting capacities of users and sustaining implementation through networking of actions within and across developing countries as well as between the developing and developed worlds, iterative incremental development and implementation processes, interesting others overtime, OSS implementation, etc (Braa, et al., 2004).

The study suggests that competition leads to the development of an IS that is mindfully selective to contextual matters, technologies, features, functions, ideologies and strategies that are important to attract others, form alliances, and assure continuity of socio-technical orders despite realities in implementation contexts and still compromising on overall performance of the IS. As to the allocation of rule and resources, the study shows that the same role could be allocated to human and nonhuman actors at different times and locations due to the need to continue socio-technical orders despite their negative implications on efficiency and effectiveness. A nonhuman actor also influences role allocation. For example, the computer system as an efficient and effective data validation tool dictated such role allocations. The situation reveals that role allocation could not be a function of the effort required to perform tasks as pointed out by Law and Bijker (1992) and Latour (1992) rather, it could be a function of the negotiation and compromise between data quality and overall sustainability of a socio-technical order. In a resource constrained and competitive setting, choice of development technologies and ideology, role enactment and distribution,
and feature and function additions target mainly at excelling others and defining and reinforcing a socio-technical network at the expense of improved performance, decision making, and organizational effectiveness.

Generally, the paper demonstrates that besides addressing the primary goals of their existence, IS carry the interests of actors that would impact performance, future behavior and structure of organizations, and specify the current and future environment in which they will be running and the functions they can provide to current and future users despite the use context. The features, functions and elements embedded in an IS and the socio-technical arrangement could resist future changes due to the magnitude of mobilized supporters and the established socio-technical network. The paper suggests that IS implementation in a competitive environment entails for working around the design of an IS, and compromising on performance and data quality for the sake of sustaining socio-technical order. Understanding the contextual elements and designing relevant strategy would be crucial to succeed in implementation.

5.1.3. Paper 3


This paper explores how key stakeholder groups in an organization interpreted OSS as a technology and the processes of its implementation, and how interpretation differences, in turn, influenced action and behavior. The research was conducted in Addis Ababa University Library (AAUL) in the course of implementing an OSS-based integrated library system (OILS) called Koha. The research was guided by and interpreted in the eyes of the technological frames analytical framework (Orlikowski & Gash, 1992, 1994).

The findings of the interpretative case study show that the key stakeholder groups in AAUL perceived that implementing an integrated library system would solve drawbacks of the manual system, change image of the library to the better, and facilitate collaboration with

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6 The previous version of this paper was published in the proceedings of the 31st Information Systems Research Seminar in Scandinavia (IRIS 31st) “Public systems in the future – possibilities, challenges and pitfalls” Are Sweden, August 10-13, 2008 http://www.iris31.se/
similar libraries regardless of time and location. However, they had divergent views on implementing an OSS, feature and capability of the chosen software, and the processes of converting the old (manual) routine and paper-based data into electronic versions. The management and technologists, on the one hand, and users on the other hand, promoted similar viewpoints with slight differences on these issues. Users focused on immediately solving drawbacks of the old system and improving day-to-day operations while the management and technologists promoted the strategic importance of OSS not only for local use but also for the nation in general.

The perception of the management and technologists was framed around the strategic importance of OSS in building a knowledge hub that would step-by-step customize and implement Koha in AAUL and foster its implementation and further development across the country. As a result, their attention was focused on the existence of core library functions, feature and function additions through time, bypassing financial limitation through OSS customization, and long-term capacity development agendas. Their actions were targeted at winning the support of the source of fund and quickly deploy Koha. They gave less emphasis to documentation, reporting, and convincing the rest of the library staff, and regarded users as threats to the process and denied them active participation.

Users interpreted the nature of the software from expertise requirement perspective and lack of third-party support in customization, configuration, installation, retrospective conversion and knowledge transfer. They also required for a solution that immediately solves problems of the old system and the availability of all of the required functions. Users were in need of a working system that solves drawbacks of the old system without taking time. Although users were not happy with the functions of Koha, they thought that it could be improved through continuous interactions with technologists. However, lack of a plan to incorporate required functions and inadequate technical expertise to effect changes damaged the relationship between users, and technologists and the management. Users finally stopped reporting technical bugs, continued using the new system and undermined the expertise of technologists. Users interpreted features of Koha in terms of the knowledge and experiences of technologists, responses to bugs and their timing, and participation in the customization process. When it comes to converting the paper-based data into an electronic format, the actions of users were linked to their knowledge of the librarianship profession and the leadership. The group tended towards obeying orders from the project.
manager rather than their profession because of its immediate impact on their career, and considered Koha and the process to be threats to their professionalism and career.

The interpretations of key stakeholder groups in AAUL were shaped by nature of the software, lessons from past automation efforts, change of the management style, and political processes. History of automation attempts in AAUL show the complexity and challenges of IS acquisition and development because of financial, political, human resource, and other factors. These factors remained the same when the library opted for OSS adoption and directly impacted the perceptions of actors although differently. The management considered OSS customization to be a novice approach that would have a bright future prospect, while users perceived it to be similar with previous failed exercises.

Because of perception differences, knowledgeable and experienced employees were denied active participation, collective decision-making style was damaged, and staff mobilization became difficult. Frame incongruence brought difficulty to the implementation process dictating the management to take corrective actions, which in turn resulted in negative consequences. The implementation outcome was shaped also by the inherent ambitions of the staff to change the image of the library to the better and due to the changed management style from participatory to authoritarian. The authoritarian management style demanded all employees to work with and deliver products using the new system despite problems. Partly due to the ambition of the employees to change the library to the better, they tended towards obeying the new style. The study points out that even if the potential of OSS in developing countries is immense, its realization could be affected by several contextual factors such as interpretation differences and measures taken to harmonize it.

### 5.1.4. Paper 4


This research explored the organizational change that unfolded during the implementation of an OSIS in a public sector developing country context and how aspects of OSS such as license, openness of source code and the community development model shape the change. The research uncovers how changes inscribed in to an IS artifact can shape an
implementation processes with the mediation of local circumstances and planned targets and the effect of aspects of OSS on organization change. The empirical material for this research was based in the public higher education sector in Ethiopia called Addis Ababa University (AAU) library. The study investigated the old, inscribed (in to Koha), the planned and the resulted work processes, and transformation processes.

The study shows that the noninvolvement of license cost opens up new opportunities for resource constrained organizations in developing country to acquire, study, modify and implement an OSS-based integrated library information system (OLIS). Adoption of an OSS also avoids the often lengthy bureaucratic negotiation processes and associated corruptions apparent in the public sector. Even if the noninvolvement of license cost allowed AAUL to easily acquire software, local circumstances including the existence (not) of an environment fertile for implementation such as expertise availability and plans, impacted localization, configuration, enhancement, etc and shaped the resulted organizational changes. The study reveals that implementation of Koha in AAUL resulted in a cataloguing routine that was different from the old, the envisaged, and the work process inscribed into Koha. The implementation process and the outcome have changed the cataloguing routine, relationships among the library staff and their mindsets. The findings show that the library had opted for changing the old cataloguing routine towards the routine inscribed into Koha as mediated by its plan, the opportunity offered by Koha and expertise limitations apparent during the time. As a result it gave less emphasis to intermediate steps of transformation. For example, due to the plan to abandon cards, the opportunity offered by Koha to avoid the use of proprietary database (Bibliofile) and the limited techno-scientific capacity, developers gave less priority to making Koha able to produce cards and interface it with Bibliofile. As a result catalogers (users) were forced to use the old system (Bibliofile) for producing cards and they manually populate Koha with data.

The implementation of a new system in the library has extended the cataloguing routine. This change can be analyzed by considering the ostensive, performative and material aspects of routine (Feldman & Pentland, 2003; Volkoff, Strong, & Elmes, 2007). The ostensive aspect of the cataloguing routine, i.e., the process of making books accessible to users, remained stable. However, the specific actions of making books accessible to users in AAUL, the performative aspect of cataloguing, were changed, i.e., the cataloguing routine in practice was changed. The performative cataloguing routine was extended because of lack of expertise to embed some of the manual activities into Koha, i.e., lack of expertise to give
material form to activities. For example, interfacing Koha with Bibliofile would have given material form to the manual activity of exporting data from Bibliofile and feeding them to Koha.

Openness of source code and community-based development model are core characteristics of OSS and these are the very elements that have shaped the implementation process and its outcome in AAUL. The OSS license offered the library to acquire Koha free of charge and the freedom to study, modify and implement it (Neumann, 2005; von Hippel & von Krogh, 2003). The community-based development model facilitated the participation of developers and users (of Koha) around the world in the adaptation, configuration and implementation processes. Due to the nature of the software and the development model, localization and implementation became the responsibilities of mainly inexperienced and less skilled local developers. Had the developers were knowledgeable and experienced with the technologies of Koha, adaptation and intermediate solution provision would have been much easier. However, it was not the case in AAUL. As a result, openness of the software and the development model contributed a lot towards the implementation outcome and the unfolded changes.

The study reveals that lack of expertise and a plan that tended towards introducing a radical change without considering step-by-step development risks IS implementation and extends organizational routines unnecessarily. Even if OSS offers the opportunity for localization, it could be affected by the existence of local capacity. The resulting organization changes due to the implementation of OSS by following the community development model could be different from proprietary system implementation because of skill and expertise differences and obstacles in developing countries.

5.1.5. Paper 5


This paper investigates the OSS adoption trajectories of two public sector organizations in Ethiopia in an attempt to understand the micro-processes of adaptation, implementation, enhancement and indigenous technological capacity development. As indicated in paper 4 above, the implementation of an OSS–based library system has unnecessarily extended the
cataloguing routine in AAUL. This research investigates the micro-processes of adaptation and implementation in AAUL and the college of Telecommunications and IT library (CTITL). The study tried to answer the questions: How to make use of the distributed environment to facilitate end-user OSS implementation in the public sector of Developing countries? How can Developing countries develop technological capability through OSS implementation? What is the role of information infrastructure in stimulating learning in a distributed environment?

Contrary to the traditional practice, the implementation of Koha in AAUL and CTITL were results of collaborative efforts among locally co-located and globally dispersed actors that shared experiences, knowledge, technology and value mainly voluntarily. The developers who were embedded in the local socio-technical context acquired an OSS, studied the code, and upgraded their knowledge and skill through the voluntary support of developers and users that are dispersed across geography, organization and time. The association of local and international partners and the sharing of experiences, knowledge, code and best practices made implementation of Koha in the two libraries possible.

The need to make use of Koha in the two libraries triggered practice-based learning and sharing processes involving local and global actors through the mediation of the information infrastructure. The development of Koah in AAUL facilitated for local experts from different departments of the same university that have different background, knowledge and experience to come together, and learned and shared their knowledge, experiences, best practices, solutions, documents, etc among themselves being situated in the local socio-technical context. Although this arrangement did not last longer, it had created an environment conducive for the developers in the library to acquaint themselves with the technologies of Koha, and the tricks of integrated system installation, configuration, customization and administration through formal practice-based trainings and by working together with experienced and knowledgeable experts. The rest partners also acquired knowledge on a new system and a new practice.

The developer in CTITL who is also a librarian by training learned about OSS, Koha, its source, best practices, etc from AAUL. Unlike the developers in AAUL, this person did not benefit a lot from local partnerships rather sought advice from the global developers/users of Koha by posting inquiries and studying email archives. The developers in AAUL also relied more on the global Koha developers/users and Koha’s email archives to customize,
install, configure and enhance Koha once these activities became their responsibilities in full.

The developers in the two libraries exploited the voluntary support of Koha developers and users that were dispersed across space, organization and time in the course of understanding, localizing and implementing Koha in their respective libraries. The developers posted inquiries and studied archives of mailing lists to advance their understanding, improve local practice and solve problems. Analyses of the postings from and to the local developers suggest that the locals have learned the technologies of Koha; the tricks of customization, implementation and enhancement; and improved the level of detail, relevance and completeness of inquiries they were posting. The local developers assimilated the advices and implemented the changes although there were advices and suggestions which were not implemented especially by the developers in AAUL. Among the implemented two modules, one of them was not properly configured and it was not offering the required functions to users. Furthermore, the pace of development with new releases was slower in AAUL than CTITL which finally led the library to announce for its willingness to pay for the services of migration to new releases and further customization of Koha in AAUL.

CTITL however was utilizing all the functions of Koha even by including full text materials and customizing Koha as its own web site. It was keeping abreast of new releases relatively faster than AAUL. The developer started translating Koha into one of the local languages and it had attracted other local developers that were not based in either of the libraries. The developer finally learned to post relevant inquires, able to understand and implement fixes, customize Koha according to local needs, implement Koha, incorporate additional features, change the look and feel of Koha, and migrate to new releases whenever there were such releases. He also advised some local libraries on best practices, technologies and OSS in general and Koha in particular but it was limited.

The two cases reveal that by participating in shared OSS implementation activities local developers in Developing countries can learn technologies and the tricks of adaptation, implementation and enhancement. The participation of local developers in the implementation process was shifted from the periphery to the center through practice, learning and interaction with old timers. However, the level of centrality could be different
for the two groups of developers which can be apparent considering adaptation and implementation levels of Koha and the reactions of users in the two libraries.

Furthermore, the cases disclose that even if OSS implementation facilitates the development of technological capacity, it demands a certain level of previous knowledge. The previous skill and knowledge of the developer in CTITL in related technologies helped him to learn the technologies of Koha faster than the developers in AAUL. This suggests developing countries to give due attention to develop local capacity that can be able to absorb and work with local and global peers. The arrangement in AAUL to make use of local IT expertise was a good strategy to introduce developers to the technologies of Koha through formal training and practice even if it did not continue. Besides making use of Koha in their respective libraries, the local developers were serving as knowledge hub for local libraries in Ethiopia concerning Koha, although the sharing of experiences and resources among the locals was limited so far.

OSS implementation projects in Developing countries are therefore required to consider higher participation in the global arena and devise mechanisms to network locals among themselves. Further localization could be possible and easier if more developers join the effort.

5.2. Summary of Key Findings

The following table summarizes key findings of the five papers discussed above in terms of aim, research setting and methods, and key findings.

<table>
<thead>
<tr>
<th>P#</th>
<th>Aim of the paper</th>
<th>Context and Methods</th>
<th>Key Findings</th>
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<tbody>
<tr>
<td>1</td>
<td>To explore issues and challenges of IS implementation.</td>
<td>ARTIS implementation in the public health care sector of Ethiopia. Interpretative case study.</td>
<td>• The mere existence of a dire need for an IS does not guarantee smoother implementation or shrinks implementation down to technical matters. Especially, in the context where donors play significant roles and are interested in similar processes, like in the public health sector of Ethiopia, IS implementation becomes complex, challenging, and involves negotiation and displacement of interests. • IS implementation in the public health sector of Ethiopia was not just a technical problem solving exercise but a complex socio-technical process where various circumstances and events shaped both the process and its outcome.</td>
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<tr>
<td>#</td>
<td>Aim of the paper</td>
<td>Context and Methods</td>
<td>Key Findings</td>
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| 2 | To explore embedded interests, translations, and socio-technical order formation. | ARTIS implementation in the public health care sector of Ethiopia. Interpretative case study. | • Implementation success depends on the strength, flexibility, and expandability of the constructed actor–network, and on successfully countering against the counter network.  
• The adopted development and implementation strategy brought global actors that had the expertise of dealing with social, technical, political, and organizational matters and their resources, and less experienced local practitioners together into a group.  
• The implementer group planned and acted together in each and every aspect of the implementation process. The less experienced practitioners participated in, and later led, the entire implementation and expansion process. They had legitimate access to resources, stories, etc.  
• The practitioner group developed a unique identity through practice, meetings, workshops, conferences, etc.  
• The OSS nature of the ARTIS (free software and service) strengthened the negotiation power of implementers and attracted other local and global actors. The philosophy and practice of ARTIS has reinforced and strengthened the ARTIS actor-network.  
• ISs could be embedded with actors’ interests, which would have profound effect on performance, behavior, and structure of adopting organizations. These interests specify current and future operational environments and the functions they can provide to current and future users; and features and functions may not consider realities of the use contexts.  
• The development of an IS could be selective to contextual matters, technologies, features, functions, ideologies, and strategies that are important to attract others, form alliances, and assure continuity of socio-technical orders regardless of realities in implementation contexts, importance of these features, and still compromise the overall performance of an IS.  
• Socio-technical networks could reflect the interests, ideologies, and strategies of the dominant and the powerful actor, the one that defines both the problem and the solution, and produces and achieves collective goals. These elements could resist future counter changes due to the magnitude of supporters they mobilize.  
• The same role could be allocated to human and nonhuman actors at different times and locations due to the need to continue socio-technical orders despite their negative implications on efficiency and effectiveness. Role allocation could not be a function of the effort required to perform tasks rather, it could be a function of the negotiation and compromise between data quality and overall sustainability of a socio-technical order.  
• The choice of development technologies and ideology, role enactment and distribution, and feature and function additions target mainly at excelling others and defining and reinforcing a socio-technical network at the expense of improved performance, decision making, and organizational effectiveness.  
• The adopted implementation strategy that blurred the global/local dichotomy of experts in local actions strengthened... |
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<th>Aim of the paper</th>
<th>Context and Methods</th>
<th>Key Findings</th>
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<tbody>
<tr>
<td>1</td>
<td>To explicate interpretations, subsequent actions, and behaviors of key stakeholder groups towards OSS and to identify the elements and processes that shaped interpretations.</td>
<td>Implementatio n of Koha in Addis Ababa University Library. Interpretative case study.</td>
<td>• The capacity development strategy and the attempt to network actions within and outside of the nation assured continuity and boosted the beneficiaries’ reliance on the established socio-technical network.</td>
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</table>
| 3 | To explore the organizational changes and roles of aspects of openness of software in the change. | Implementatio n of Koha in Addis Ababa University Library. Interpretative case study. | • Major stakeholder groups in AAUL (users, technologists and the management) interpreted OSS differently and the difference challenged the implementation process and its outcome.  
• The interpretation of the management and technologists was framed around the strategic importance of OSS such as to build knowledge hub and advance implementation throughout the country. Users stressed on immediately solving drawbacks of the old system, and demanded third party support, existence of full functions, and availability of local expertise that would be able to customize, install and enhance the software.  
• Users interpreted features of Koha in terms of the knowledge and experiences of implementers, responses to bugs and their timing, and their lack of participation in customization processes.  
• The interpretations of key stakeholder groups were shaped by nature of the software, lessons from past automation efforts, change of the management style, and political processes.  
• Knowledgeable and experienced employees were denied active participation, collective decision-making style was damaged, and staff mobilization became difficult.  
• An intervention aimed at solving perception differences and subsequent actions denied the active participation of knowledgeable and experienced employees.  
• The inherent ambitions of the staff to change image of the library to the better and the changed management style from participatory to authoritarian contributed positively to the outcome.  
• The research suggests the importance of bringing the expertise arrangement that exists along with an OSS product to the forefront in negotiations related to OSS implementation. |
| 4 | | | • The OSS license allowed AAUL to acquire, study, modify, and utilize an integrated library system. Adoption of OSS also avoided the often lengthy bureaucratic negotiations and associated corruptions apparent in the public sector.  
• There was a gap between the work processes inscribed in to Koha and the actual cataloguing routine, and between Koha and the planned cataloguing.  
• The implementation of Koha in AAUL resulted in a cataloguing routine that was different from the old, the envisaged, and the one inscribed into Koha. It has also changed relationships and mindsets of the library staff.  
• The library opted for changing the old cataloguing routine towards the routine inscribed into Koha as informed by its plan, the opportunity offered by Koha, and expertise limitations.  
• Intermediate solution provision was avoided partly due to lack of expertise and the plan to implement an ideal system. |
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<th>P #</th>
<th>Aim of the paper</th>
<th>Context and Methods</th>
<th>Key Findings</th>
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| 5   | To investigate the micro-processes of OSS adaptation, implementation, enhancement and indigenous technological capacity development. | Implementatio n of Koha in Addis Ababa University Library. Interpretative case study. | • The implementation of Koha unnecessarily extended the work practice of the cataloguing routine.  
• Due to the nature of the software (OSS), localization and implementation became the responsibilities of inexperienced and less skilled local developers. Inability of local developers to give material forms to some activities unnecessarily extended the cataloguing routine.  
• The study reveals that lack of expertise and a plan that tends towards introducing a radical change without considering step-by-step development risks IS implementation and extends organizational routines unnecessarily.  
• Even if, in principle, OSS offers the opportunity for localization and the freedom to study, change, and distribute OSS, all depend on the availability of local expertise and the adopted strategy to make use of the globally distributed expertise.  
• The implementation of Koha in AAUL and CTITL were the results of collaborative efforts among locally co-located and globally dispersed actors. They shared experiences, knowledge, technology, and value mainly voluntarily.  
• The developers who were embedded in the local socio-technical context acquired an OSS, studied the code, and upgraded their knowledge and skill through the voluntary support of developers and users that are dispersed across geography, organization, function, and time.  
• OSS triggers practice-based learning and resource sharing involving local and global actors through the mediation of the information infrastructure.  
• OSS implementation facilitates collaboration and learning among experts of different backgrounds regardless of functional, organizational, time, and geographical boundaries. Each of the participants learned something by involving in local practices, by studying email archives and by posting inquiries to developers/users of the specific software.  
• OSS implementation offers the opportunity to develop skills that are necessary to download and make use of software but demands a certain level of knowledge to absorb advices, read codes, understand help lines, and resources.  
• Hybrid expertise (knowledge of both IT and the domain) is an advantage in OSS customization.  
• By participating in shared OSS implementation activities local developers in developing countries could learn technologies and the tricks of adaptation, implementation and enhancement. They can also benefit a lot if such efforts are coordinated among the locals themselves.  
• OSS implementation projects in developing countries are required to consider higher participation in the global arena and devise mechanisms to network among themselves. |
5.3. Synthesis and Discussion of Findings

The aims of this dissertation, as stated in chapter 1, is to propose an implementation approach that seeks to bring together the resources and actions of globally distributed actors into a situated implementation practice and to shift the focus of attention to communities and practice as a means to circulate knowledge and facilitate innovation with IS. In order to achieve the aim, the dissertation draws upon the following interlinked research questions:

**RQ1:** What are the affordances and constraints of the philosophy and practice of OSS towards OSIS implementation in developing countries?

**RQ2:** What are the conditions that advance a situated OSIS implementation work practice and the movement of knowledge among similar practices in the context of globally dispersed and loosely coordinated OSIS implementers?

**RQ3:** How can the actions and resources of globally distributed practitioner communities that are engaged in a similar OSIS implementation practice alleviate the challenges of IS implementation in developing countries?

This section synthesizes the empirical findings of the appended papers along the lines of the research questions, and discusses them in light of the notions of work practice, learning, knowledge circulation, and innovation in situated and trans–situated contexts, building up on the notions of CoP and NoP theories as discussed in chapter three. The following table presents synthesis of the findings, followed by a discussion section.

### Table 12: Synthesis of findings in relation to research questions

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<th>Research Question</th>
<th>Paper</th>
<th>Key Findings</th>
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<tr>
<td>What are the affordances and constraints of the philosophy and practice of OSS and OSIS implementation in developing countries?</td>
<td>1, 2, 3, 5</td>
<td><strong>Affordances</strong>&lt;br&gt;• Code openness, free availability and community participation in OSS facilitate the establishment, strengthening and expansion of an actor–network, diminish the competitive advantage of competitors, and hence, play significant roles in reinforcing actor–networks and counteracting against counter networks.&lt;br&gt;• The nature and characteristics of OSS strengthens the negotiation power of implementers and attracts other actors aboard an implementation network regardless of barriers such as organization, function, time, and geography.&lt;br&gt;• The noninvolvement of acquisition cost attracts resource-constrained</td>
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The philosophy of OSS opens up the means for networking the situated practices of globally dispersed actors. It creates an opportunity for actors that are dispersed around the globe to take part in situated practices at different levels and capacities. For example, participation ranges from recommending and effecting technical improvements to directing to solutions.

- OSS gives unprecedented opportunities to local practitioners to study, change, adapt software, and establish relationships with global communities that are engaged in similar practices.

- OSS triggers practice-based learning and sharing of knowledge, source code, help, advice, and other resources within and communities of practitioners.

- OSS facilitates for the emergence of loose epistemic practitioner communities that are dispersed around the globe.

- The philosophy and practice of OSS shifts the responsibility of leading and implementing systems to practitioners of developing countries than those who develop systems.

### Constraints

- Those who develop systems may not directly lead and participate in implementation, and hence, development expertise may not directly benefit implementation.

- Concentration of technical support and focus of attention on latest releases constrain the effort of making use of past releases.

- Lack of up to date documentations constrain learning and systems implementation.

- Beneficiaries could interpret the OSS technology in terms of the expertise of local practitioners and lack of direct third party support, instead of looking into the wider developer and user communities of an OSIS.

- Similar to other imported technologies, an OSIS suffers from context disparity and inscribe work processes that are different from the work practices of the implementation context, creating design–reality gap.

- Global dispersion of actors’ limits direct involvement in local situated implementation practices and hence, knowledge sharing, especially limits involvement of global actors in local social and organizational matters.

- Because of constraints, OSIS implementation could be challenging and may unnecessarily extend organizational routines.

### Collocation, mutual engagement, and socialization

- Global actors that had the experience of implementing related systems in different but similar contexts brought the expertise of dealing with social, organizational and technical matters and resources in to a local implementation practice.

- Presence of experienced and skilled global actors in an implementation site in time and space.

- The group, which was composed, of local and global practitioners engaged in a mutual negotiated implementation work practice.
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<th>Key Findings</th>
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| among similar practices in the context of globally dispersed and loosely coordinated OSIS implementers? | 1, 2, 5 | • The global actors shared implementation accounts of related systems in the same and different contexts to the less experienced newcomers.  
• The ARTIS group organized and participated in meetings, conferences, and workshops with the presence of key stakeholders mainly to promote the system.  
• AAU Library established a local group composed of individuals who developed expertise in the technologies of Koha. |
| Legitimate access to implementation accounts | | • The implementation of an OSIS could be facilitated through access to the implementation accounts of practitioners dispersed around the globe. In the case of ARTIS, the global actors shared implementation accounts through stories, research reports, and formal education.  
• The users’ mailing lists was the main source for the implementation accounts of Koha in different sites around the globe.  
• The implementer group composed of old timers and newcomers, in case of ARTIS, shared implementation stories through reports and informally discussed issues, plans, actions, demands, etc. |
| Documentation, communication and resource sharing | 5 | • Availability of documentations such as design documents, implementation stories, and manuals were crucial for local practitioners to acquaint themselves to technologies, understand logics and perform implementation activities.  
• Documents dealing not only with technical and functional matters but also with OSS, its success and the particular software (Koha in this case) were important for facilitating implementation.  
• Help lines in the source code that communicated structure, purpose, and logic of a particular code were core for creating common understanding and communicating intent.  
• The local practitioners demanded support and solutions from the globally dispersed actors through electronic mail. The inquiries ranged from asking for a direction/document to how to do a certain task. The responses ranged from providing necessary directions to code solutions. |
| How can the actions and resources of globally distributed practitioner communities that are engaged in a similar OSIS implementation practice alleviate the | 1, 2, 5 | Voluntary actions  
• The voluntary actions and resources of globally distributed actors significantly reduce financial resources that would be incurred otherwise.  
• Free availability of OSIS, resources and services open up opportunities for developing countries to facilitate IS implementation and use.  
Collaboration in practice  
• The open collaboration in OSIS implementation attracts interested, knowledgeable and motivated practitioners from around the globe into a practice.  
• The participation of globally distributed actors in a local practice, or |
challenges of IS implementation in developing countries?

**Key Findings**

- Mutual engagement of practitioners, alleviates the prevailing techno-scientific knowhow limitation in developing countries, thereby facilitating socio-technical change in a given context.

**Techno-scientific knowhow development and sustainability**

- The participation of local actors in OSIS implementation practices coupled with the philosophy of OSS, paves the way for knowledge circulation and learning. The arrangement allows local practitioners to be full-fledged member of a community around specific software and the OSS community in general. Learning becomes continuous, evolving and sustainable.

- The implementation practice that involves globally distributed actors, legitimate access to global repositories that accounts for implementation practices of a software in different sites, and the everyday learning–in–working could possibly sustain capacity development and hence, implementation.

- IS implementation is continuous and evolving phenomena and the social and technical arrangement around OSIS implementation would be suitable to deal with such matters.

**Knowledge and best practice circulation rather than transfer**

- Shifting attention away from trying to transfer knowledge and best practice, to concentrating on the emergence of communal practices and epistemic groups across the globe would benefit IS implementation in developing countries.

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**5.3.1. Tensions between affordances and constraints of OSS**

The philosophy and practice of OSS have changed the organization, form and principles of IS implementation in developing countries in many respects. It has shifted implementation responsibility away from those that have developed expertise on a specific system to users that are new to technicalities of a system, and to less experienced and less skilled practitioners. The implementation process encompasses managing, streamlining and directing voluntary actions and resources of loosely coupled globally distributed actors as well as managing technical, social, political and organizational matters towards a successful end. Unlike traditional implementation approaches, OSIS implementation demands local practitioners to develop technological capacity that makes them able to configure, enhance, and change a given system according to local requirements as well as develop competence in making use of distributed resources. Furthermore, capacity development and implementation have become practice-based processes that can be shared among locally
situated and globally distributed practitioners with the mediation of the Internet information infrastructure.

Frequent software update and early release are features of OSS that have got prominence and contributed to the success of OSS (Raymond, 2000). They tell the high frequency and continuity of change and go in line with continuous, evolving and incremental changes that organizations exhibit. However, they could limit movement of knowledge and similarity of practices across sites because of version difference and concentration of attention and resource on latest releases. Practitioners’ focus on latest releases and lack of up to date documentation that explain design, logic and operation compromise common understanding development, knowledge sharing and implementation practices, as indicated in papers 3 and 4.

The strength of OSS lies upon the global arrangement of expertise and resources (Raymond, 2000; von Hippel & von Krogh, 2003). The global arrangement is especially relevant to developing countries to address the challenges of resource and expertise limitations. However, organizational members could interpret an implementation practice from local practitioners’ knowledge and expertise perspective instead of considering the wider socio-technical arrangement. The global socio-technical arrangement in an OSIS development and use may not be visible to organizational members. Furthermore, similar to commons-based production, implementation of an OSIS could suffer from motivational and organizational challenges (Benkler, 2002, 2006). Individual contributors may not get material reward and coordination of human effort and integration of contributions could be challenging. As a result, an implementation process could face the challenges of staff and resource mobilization at a local level as reported in paper 3.

Similar to other imported technologies, an OSIS could suffer from country context disparity and may inscribe work processes that are different from work practices of an implementation context, creating design–reality gap (Heeks, 2002). Furthermore, global dispersion of actors’ limits their direct involvement in situated implementation practices, and hence, compromise the movement of knowledge, especially limits involvement of global actors in local social and organizational matters of an implementation. Because of these constraints, implementation of an OSIS could unnecessarily extend organizational routines and, as a result, affect relationships among different stakeholder groups in an organization.
as discussed in paper 4. There is a tension between global distribution of practitioners and situatedness of OSIS implementation for the emergence of a communal work practice.

Although the above elements inhibit OSIS implementation, there are many elements of OSS that facilitate collaboration, sharing, capacity development and, ultimately, the practice of OSIS implementation in developing countries. Among the bottlenecks of IS implementation in developing countries are financial resource and techno–scientific knowhow limitations. The changed philosophy of software ownership, the copyleft principle (Raymond, 2000) and the communal practice (Benkler, 2002, 2006; G. Lee & Cole, 2003) allows resource constrained organizations to acquire software, share global knowledge and resources, and get technical support free of charge. As indicated, IS implementation is a socio–technical process that involves different stakeholders with divergent interests, power relations, and involves politics besides the technical. OSS facilitates for the establishment, strengthening, and expansion of an actor–network around implementation, reduces the competitive advantage of competitors, and hence, plays significant roles in reinforcing actor–networks and counteracting against counter networks as discussed in papers 1 and 2. At a normal circumstance, free availability of software and service outweigh proprietary software, and hence, strengthens the negotiation power of implementers. For example, the automation plan in AAU Library that was started in the end of the 1980s finally concluded in 2004 because of OSS.

The open participation attracts local and global actors aboard an implementation network. Openness of code gave unprecedented opportunities for local practitioners to study, integrate, and adapt software. The OSIS implementation practice serves as means to network the actions of practitioners engaged in similar practices regardless of barriers such as organization, function, time, and geography. It also creates an opportunity for practitioners that are dispersed around the globe to take part in local implementation activities at various capacities ranging from recommending solutions and effecting technical changes through sharing best practices to directing to solutions. OSS triggers practice–based learning and sharing of knowledge, code, help, advice, and other resources within a local group and between global and local actors as indicated in paper 5. OSIS implementation demands and facilitates the emergence of a local epistemic group.

There is a tension between affordances and constraints of OSS as discussed above. The success of an implementation, then, depends upon the degree to which an implementation
approach addresses the tension. This dissertation argues in favor of laying down the necessary conditions that facilitate for the emergence of a communal practice. The development of a communal practice facilitates for the circulation of knowledge and best practices among practitioner communities engaged in similar practices regardless of boundaries such as geography, organization, function and time as discussed below.

5.3.2. Conditions that facilitate OSIS implementation

The production of OSS involves centrally managing the distribution, development and integration of modules, and versioning and releasing of an integrated system. The roles of distributed developers have been to contribute code snippets or modules. OSIS implementation, on the other hand, is concerned with making use of a “finished” product by an organization and keeping up to date with releases and enhancements. Those who developed expertise of a system at the time of production have little role and effect in implementation, especially in the case of system that are produced in a commons-based organization model. Managing technical, social, political and organizational issues of an implementation as well as the actions and resources of globally distributed actors rests upon beneficiaries. Furthermore, because of country context differences (Heeks, 2002), the role of agency at the time of production and use (Orlikowski & Barley, 2001), and inability to exhaustively determine the pattern of use of a technology at the time of production (Bijker & Law, 1992), similar to other technologies OSISs also require adaptation to use contexts as part of the effort to put them into use. The adaptation displaces some aspects of both the use context and the technology in a continuous basis (Feldman, 2000; Heeks, 2002; Orlikowski, 1996; Tsoukas & Chia, 2002). In an OSIS implementation, practitioners that are engaged in similar practices but dispersed across the globe share knowledge, resources and these challenging systems implementation tasks as discussed below.

5.3.2.1. Mutual engagement in a communal practice

OSIS implementation is a complex situated work practice that involves social, technical and organizational elements; global technological arena and its actors, as discussed in chapter 3 also influence it. Practice is the only vehicle for circulating knowledge (both explicit and implicit) among practitioners (Brown & Duguid, 2001; Duguid, 2005; Orlikowski, 2002) and it is temporally, materially, and socially situated action. In a situated practice, newcomers work together, interact face to face, negotiate meaning, share stories with old timers, and
get access to information repositories to learn tricks of a practice. Through mutual engagement, socialization processes, legitimate access to periphery of a practice and to shared repertoire, newcomers learn not just the practice but they learn to be practitioners (Brown & Duguid, 1991; Vaast, 2004). The CoP engages in communal practices and holds communal knowledge. The implementation of ARTIS features such characteristics of a community of practitioners such as collocation of actors in space and time, collaborative engagement, creating and sharing of stories, and constructing meaning that was applicable to address a particular problem in a specific context and communal identity.

The implementation of ARTIS brought skilled and experienced global actors and less experienced local practitioners together in to a group. Distinguishing between global and local practitioners was not possible. The global actors that had the experience of implementing related systems in different but similar contexts brought with them the expertise of dealing with social, organizational and technical matters as well as resources in to a situated implementation practice. The group engaged in a mutually negotiated implementation work practice and socialization processes. Members of the group acted together, created and exchanged development, implementation, strategy, challenge and success related stories. They also organized and participated meetings, conferences, workshops, etc and produced collaborative research outputs. These processes ultimately resulted in a shared understanding of the implementation work practice and the construction of individual and group identities. The accumulated insight is not a private substance but a socially constructed one. The individual practitioner and HISP, as a group, was regarded, internally by members and externally by others, as champions of OSS. The socially constructed meaning reflects the views of the group towards social, technical, political and organizational matters of OSIS implementation in time and space, which others such as competitors, for instance, may have a different perspective.

The implementation of Koha in AAU Library followed a similar trajectory of establishing a group that was composed of experienced and less experienced individuals similar to ARTIS but with a different team composition. The group was composed of local actors only; it did not have the expertise of implementing integrated front-end systems like a library management system, and hence, lack the expertise of dealing with social, political and organizational issues; and were novice to Koha. The experienced practitioners, however, had expertise in the technologies of Koha such as the programming language (Perl) and database management system (MySQL) and its operating platform, Linux operating system.
and Apache web server technology. They were also expert in computer networking including client/server architecture that Koha was running on. The group formation was not bound to the structure of the library rather it looked into expertise at least from within the University.

The group engaged in learning-in-working sessions of installing and configuring Linux and Koha, and coding (programming) with Perl although it was on a test server. The OSS created an occasion for local practitioners to come together, engage in practice, learn from old timers, and circulate knowledge. The process allowed newcomers to become insiders. This form of mutual engagement served as a springboard for succeeding implementation activities of Koha in AAUL.

Mutual engagement serves a dual purpose here: it helps to improve practice through collaboration as well as helps to circulate knowledge. The discussions show the importance of mutual engagement in practice for newcomers to acquire knowledge that makes them able to act in a socially recognized ways, share the particular community’s subjective viewpoint and speak its language.

5.3.2.2. Legitimate access to implementation accounts and documentations

In a trans–situated context, like in the case of a commons-based OSIS implementation, mutual engagement in a situated practice may not be possible, but individuals and groups engage in similar practices in sites that are distributed across the globe. Nevertheless, practitioners create and share implementation stories, socially construct specific viewpoint on the nature of software (code openness, free distribution, copyleft license), and development and implementation organizational forms (individual-driven, global distribution and loose coordination), maintain and perpetuate group and individual identities using the Internet information infrastructure.

In OSIS production, practitioners voluntarily and freely devote personal resources and services for the good of the public (von Hippel & von Krogh, 2003). They build electronic information repositories that reflect various aspects of a given system’s development and implementation such as designs, changes, communications, implementation stories, news, views, success stories, etc (Ducheneut, 2005). Koha features such a shared information repertoire for both the developer and user communities. The user community creates and exchanges information about the implementation of Koha in different sites across the globe.
It features specificity, in a sense that the information deals with a situated practice, and it could be adaptable, i.e., permits new interpretations that can be used in new contexts.

The practitioners in the two libraries facilitated the implementation of Koha by accessing implementation accounts and interpreting problems in light of the accumulated data. The practitioners sought solutions for inquiries that were not yet answered by the user community from the accumulated data. Similar to the photocopy repair technicians that created and exchanged stories and ultimately constructed meaning out of the conflicting and confusing data by engaging separately in multiple sites with different challenges and machines, the Koha implementers created and exchanged implementation stories in different contexts and constructed meaning that are important to address challenges of a practice in a new context. However, unlike the rep's, Koha implementers did not have the chance for a face-to-face interaction with the global actors or with those who created and shared the stories.

In addition, documentations that deal with not only the specific software and its successes but also the success OSS in general played roles in dealing with social aspects of implementation processes. This is particularly evident in the decision of the AAU Library management to adopt the decision of OSS customization by considering success stories of Koha, status and prospect of OSS, and strategic importance of OSS to the Library and the country as a whole. Help lines in the source code of software were also essential in communicating structure, purpose, and logic of a particular code snippet and its relationship to the whole system, and in ultimately creating common understanding and communicating intent.

Although practice is materially, temporally and socially situated action, globally distributed practitioners could build useful information repository that reflect implementation accounts of an OSIS in a specific context, which could be adaptable and useable to new contexts. Legitimate access to such information repository allows newcomers to develop common understanding of the practice.
5.3.2.3. Communication and mobilization of resource

In a co-located practitioner group, such as in a CoP, individuals interact face-to-face to get a work done. The face-to-face interaction creates an ideal situation for circulating knowledge within the practitioner community. In the absence of face-to-face interaction, however, IT mediates the communication. In an OSIS implementation, the communication focuses on addressing implementation problems, and exchanging codes, advices and solutions. The communication could take different forms, but electronic mail was the sole means for direct communication among practitioners. In the implementation of Koha, the local practitioners demanded support and solutions from globally dispersed actors through electronic mail. The inquiries ranged from asking for a direction/document to how to do a certain task. Some of the questions were unanswered, and responses ranged from providing necessary directions to code solutions. As indicated in paper 5, the responses are practice-based; respondents mention what worked where and why they are suggesting it. The local practitioners effected some of the changes as advised by global practitioners and some of the issues remained unaddressed.

Communications and interactions were not bound to global actors but also included other local practitioners engaged in similar practices. The implementation of OSIS, therefore, involves a range of tools and mechanisms and features presence and absence of global actors in time and space. The implementations, therefore exhibited a range of participation as detailed in chapter 3. From such communal practices, practitioners develop communal knowledge that makes them able to improve the practice of OSIS implementation. The collocation and communal practice have created an environment conducive for the movement of knowledge that is inherent in best practices. As an example, further enhancement of ARTIS and addressing social, political and organizational issues were left to local practitioners, which they successfully carried out.

The critics of CoP theory raise power struggle and unwillingness among members to share knowledge as obstacles to the development of a CoP, ultimately leading to the emergence of a closed epistemic community (Roberts, 2006; Vaast & Walsham, 2009). The very notion of OSS, however, builds upon voluntarism and communalism and it is unlikely not to share knowledge or resources in such a belief and exercise power or gain recognition, as a result, in such circumstances (Benkler & Nisenbaum, 2006). The voluntary practice could bypass
authority and power relations that would inhibit knowledge sharing and learning in epistemic communities.

5.3.3. Distributed collaborative implementation and developing countries

As indicated earlier, OSIS implementation is a distributed phenomenon that brings the actions and resources of globally dispersed actors into a situated practice. The approach renders greater responsibility to practitioners in a situated setting to manage, streamline, and make use of global actions and resources and deal with social and technical matters. The globally distributed arrangement would solve the challenges of IS implementation in developing countries through collaborative action and techno–scientific knowhow development inherent in the process. As indicated in chapter 3, the bottlenecks of IS implementation in developing countries included problem associated with technology transfer conceptualization which shifts attention away from practice, country context differences and associated disparities, impediments in developing countries and fragmented top-down initiatives. The distributed OSIS implementation addresses some of these challenges through voluntary actions and resources of globally distributed actors, collaboration and by focusing on practice as discussed below.

5.3.3.1. Voluntary actions and resources

OSS builds upon voluntarism and communalism; voluntary actions and resources, open participation and copyright that protect copyleft are the bedrocks of OSS. These core characteristics allow developing countries to acquire software at no cost, study, modify and redistribute it, and attract collaborative implementation. Free availability of OSIS and voluntary-based free services and resources significantly reduce financial resources that organization could incur otherwise. For example, free availability of ARTIS and associated services interested health care providers in Ethiopian and diminished the competitive advantages of competitors; the adoption of Koha also significantly reduced financial resources that the libraries would have incurred to purchase proprietary software and train their personnel.
5.3.3.2. Collaboration in practice

OSIS implementation is not an isolated work practice that practitioners in an organization can carry it out alone. The process involves a range of collaborative mechanisms that enhance a situated practice. The open collaboration in OSIS implementation attracts interested, knowledgeable and motivated individuals and communities to take part in a work practice regardless of location, organization, culture, and time. Collaboration ranges from mutually engaging in a situated practice through technology-based resource exchanges to legitimate access to repositories, as indicated in section 3.6.

These social processes facilitate situated practices by permitting the movement of best practices, resources and by providing accumulated data that could help to construct meaning and solution for new situations. Besides the specific OSS communities that are organized around the development and implementation of specific software, the open collaboration attracts anyone interested including the Diaspora to take part in implementation activities. This situation does not only facilitate implementation and paves the way for sustainability, but also averts the prevailing brain drain in developing countries; i.e., the open collaboration in OSS facilitates brain gain by allowing participation despite location and time.

5.3.3.3. Techno-scientific knowhow development and sustainability through practice

Techno-scientific knowhow is the key to implementation, use and sustainability of systems. Lack of it has been playing a negative role in developing countries (Avgerou, 2008; Heeks, 2002; Odedra, 1992). Project-based supports, which usually operate in a fixed time frame and budget, lack of understanding of the multi-faceted aspects of the implementation context, and the notion that “if it works for us, it should work for you” did not solve the problem (Odedra, 1992). In situations where an implementation was successful, sustainability could be questionable because of staff turnover and other related factors. Transferring best practices by codifying knowledge does not work too.

The participation of globally distributed actors in a situated local practice through various mechanisms, including mutual engagement, legitimate access to global repositories that accounts for implementation practices of a software in different sites, source code and related mechanisms for creating common understanding, etc. circulate knowledge inherent in best practices. The arrangement allows new practitioners to be full–fledged member of a
practitioner community that is organized around specific software, by speaking languages of the community, and the OSS community in general. Therefore, it alleviates the prevailing techno-scientific knowhow limitation in developing countries, thereby facilitating socio-technical change in a given context.

Learning-in-working is a continuous and evolving process and it would be sustainable as far as a practitioner community of a given OSIS remains active. IS implementation in organizations also exhibit a similar pattern of continuity, evolvement and improvisation (Heeks, 2002; Orlikowski, 1996). One time appropriation and implementation of a system does not guarantee successive enhancements and sustainable service and functionality. Rather, the characteristics inherent in practice-based learning create a good occasion for practitioners to deal with implementation in a continuous basis. The continuous learning and systems enhancement can also be linked to frequent releases of OSIS.

5.3.3.4. Knowledge and best practice circulation rather than transfer

Systemic and network technologies cannot be transferred from technologically advanced West to developing countries and put into use exactly as they are. Technical, operational and use knowledge are equally important to make use of such systems besides the need to contextualize them according to use contexts. The transfer of best practices from where success is achieved to a new site significantly influences an implementation process and its output. Arranging for distributed implementation shifts attention away from activities associated to the notion of knowledge and best practice transfer to creating an environment conducive for the emergence of communal practices and epistemic communities.

Knowledge and best practices cannot be transferred from sites where success was achieved to new sites but circulate through practice. Practice is the vehicle for circulating knowledge and learning is not just about acquiring knowledge but also identity and acting in a socially recognized ways. Participating in a communal practice just does that. Therefore, focusing on a practice-based distributed implementation shifts attention and effort away from the notion and associated activities of knowledge transfer to circulation. It also creates a unique opportunity and mechanism to network epistemic communities that are engaged in similar practices towards the same end.
CHAPTER 6: CONTRIBUTION AND CONCLUSION

This chapter summarizes the study presented in this dissertation in three sections. The first section presents theoretical and practical contributions of the dissertation. The second section outlines limitations of the study and thereby envisions future areas of research. The chapter ends by providing concluding remarks in section 3.

6.1. Contributions

This dissertation contributes theoretically and practically to the research domain of IS in developing countries. Specifically, it contributes to the study and practice of OSIS implementation by introducing the notions of CoP and NoP theories to understand OSIS implementation work practice, learning-in-implementation, redefine knowledge and technology transfer, and propose a community-focused and practice-based implementation approach as discussed below.

6.1.1. Theoretical Contributions

The dissertation identified aspects of OSS that constrain and promote OSIS implementation in developing countries. It also identified conditions that advance a situated OSIS implementation work practice and the movement of knowledge among similar practices in the context of globally dispersed and loosely coordinated OSIS implementers. Furthermore, it outlined an implementation approach as discussed below:

6.1.1.1. Outline an OSIS implementation approach

The dissertation outlines an empirically grounded community-focused and practice-based distributed collaborative approach for OSIS implementation in developing countries. The approach takes into account features of OSS, the nature and challenges of IS implementation, and the importance of networking of actions to tackle challenges and sustain implementation in developing countries. The dissertation proposes for networking actions across sites by focusing on practitioner communities and work practices according to the notions of CoP and NoP theories. Doing so helps to integrate and deal with OSIS implementation work practice and learning-in-implementation, which are integral parts of everyday life of implementers. It also provides mechanisms to conceptualize knowledge,
knowledge circulation and social construction and perpetuation of work practices and individual and group identities.

The dissertation has extended the CoP and NoP theories to the practice of OSIS implementation. Unlike canonical organizations that the theories have been commonly applied, the organization of OSIS implementation features openness in terms of participation and sharing, and entertain ideals that promote voluntarism and communalism, willingness to share resources freely, and none restriction on what is shared. The contribution of this study also relates to the adoption of an implementation approach that builds upon the notions of CoP and NoP theories, specifically, with regard to work practices, knowledge/knowing, knowledge circulation, learning-in-working, and a focus on practitioner communities as discussed below.

1. **Knowledge circulation in OSIS implementation**

The dissertation provides a new perspective for considering technology and knowledge transfer from technologically advanced West to developing countries. As various studies have attested, technology and knowledge transfer conceptualizations and associated activities did not successfully transfer systemic and network technologies (Braa, et al., 1995; Nhampossa, 2005). Studies have proposed translation, learning and networking of actions as alternatives to the study and practice of technology, knowledge and best practice transfers, and sustainability of actions in developing countries (Braa, et al., 1995; Heeks & Stanforth, 2007; Nhampossa, 2005). Unlike these studies, however, this dissertation provides a different conceptualization of work place learning and best practice and knowledge circulation in OSIS implementation. It shifts the focus of attention away from the notion and associated activities of knowledge and best practice transfer to community-focused and practice-based knowledge and best practice circulation through participation in practice and learning-in-working.

The dissertation argued against the perspectives that promote the notion of best practice and knowledge transfers because 1) best practice cannot be transferred 2) the approaches abstract intricacies of a practice and detach learning from working and the context in which it is learned. It has argued for a perspective that views practice as the vehicle for circulating knowledge and best practices within and among communities of practitioners. The dissertation suggests that participation in OSIS implementation is the
best vehicle for mastering technologies, developing techno-scientific competence, and circulating knowledge embedded in best practices.

The ideals and practices of OSS, such as the sense of community, openness for collaboration, participation, sharing and practice-based characteristics, are ideal conditions for perspectives that support practice-based knowledge circulation, like the one outlined in this dissertation. Furthermore, automatic legitimacy to practice, access to data repositories (implementation stories), source code and related documentations, as well as the will of members to share resources promote the social construction of OSIS implementation, knowledge circulation and the construction and perpetuation of individual and group identities.

These processes are continuous, evolving, incremental and communal and help to deal with continuous, evolving and incremental technology-based organizational change and sustainability. The dissertation shows the possibility of knowledge circulation within a practitioner community and among communities of practices that are engaged in similar practices regardless of geography, time, space, organization and culture.

2. Integrate learning and OSIS implementation

Approaches that separate learning from practice and the context in which it learned could not properly address the intricacies of work place learning (Brown & Duguid, 1991). Furthermore, learning is not just about acquiring rules of the game but also involves self identification and acting in a socially recognized ways (Duguid, 2005). Learning, in this case, is continuous, evolving, and incremental, cannot be separated from everyday practice and can be explained in terms of communities being joined and personal identities being changed (Brown & Duguid, 2001; Duguid, 2005).

The dissertation, therefore, argued in favor of OSIS implementation approaches and strategies that integrate together implementation and learning-in-implementation and deal with these elements in connection with communities and network of practices. Learning does not only involve acquiring facts about the world but also acquiring the ability to act in the world in a socially recognized ways. The process can be well explained in terms of the communities joined and identities that can be displaced as a result. Practice-based and community-focused learning paves the way for new comers not just to understand a practice but also to be a full-fledged practitioner through time.
The ideals and practices of OSS, as discussed above, create an environment conducive for learning-in-implementation and the formation of group and individual identities. Individual and communal efforts such as the construction of implementation accounts, willingness to freely share resources and provision of services at no cost facilitate the social construction of OSIS implementation work practice and address specific problem in a given context in the light of worldview that can be socially constructed out of the accumulated data.

The ideal situation for learning-in-working would be through face-to-face interaction in a situated action and through mutual engagement, socialization processes and accessing repositories, by being member of a CoP. The communities of practice holds collective knowledge because of the communal practice and learning and knowledge circulation would be straightforward. In globally dispersed communities of practice, knowledge circulation and learning depends on the existence of shared embedding circumstances and richness of communications. Similarity of practices across site facilitates the movement of knowledge.

The dissertation has conceptualized the participation of global actors into situated practices to take the form of a spectrum where at the tail are source code and associated documentations while at the wider end are features exhibited in a typical CoP. Through practice, newcomers ascend to the center of the community, meaning that they acquire the tacit and explicit knowledge of a CoP and speak its language. Simply, because of the process, newcomers will become full-fledged practitioners and identify themselves with the community.

3. **Practice and community – alternative notions for networking actions**

Various studies attest to the importance of networking of actions and resources for supporting and sustaining implementation in developing countries and suggest different mechanisms to do so (Braa, et al., 2004; Heeks & Stanforth, 2007). Project-based efforts to network actions and canonical organization-focused networking could suffer from various problems including their very nature such as time limitation, inflexibility, cost, etc. Focusing on practice and communities provides another mechanism for networking of actions. Especially in the context of OSIS implementation, which is a community and practice based phenomenon, shifting attention to the alternative mechanisms would
help to address the challenges of implementation in developing countries in a sustainable way.

4. Distributed collaborative implementation approach

Building upon the above points, the dissertation proposed a community-focused and practice-based distributed collaborative approach. As visually illustrated in section 3.6 Figure 4, a CoP in an organization engages in implementation activities by accessing resources of other CoPs that are engaged in similar practices as well as seeks for the involvement of actors in a situated practice in a number of ways as visualized in Figure 5. Because of similarity of embedding circumstances, and social, historical, cultural and other contextual similarities, communities of practices in given geography could exhibit uniformity than globally dispersed CoPs. The support and movement of knowledge within such a NoP could be different. For example, developers in AAU Library have provided advices and solutions to other developers in another library who were trying to implement the same system based on the specific condition of the Internet technology in the country. Furthermore, local developers were collaboratively engaged in further contextualizing Koha according to the Ethiopian context through the introduction of support for Amharic language, the national language of Ethiopia. These CoPs constitute a national NoPs. The national NoP, in general, features unique elements that would easily circulate within the national NoP but may not easily circulate within the global communities of practice.

The proposed approach, therefore, suggests that mobilization of local (national) CoPs as well as strong attachment to globally dispersed CoPs would facilitate the movement of knowledge embedded in best practices, OSIS implementation, and group and individual identity formation and perpetuation, thereby developing the techno-scientific competence of practitioners, and addressing the challenges of IS implementation and sustainability in developing countries.

Focusing on distributed collaboration as outlined in this dissertation and laying down the conditions for its emergence help to alleviate the prevailing challenges of IS implementation; take advantages of opportunities opened up by OSS; and improve and sustain OSIS implementation in developing countries. The dissertation empirically shows that free availability of OSS and the will, actions and resources of globally dispersed actors by itself and on its own could not address the challenges of IS implementation and utilization in
developing countries and does not make them able to benefit from OSS. Developing competence in exploiting global actions and resources as well as devising appropriate strategies towards the same end are equally important. The dissertation also suggests organizations in developing countries to lay down necessary conditions and mechanisms for the emergence of a local community of practitioners in an organization that would actively take part in an OSIS implementation work practices at national and international levels.

6.1.1.2. Extending the CoP and NoP theories

The CoP and NoP theories have been criticized for not giving due attention to power relations, trust and predisposition (Fox, 2000; Roberts, 2006; Vaast & Walsham, 2009). Power struggle and lack of will to share knowledge were mentioned as obstacles for the development and sustainability of CoPs. Unlike canonical organizations, however, although detailed investigation is required, power in OSIS community relates to frequent communication and willingness of practitioners to share relevant and necessary resources and solutions to others. It is the giving of resources and services that rewards individuals and groups and, which helps to mobilize support and exercise power in OSS; hiding resources and inactive participation is counterproductive and could isolate practitioners or communities rather than benefiting them. Therefore, it could be possible to say that the very nature and philosophy of OSS protect the issues of power struggle and address the will of members to share resources.

6.1.2. Contributions to Practice

The dissertation shows the relevance and importance of focusing on practice and communities of practitioners to facilitate both the practice of OSIS implementation in developing countries and the circulation of knowledge within and among practitioner communities. The dissertation contributes to the practice of IS implementation by showing the importance and mechanisms of networking practices and communities to facilitate collaboration and sharing in implementation. It also shows that although free availability of OSIS is a step forward, by itself and on its own does not address the challenges of implementation in developing countries. The dissertation proposes a mechanism for making use of global resources and actions to address challenges, and improve and sustain the practice of IS implementation in developing countries. The proposed approach could serve as a starting point for practitioners, planners, and decision makers to focus on networking
and sharing aspects and give due attention and resources to it before embarking on implementation projects.

The dissertation provides a mechanism for alleviating some of the challenges of IS implementation in developing countries. The bottlenecks of IS implementation in developing countries has been linked to lack of techno-scientific capacity, the competence that would assimilate technologies, and change and enhance them. This study empirically shows how developing countries and resource-constrained settings could use OSIS to alleviate the challenges of IS implementation and sustainability. There are two possibilities for addressing expertise problems in developing countries. First, engaging in OSIS implementation by itself promotes the development of local technological capacity that would take care of all implementation related activities. Second, networking of practices and open collaboration invites for the participation of individuals and groups around the globe, including the Diaspora, into situated implementation activities. Therefore, practitioners could use the approach to plan for an OSIS implementation.

Furthermore, it helps practitioners and planners to focus on practice and communities as a means to network related local initiatives and globally dispersed actions and resources. The approach allows practitioners to shift attention away from trying to transfer knowledge and best practice and concentrate on the emergence of communal practices.

6.2. Future Researches

This research has investigated into the implementation of OSIS in a developing country context focusing on practice, community, knowledge circulation, and learning and proposed a distributed model to understand and plan for collaboration and sharing evident in the process. The research did not address the following areas and further research would be important.

- This research has applied the notions of CoP and Nop theories in the context where the sense of community and collaboration is very high, the OSIS practice and the Ethiopian context. Some researchers note that in countries like the USA and the UK, where the pursuit of neo-liberalism has eroded the sense of community, communities of practice may be a less effective means through which to organize knowledge creation and transfer (Roberts, 2006). Ethiopians have cultural traits and grass-root institutions that promote the sense of community and collaboration in
practices. These may play positive roles in OSIS implementation and investigation into the relationship between the historically constituted socio-cultural traits of the context and the proposed model would be beneficial.

- Further research into the interaction between the proposed model (or the CoP) and the organizational structure or simply understanding how communities of practices interact with the formal structure of an organization is important.

- Clearly pinpointing what is shared and what is not among CoPs in trans-situated contexts and why would also benefit the notions of knowledge circulation in OSIS implementation practice.

6.3. Conclusion

The research reported in this dissertation has investigated into the micro-processes of OSIS implementation in public sector organizations in Ethiopia drawing upon the notions of practice-based theories. The dissertation explored the relevance and the processes of networking distributed practices, resources, and practitioner communities in OSIS implementation in a developing country context. The research was aimed at outlining an implementation approach that brings together the resources and actions of globally distributed actors into a situated implementation practice and to focus attention on communities and practice as a means to circulate knowledge and facilitate IS innovation. To do so, the research was designed as a qualitative interpretative case study and drew upon the CoP and NoP theories that tend to integrate learning, working and innovating.

Based upon the CoP and NoP theories, the dissertation argued for a shift of attention away from the notions and associated activities of technology and knowledge transfer to a focus on practice-based and community-focused approach for knowledge circulation, learning-in-working, social construction of OSIS implementation work practice and the construction and perpetuation of individual and group identities. The dissertation adopted the perspective that practice is the vehicle for circulating knowledge among communities engaged in communal and similar practices; workplace learning is about not only acquiring facts about the world but also the ability to act in the world in a socially recognized ways and it is a complex social process. Hence, practice and community are important to explain workplace learning.
By exploring the micro-processes of OSIS implementation in the public health and education sector organizations in Ethiopia, the research identified the effects of the ideals and practices of OSS on OSIS implementation and conditions that facilitate for the emergence of communal practices. Code openness, free availability and community involvement could facilitate implementation in developing countries. While concentration of attention on latest releases, lack of direct benefit of implementation from development knowledge, and lack of direct involvement of global practitioners in situated practices constrain implementation. The research identified shift of responsibility of implementation away from original developers to practitioners in developing countries as both an opportunity and a challenge. It is an opportunity because it triggers practice-based learning and it is a challenge because of the difficulty of implementation, lack of expertise and resources in developing countries.

The study shows that co-location of practitioners, mutual engagement, socialization processes, legitimate access to implementation accounts, documentations, communications and sharing of source code, advice and solutions facilitate for the emergence of a communal practice, the movement of knowledge, the social construction of meaning and identity. These elements help to improve practice as well as develop the competences of new practitioners. Based upon the findings, the dissertation outlined a community-focused and practice-based distributed collaborative implementation approach, conceptualized the collaboration evident among trans-situated communities of practitioners and pointed out how it can help to alleviate some of the challenges of IS implementation in developing countries. The research, hence, argued for networking globally distributed action and resources focusing on the notions and associated activities of practice and communities, for a shift of focus away from the notions and activities of knowledge transfer to practice and community-based knowledge circulation, and for an implementation approach that integrates learning and working.
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APPENDICES
IMPLEMENTATION OF AN ANTIRETROVIRAL THERAPY MODULE IN ETHIOPIA: ISSUES AND CHALLENGES

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Abstract: This research was carried out in an attempt to introduce computer-based antiretroviral therapy module in the public health sector of Ethiopia that brought together different technical and non technical elements forming an actor-network. It details how the module is designed, redesigned and implemented in some of the ART Clinics in Addis Ababa drawing upon the notions of moments of translation and inscription of ANT. The moment of problematization was catalyzed by the insufficient capability of the manual system to satisfy the needs of some of the actors and the need to achieve own goals for others. This moment laid down the ground for the development and implementation of the ART module, an encryption designed in accordance with the manual ART system, to be an obligatory passage point for all of the actors as a means to satisfy their own goals. Further to negotiation, flexibility of the design to accommodate local context of use and availability of local capacity to design, change and provide continuous enhancement and support were crucial to interest and bring additional actors aboard the network and to mobilize them and, hence, successfully implement the module, which in turn attracted other actors to join the network.

Keywords: IS implementation, IS adaptation, developing country, actor-network theory, moments of translation, health information system, antiretroviral therapy, inscription.
IMPLEMENTATION OF AN ANTIRETROVIRAL THERAPY MODULE IN ETHIOPIA: ISSUES AND CHALLENGES

1. INTRODUCTION

Development and introduction of IS in organizations is not always a success factor. Some systems fail to work prior to introduction, during introduction or after they are introduced to an organizational setting. Some of the causes of failures can be the project team’s assumption that the computer system would bring about changes in the work practices of personnel (Heath and Luff, 2000); ISs are viewed as objects (Askenas and Westelius, 2000); lack of proper understanding of how automated systems actually are integrated in the work they support (Gasser, 1986); potential fear of lose of control over data (Markus, 1983); denial of the existence of power relations and conflicts in an organization and technology is seen as unproblematic and neutral (Mitev, 2000).

The successful development, introduction and use of IS calls for the involvement of not only technological elements but also the social and local context of use and close interplay between technical, institutional and economical factors (Braa, Monteiro and Reinert, 1995). Technologies, especially systemic, they argue, cannot be transferred but learned through the process of local context based translations. Taking all the actors into consideration is the way to develop and implement systems.

HISP Ethiopia with the support of collaborating countries developed an Antiretroviral Therapy (ART) module with the aim to ensure evidence-based service provision, planning and management of ART and to eventually realize an HIV/AIDS Management System (IHAMS). Consequently the module is implemented in five ART Clinics in Addis Ababa, Ethiopia.

This paper explores the development and introduction of the ART module in Ethiopia drawing upon ANT, particularly, the concepts of inscription and translation under the HISP action research framework (Braa, Monteiro and Sahay, 2004). To this end, the paper sets the theoretical framework and concepts used to explain the case in the following section. The research method is presented in section three followed by a section on staff composition, data collection, analysis and major problems of the manual ART system. Section five discusses the introduction of computer based ART module from ANT perspective. Finally, concluding remarks are given in section six.

2. THEORETICAL FRAMEWORK

The IS literature states user participation and involvement to be essential only to develop systems that adequately capture user requirements and, hence, a system that satisfy user informational needs (Butler and Fitzgerald, 1997). High degree of direct and indirect user participation, therefore, cannot guarantee the successful implementation and use of ISs in an organization. Diffusion of innovations, the theory of reasoned action, the technology acceptance model, the theory of planned behavior, and social-cognitive theory are among the

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\[\text{IHAMS}\]\(^2\) is planned to encompass the management of voluntary counseling and testing, prevention of mother-to-child transmission, opportunistic infections, sexually transmitted infections, home-based care, ART pharmacy, indicators, GIS, service mapping, referral linkage and TB functions.

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core theoretical frameworks that have received widespread validation for many technological innovations. However, they neglect the realities of implementing technology innovations within organizations, especially when adoption decisions are made at the organizational, division, or workgroup levels, rather than at the individual level (Gallivan, 2001).

The outcomes of applying traditional innovation models are sensitive to the fit between the assumptions underlying these models and the specific features of the adoption context and the technology in question. These approaches fail to satisfy the purpose: when the adoption decision is made at the organizational level and employees are mandated to use the technology; for more complex technologies and adoption scenarios which require high levels of coordination across multiple adopters; or where the technology has a high “knowledge burden” (Gallivan, 2001). Instead, technology use and other outcomes depend on implementation activities that must be coordinated and synchronized across many adopters who may be distributed across multiple departments or geographic locations.

The Actor Network Theory (ANT) that has born out of the interdisciplinary field of STS (Monteiro, 2000) helps us deal with the world of hybrid entities (Tatnall and Gilding, 1999). It provides a language to describe how, where and to which extent technology influences human behavior and vice versa at a flexible granularity of analysis (Monteiro, 2000).

Different actors, both human and non human, interact and influence one another while accomplishing tasks forming networks. It is this network that links together the technical and non-technical elements (Monteiro, 2000) which in turn can be a network by itself and/or part of another actor-network.

ANT is concerned with studying the mechanics of power as this occurs through the construction and maintenance of networks.

[ANT] explores the ways that the networks of relations are composed, how they emerge and come into being, how they are constructed and maintained, how they compete with other networks, and how they are made more durable over time. It examines how actors enlist other actors into their world and how they bestow qualities, desires, visions and motivations on these actors. (Tatnall and Gilding, 1999, p. 959)

ANT gives equal explanatory status to all actors (Monteiro, 2000; Tatnall and Gilding, 1999) following the principles of: agnosticism (analytical impartiality), generalized symmetry (no special analytical explanatory status) and free association (the elimination and abandonment of all a priori distinction between the technological or natural, and the social) (Callon, 1986). It considers a path of innovation in which all the actors co-evolve.

Durability of the actor-network is crucial to sustainability and can emanate from the durability of the bonds that hold the actors together and/or from the composition of durable and simplified networks (Tatnall and Gilding, 1999). Here the notions of inscription and translation are very important. The notion of inscription can “describe how concrete anticipations and restrictions of the future patterns of use are involved in the development and use of technology” (Monteiro, 2000, p. 77). The term ‘immutable mobile’ is used to describe such inscriptions to refer to the stable and unchanged nature of the inscription (Tatnall and Gilding, 1999).

Aligning the interests of actors in the network through continues negotiation, brining others aboard and re-interpretation, re-presentation or re-appropriation of an inscription, which is also called translation, assures stability and social order (Monteiro, 2000). The size of other actors brought on the network indicates the amount of power that has been exercised (Latour
Shaping and reshaping of the inscription is essential for its continued existence and spread. Inertia of the innovation cannot account for its spread.

The key to innovation is the creation of a powerful enough consortium of actors to carry it through, and when an innovation fails to be taken up this can be considered to reflect on the inability of those involved to construct the necessary network of alliance amongst the other actors (McMaster, Vidgen et. al. 1997 in Tatnall and Gilding, 1999, p. 961).

Translation involves all the strategies through which an actor identifies other actors and arranges them in relation to each other. It involves problematization, Intéressement, enrolment and mobilization (Madon, Sahay and Sahay, 2004). The actor first problematizes the situation and makes others to develop interest on the innovation and follow it. Following, the actor facing the problem will be convinced that their problem will only be solved by the solution forwarded to them. As a third momentum in the translation process, alliances are consolidated through bargaining and making concessions. Finally, partners are mobilized making them legitimate spokespersons of the groups they claim to represent. This process is facilitated if other possibilities are first blocked off (Tatnall and Gilding, 1999).

This paper explains the development and implementation of an ART module in ART Clinics in Ethiopia drawing upon the notions of inscription and translation as discussed above following the research method presented below.

3. RESEARCH METHOD

The research adopted a qualitative approach with the underlying epistemological and ontological notions of the interpretive philosophy. Accordingly, the phenomenon under investigation is assumed to be subjective which can exist only through the actions of humans in creating and recreating it emphasizing on the subjective meanings, social-political, and symbolic actions of humans (Morgan, 1983, Orlikowski and Baroudi, 2002, Walsham, 2002). Valid knowledge construction and evaluation involves understanding how practice and meanings are formed and informed through in-depth examination of and exposure to the phenomenon of interest (Orlikowski and Baroudi 2002, Walsham 2002). These studies assume that:

“people create and associate their own subjective and inter-subjective meanings as they interact with the world around them. Interpretive researchers thus attempt to understand phenomena through accessing the meanings that participants assign to them.” (Orlikowski and Baroudi 2002, pp: 55)

Anchored in this assumption, the author of this paper collected data concerning the nature and drawbacks of the manual ART system and the development, introduction and rollout of the ART module from ART Clinics in Addis Ababa from March to August 2006. The primary informants of this research were the staff of four ART Clinics in four Hospitals such as the Armed Force and Military General Hospital (AFMGH), Tikur Anbesa Teaching Hospital (TATH) and Zewditu Memorial Hospital (ZMH, Zewditu for short). Besides, the AACAHB is responsible for the overall operation of ART service in Addis Ababa city, the national HAPCO takes care of it at a national level and four USA-Based Universities provide technical support throughout the nation, i.e., all of them have direct interaction with the system. These informants were significant to help understand the overall operation of the

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3 Four universities from the USA such as the University of Washington (I-TECH), John Hopkins University (JHU), University of California (UC) at Santiago and University of Colombia have been mandated to lead all ART related efforts in Ethiopia. To facilitate their activities, Ethiopia has been logically divided into four parts and each part is given to one University.
manual system, pinpoint its drawbacks and regarding implementation and rollout of the module. Zewditu was used as a case to capture the details of ART data creation, collection, compilation, management, flow and utilization aspects of the manual system.

The research mainly employed unstructured interview to collect the necessary data supplemented with onsite observation, discussion and review of both electronic and print documents. Various publications of the FMOH and others on ART and related matters informed this research about the management and coordination structure, and the flow of patients and information at different levels.

Furthermore, as member of HISP Ethiopia, I was engaged in most of the discussions made with different stakeholders, including the above, concerning implementation and rollout of the ART module. I have also participated in the development process through testing/evaluation of the module and reflecting the result back to the developers.

All of the interviews were conducted in the offices of the interviewee while they were on duty. As a result, most of the sessions held at the Clinics and the Pharmacy were full of interruptions predominately by patients. I have transcribed the interview immediately after each session and presented the result back to the informants occasionally. I also have developed an activity diagram detailing the ART process using the Unified Modeling Language and presented the result back to the interviewee for comment. This process was repeated until the activities were properly captured. Altogether, a total of 36 unstructured interviews were conducted as stated below:

<table>
<thead>
<tr>
<th>RESPONDENTS</th>
<th>SIZE</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART Coordinator</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Physician</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Nurse</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Data Clerk</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Pharmacist/ Druggist</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Laboratory Tech.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>AACA HB Official</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Representative of USA-Based</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Universities</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Respondents by specialization and frequency

4. THE RESEARCH SETTING

HIV was first detected in Ethiopia in 1984 and the first two cases were reported to the FMOH in 1986 (FMOH-Ethiopia, 2004a). The population lost to AIDS was about 900,000 by 2003 and it is projected to reach 1.8 million by 2008 if present trend continues. The following table shows the major HIV indicators in Ethiopia.

<table>
<thead>
<tr>
<th>ALL AGES</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult prevalence (%)</td>
<td>4.2</td>
<td>4.4</td>
<td>4.6</td>
<td>4.7</td>
<td>4.8</td>
<td>4.9</td>
<td>5.0</td>
</tr>
<tr>
<td>HIV-pos population</td>
<td>1,361,628</td>
<td>1,474,758</td>
<td>1,590,967</td>
<td>1,706,016</td>
<td>1,820,914</td>
<td>1,930,785</td>
<td>2,037,112</td>
</tr>
</tbody>
</table>
Among the major solutions established to combat the pandemic is ART (FMOH-Ethiopia, 2004a). To this end, the FMOH has developed policy and guidelines that sets the minimum criteria for resource requirements, the management and coordination structure, the flow of a patient, and the report/information flow of health related indicators (see figure 2, 3, and 4) and trained manpower, prepared data collection and reporting forms.

ART may bring the envisaged positive impacts if properly administered with 100 % coverage. Its success is also highly tied to patients’ adherence to regimens which in turn demands follow up throughout the lifetime of patients. However, since ART is supposed to be taken for life and due to the ever increasing size, provision of care and support for patients maybe compromised. The increasing size of patients makes care givers to collect and manage huge amount of data on paper which turns out to be unmanageable in the near future in a resource constrained setting. The tendency can have negative effect on evidence-based service provision, planning and management of the service.

Zewditu is a general hospital that offers In-patient and Out-patient services mainly to patients referred to from health centers in Addis Ababa and other parts of the country, and it is directly accountable to AACAHB. The Hospital started ART in 2003 to patients coming from within the hospital and other health facilities mainly from Akaki/Kaliti and Cherkos sub-cities. Since the beginning of ART until September 8, 2006, 10,356 patients enrolled to ART out of which 5,938 and 3,695 of them started and were on ART, respectively (FMOH-Ethiopia, 2006). The following table presents the composition and responsibility of staff of the Clinic:

<table>
<thead>
<tr>
<th>Staff</th>
<th>Responsibility</th>
<th>Role in Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physician</td>
<td>Diagnose and treat HIV/AIDS patients.</td>
<td>Fill out some parts of intake and follow-up forms, drug prescriptions and different types of test requests.</td>
</tr>
<tr>
<td>Clinical Nurse</td>
<td>Offer service in the Card Room, counsel patients, assist physicians and take care of patients with poor adherence and those who have ART related problems.</td>
<td>Fill out some parts of intake and follow-up forms and different types of test requests.</td>
</tr>
<tr>
<td>Lab. Technician/Radiologist</td>
<td>Conduct laboratory/radiology tests.</td>
<td>Fill out the test report form and copy the result of the test into appropriate register books, and compile monthly test related data.</td>
</tr>
</tbody>
</table>
Pharmacist/Druggist | Drug stock management, dispense ARV’s, counsel on drug adherence and follow up of patients. | Fill out drug dispensing forms, and compile drug consumption related report.  

Data Clerk | Record each transaction patients make with the Clinic into Register Books and compile statistical and cohort reports at different frequencies. | Fill out Pre-ART and ART Register books based on intake and follow-up forms, patient folder and screening report and produce patient and regimen related reports.  

Table 3: Staff composition and responsibility

The staff meets every Thursday to make all rounded discussion about ART and ART in the Hospital in particular. It is used as a forum for sharing experiences, address problems and discuss future plans.

4.1. Data Collection and Analysis

All ART Clinics in Ethiopia use the same kind of paper-based forms to collect clinical and non clinical data about patients. These forms consist of lots of columns and the same data is required to be duplicated here and there. The huge amount of data to be collected, the requirement for duplication and the constantly increasing patient size aggravates the problem of accurate data collection, analysis and presentation. It also complicates the process of reviewing the medical history of a patient at hand.

One of the physicians stated the following in relation to filling out forms:

… data recording in the forms took about 45 minutes initially, when we were new to them. Now we are familiar with them and it takes only fifteen minutes to do it …

The patient’s folder and the referral/screening report are the first sources of information for filling out some of the fields of the Pre-ART Register book which consists of about 38 fields (16 of them are optional). The seven pages intake form, consisting of 25 fields per page on average and the Follow-up form, consisting of 35 fields (some of which are optional) are used as sources of data for the ART Register Book that has 68 fields and for the Pre-ART Register Book.

Further to the size, some of the fields are repeated several times in some of these forms. The Intake form has 10 mandatory fields repeated in all of the seven pages and 17 mandatory fields exist on both the Intake and Follow-up forms. Besides, the Pre-ART and ART Register Books, altogether having 106 fields, are duplications of what is already recorded in the Intake and/or Follow-up forms. Added with the ever increasing size of patients, let alone summarizing and analyzing data on time, data collection has become difficult and resource consuming.

As a result, the Data Clerk which is supposed to fill out Intake form A (patient registration form), 1st part of form E (social assessment form) and the headings of all of the Intake and Follow-up forms is no more doing it. Rather, it became the responsibility of ART Nurses and Physicians who are busy discharging their own duties. Furthermore, it became difficult for the Data Clerk to go through the Intake and Follow-up forms of every patient and copy the data into the Pre-ART and ART Register Books.
Currently, an ART Physician diagnoses about 40 patients per day on average and there are 5 ART Physicians on duty five days a week. It means that, on average, the Data Clerk goes through the folders of 200 patients, extracts the required data and copies them into the Pre-ART and ART Register Books everyday. Recognizing the problem, the Clinic introduced its own abridged version of the Follow-up form that has only 14 fields. This new arrangement demanded the Physicians to rewrite some of the data from the Follow-up form into the new one everyday.

The Data Entry clerk said the following:

“… my responsibility is difficult to discharge. If I’m absent for one day from my job, I will get piles of documents waiting for me…”

From the discussion, one can see how problems related to data collection can bring change on the way an organization discharges its responsibilities. Compilation of monthly Pre-ART, ART, and Regimen reports is another activity of the Clinic. The Data Clerk demanded two full working days to produce a one month report and it took two months for four people working overtime to produce a cohort report for all of the months in a year. The problem can be aggravated by the increasing size of patients, which is the current trend, and the inherent problem of human. Hence, further to huge resource consumption, the quality of the report maybe compromised.

In ART adherence level of more than 95% (missing no more than one dose per month) is required for patients to get the envisaged benefit. Poor adherence facilitates the development of drug resistant viruses. As theses viruses rapidly replicate, the treatment fails and the individual can no longer benefit from the therapy. Transmission of drug resistant virus in the community leads to a superimposed epidemic of drug resistant HIV. Therefore, it is crucial to support people on ART throughout their treatment. (FMOH-Ethiopia 2005)

At Zewditu patients with next appointment date are not identified unless s/he is present. Usually, patients that fail to show up on the scheduled date are identified long after it is lapsed. In order to identify such patients, the Data Clerk often reviews the Pre-ART and ART Register Books and picks up those patients’ whose records were not updated for the last couple of months. Then fetches the folders of these patients’ and verifies the date. Based on the result, she updates the status as “lost” to follow up in the respective Register Books. She sometimes makes further attempt to clarify the reason and reflects the change in the Register Books, if she succeeds. In a nutshell, it is possible to say that the existing system does not facilitate follow up and provision of support.

The Pharmacy uses software to manage its stock and daily transactions and produce reports. According to the Pharmacist, the software satisfies most of their requirements. It is easy, for example, to identify patients who didn’t show up on their appointment date. However, it doesn’t produce all the reports required by the AACAHB and FMOH in the required format and lacks integration with the Clinic.

The Pharmacy system was introduced in January 2005 and it uniquely identifies patients using the Hospital’s patient number. After the introduction, the Clinic started to uniquely identify patients using ART number. This lack of either physical or conceptual integration has attributed to the existence of data mismatch between the Pharmacy and the Clinic. In addition, all patients visiting the Clinic may not also visit the Pharmacy and due to errors made during report compilation, these systems produce different reports.
These are some of the major problems of the manual ART system which have a profound influence on the overall operation of the therapy. The following section discusses the processes of an ART module implementation in ART Clinics.

5. IMPLEMENTATION OF THE ART MODULE: AN ANT PERSPECTIVE

The ART module\textsuperscript{4} was developed to run on standalone and/or networked environments with a web-based interface taking the Ethiopian context into account. As an example, it accommodates the Ethiopian calendar and complies with forms and guidelines of the FMOH. The development process involved several stakeholders, the beneficiaries being active throughout.

The module is meant for solving the data management problems ART Clinics thereby improving the therapy. It computerizes the processes of maintaining Pre-ART and ART Register Books, and Follow-up and Intake data of patients, generates Pre-ART, ART, Regimen and Cohort reports at a period defined by the user. The module also has appointment, search and analysis functionalities, to mention the few, which the manual system was not able to offer.

The development and implementation of the module in ART clinics in Ethiopia formed an actor-network composed of human and non-human elements including the inscription itself. This section presents the analysis using the concepts problematization, interessement, enrollment and mobilization of translation.

5.1. Problematization

HISP Ethiopia with the support of HISP International, particularly a professor from the University of Oslo approached the AACAHB to deal with the idea of developing computer-based system that automates ART. The problems of the manual system together with the need for evidence-based service, the value placed in ICT/IS, the e-government plan were impetus. The development and implementation of the module involved the AACAHB, ART Clinics, HISP Ethiopia and International, and Developers forming a network.

The AACAHB wants to plan, execute, monitor and evaluate the activities of ART Clinics in Addis Ababa based on evidence. It is getting fixed format monthly report which may not be sufficient to grasp the service, patient, drug consumption, etc in detail.

At the Clinic the number of patients is increasing from time to time and huge amount of data is being collected even per patient. Resource mobilization was necessary to compile those mandatory reports let alone produce others. So far the system doesn’t facilitate patient follow up. The Clinic demands to collect, manage and analyze data about patients and regimens from different angles to improve the service.

HISP International as part of its goal to improve HIS in developing countries, trains students at M.Sc. and Ph.D. levels. Students are supposed to be exposed to the actual working environment and provide both theoretical and practical contributions through its action research framework. In case of the ART module, two M.Sc students have developed it and its

\textsuperscript{4} The ART module was developed by two M. Sc. students at the University of Oslo, Department of Information Science who are also members of HISP in collaboration with other members of the HISP network.
design and implementation involved others including the author of this paper. The author of this paper has participated and led discussions aimed at implementation and rollout of the module in different parts of the country.

Those Ph.D. and M.Sc. students working their field works in Ethiopia are hosted by HISP Ethiopia that has been working in collaboration with five RHBs to improve the HIS. HISP Ethiopia contributes its share towards meeting the goals of HISP International and provides necessary resources and facilities with the support of HISP International and working environment through its partners.

The developers with the support of the professor formulated the ART module to be the obligatory passage point (OPP) with the ultimate aim of realizing a full-fledged HIV/AIDS management system. Hence, the present focus is confined to ART only excluding all others such as pharmacy, laboratory, TB, etc. The following figure illustrates the actors and the OPP.

![Figure 1: Illustration of Actors and the OPP](image)

5.2. **Interessement**

Interessement is about convincing the actors that the only way to solve the problem is via the proposed solution. This process was supported with presentations, demonstrations and discussions. One of the AACAHB official who also has engaged in the process said the following:
I’m very happy with the feature and functionality of the software. I have mandated you [the HISP Ethiopia] to implement the module in ART clinics where we are responsible for. I will also tell more about the nature and feature of the software to the higher officials so that it can be rolled out.

There was a need to transfer stable patients to lower level health facilities in Addis Ababa. However, the HB officials found identification of such patients difficult, and hence, approached the developers to include the functionality into the module. After it is accomplished, the AACAHB official said the following:

Really it is very interesting to easily identify those patients who are stable using the system which otherwise could be time taking and cumbersome.

The coordinator of the Clinic said the following:

… now we don’t have problem of getting information. We can get it easily and timely but we have financial constraint to implement all our plans and solve patients’ problems. …

The Data Entry clerk also said the following:

… the computer based system is really fantastic; it has features which we did not have before. … for example the possibility of producing cohort report till the date you choose. It also simplifies the task of report compilation; with three or more mouse clicks you can produce a report which otherwise takes three to four days. I’m very happy with the new system. I’m hoping that the new system alleviates me from the burden of report compilation.

In addition to the negotiations, flexibility of the module and the existence of local capacity that is able to change, enhance and provide support facilitated acceptance of the module and, hence, to isolate the actors from ‘contamination’.

5.3. Enrollment

Other actors are supposed to join the network for the proposed solution to sustain across space and geography. To this end, the author of this paper held discussions with the National HAPCO, the University of Washington5 and the University of California at Santiago6 several occasions.

The first discussion held with the two Universities was aimed at problematization and interessement, and laid down the ground for succeeding discussions, demonstration and agreement. Both appreciated the existence of data management and analysis related deficiencies at ART Clinics but wanted to evaluate the proposed solution.

During the second meeting, the HISP Ethiopia team presented the existing HIV/AIDS data management problem and its plan and approach to solving the problem – step-by-step

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5 The University of Washington is responsible for ART related activities in Tigray, Amhara and Afar Regional States.
6 The University of California at Santiago is responsible for ART related activities among the Uniformed Forces.

Proceedings of the 9th International Conference on Social Implications of Computers in Developing Countries, São Paulo, Brazil, May 2007
realization of an integrated HIV/AIDS management system – and demonstrated the ART module. The meeting emphasized the need for collaboration and resource sharing and agreed to put it into practice. Consequently, the module was introduced in Police Hospital and Federal Prison Health Center with some modification.

Zewditu, which informed development of the module, started ART before the introduction of Intake forms, i.e., early patients do not have intake data and reports have been compiled from ART and Pre-ART Register Books. Hence, the resulting ART module included interfaces/forms that are alike to the manual ART and Pre-ART Register Books meant for accepting data from the keyboard. However, there is no need for designing these interfaces for those Clinics that started ART after the introduction of Intake forms, such as the last two, and for those patients who have Intake data. Once data from the Intake and Follow-up forms are entered, the Register Books can be generated as reports avoiding data reentry since Intake and Follow-up forms are the sources of the Register Books. Accordingly, the software was customized to reflect the new context accounting for ‘negotiation of interest’.

The enrollment phase introduced new context of use that demanded for improvement of the module to reflect the new context. And, hence, flexibility of design and negotiation of actors’ interests are essential to bring others aboard the network.

5.4. Mobilization

Once the needs of the actors are satisfied, it is possible to say that they can speak on behalf of the solution provider. The AACAHB official supported the implementation of the module in ART clinics and spoke in favor of it at a conference in the presence of representatives from the FMOH which were challenging the solution.

…we have been hearing rumors from different angles that the FMOH is trying to introduce software. So far, we didn’t see anything and in the meantime HISP approached us and developed software that satisfied our need…. We will keep on using it....

The newly joined actors such as the two USA-based Universities started to speak in favor of the module and against software offered by one another University. One of the representatives said the following:

Lots of resources were allocated by one of our partner Universities to develop ART software which focused on supporting research. I think this one is better satisfies the data management and reporting needs at a facility level.

They communicated the importance and feature of the module to people at the National level. The University of Washington also took the product to demonstrate and implement it in Tigray.

These increasing interests served as impetus to further develop the module technically and function wise attracting the University of Oslo and HISP South Africa. This way we believe the implementation will scale up technically, geographically and function wise.

6. CONCLUSION

ART Clinics collect huge amount of data per patient and they are required to duplicate them here and there. Added with the ever increasing size of patients’ accurate data collection,
timely analysis/compilation and presentation of reports can become difficult, especially in a resource constrained settings. These burdens forced the Clinic to introduce its own data collection form, on top of the nationally recognized forms, and shared the data collection and duplication tasks to Physicians and Nurses. Despite the solutions, let alone summarizing and analyzing data on time, data collection has become difficult and resource consuming. The manual system is also in efficient to support follow up of patients.

The design, development and implementation of the ART module to solve some of the above problems of ART Clinics involved heterogeneous actors forming an actor-network. HISP Ethiopia with the support of its partners has developed and implemented the module in some of the ART clinics bargaining for further expansion in terms of geography, functionality and technology. The design took the local context of use into consideration.

The implementation involved convincing different actors and bringing them aboard the network. This process was facilitated through flexibility of the design to accommodate different contexts of use and availability of qualified staff to support and change it. The process of implementation not only took the ultimate end users but also donors who are involved in supporting ART in Ethiopia. Further to the existence of real life problem and a computer-based ISs (solution), continuous negotiation with stakeholders, accommodation of actors’ interests and availability of local capacity to accommodate context based requirements and provide continuous support and enhancement are necessary to succeed in the implementation of ISs.

Acknowledgement
I would like express my gratitude to the two anonymous reviewers who gave me constructive comments to improve this paper. I’m also very grateful to my supervisor Prof. Erik Monteiro, my colleagues at IFI, staff of Zewditu and others who helped directly or indirectly realize this paper. Last but not least I thank HISP for the financial support.

![Figure 2: ART Management and Coordination Structure](source: FMOH-Ethiopia (2005): Guideline for Implementation of Antiretroviral Therapy in Ethiopia)
Figure 3: Report/Information flow of health related indicators


Figure 4: Report/Information flow of health related indicators


Figure 5: ART Patient Flow

REFERENCES


### GLOSSARY OF ACRONYMS USED

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>AACAHB</td>
<td>Addis Ababa City Administration Health Bureau</td>
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<tr>
<td>AIDS</td>
<td>Acquired Immunodeficiency Syndrome</td>
</tr>
<tr>
<td>ANT</td>
<td>Actor Network Theory</td>
</tr>
<tr>
<td>ART</td>
<td>Anti Retroviral Therapy</td>
</tr>
<tr>
<td>ARV</td>
<td>Anti-retroviral</td>
</tr>
<tr>
<td>FMOH</td>
<td>Federal Ministry of Health</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>HAPCO</td>
<td>HIV/AIDS Prevention and Control Office</td>
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<tr>
<td>HB</td>
<td>Health Bureau</td>
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<tr>
<td>HISP</td>
<td>Health Information System Program</td>
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<tr>
<td>HIV</td>
<td>Human Immune Deficiency Virus</td>
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<tr>
<td>HMIS</td>
<td>Health Management Information System</td>
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<tr>
<td>IHAMS</td>
<td>Integrated HIV/AIDS Management System</td>
</tr>
<tr>
<td>OI</td>
<td>Opportunistic Infection</td>
</tr>
<tr>
<td>PLWHA</td>
<td>People Living with HIV/AIDS</td>
</tr>
<tr>
<td>PMTCT</td>
<td>Prevention of Mother to Child Transmission (of HIV/AIDS)</td>
</tr>
<tr>
<td>RHB</td>
<td>Regional Health Bureau</td>
</tr>
<tr>
<td>STD</td>
<td>Sexually Transmitted Disease</td>
</tr>
<tr>
<td>STS</td>
<td>Science and Technology Studies</td>
</tr>
<tr>
<td>TB</td>
<td>Tuberculosis</td>
</tr>
<tr>
<td>VCT</td>
<td>Voluntary Counseling and Testing</td>
</tr>
<tr>
<td>ZMH</td>
<td>Zewditu Memorial Hospital</td>
</tr>
</tbody>
</table>
Appendix 2: **Paper 2**


1 The previous version of this paper was published in the proceedings of the 10th International Conference on Social Implications of Computers in Developing Countries "Assessing the Contribution of ICT for Development" (IFIP WG 9.4) Dubai, May 2009. Dubai School of Government http://ifip.dsg.ae/
Research Article

Sociotechnical Dynamics in IS Development in Organizations: The Case of a Resource-Constrained and Competitive Context

Abstract

The literature on IS development in developing countries mainly deals with the interplay between ISs, often brought from abroad, and use contexts. This research, however, considers a locally developed IS, primarily examining the interests and strategies of human and nonhuman actors embedded in an IS and the wider sociotechnical network, as well as their respective implications for implementation contexts. Focusing on the public health sector of Ethiopia, the study examines the design dynamics of an IS over time and space vis-à-vis the use context by adopting an interpretative, qualitative case study approach. The findings reveal that the resulting IS and sociotechnical network embed mainly the interests, strategies, and ideologies of the dominant actor (the actor that defines both problems and solutions), regardless of realities in implementation contexts, and at the expense of organizational performance and effectiveness. The research reveals that IS development and implementation is a complex sociotechnical process where data quality, performance, and sustainability are negotiated orders. The study also shows the relevance of actor-network theory for explicating the development of ISs in organizations and identifying both human and nonhuman actors and their associations.

1. Introduction

The design and use choices for an IS are influenced by an individual's knowledge, expectations, and assumptions concerning the purpose, context, importance, and role of a technology in a given context (Bijker, 1995; Markus, 1983; Orlikowski, 1992; Pinch & Bijker, 1984). As social artifacts, the material forms and functions of technologies embody their sponsors' and developers' objectives, values, interests, and knowledge about that technology (Orlikowski & Gash, 1994). For example, the choice made by sponsors and developers to either centralize or decentralize an IS determines the process of work, division of labor, autonomy of employees, and decentralization or centralization of units and decisions. Besides human agency, technology could also influence the path of its development and use (Barley, 1986). Thus, technological artifacts are not exclusively the result of pure engineering and design processes; they are value-laden and embedded with the interests of actors.1 (Bakardjieva &

1. In keeping with actor-network theory, the terms “actor” and “actant” are used interchangeably in this article.)
Feenberg, 2002; Feenberg, 2000; Orlikowski & Gash, 1992).

The study of technologies in organizations should therefore entail considering the roles of both technologies and humans (Markus & Robey, 1988; Orlikowski, 1996; Orlikowski & Barley, 2001). Ignoring the role of humans in shaping technology or denying the material affordances and constraints of technologies is an inadequate approach for studying the development and use of technologies in organizations (Orlikowski, 2000). The interplay between organizations and ISs can best be explained at a lower level of abstraction (Hanseth & Monteiro, 1998) by giving due attention to the IT artifact (Hanseth, Aanestad, & Berg, 2004; Monteiro & Hanseth, 1995; Orlikowski & Iacono, 2001). The implementation literature focuses mainly on the interaction between specific organizational practices and IS presumptions (Pollock, Williams, & D’Adderio, 2007). Such has been the case in IS development projects in developing countries: Software was often brought from abroad, and effort was spent adapting it to the use context or vice versa. To complicate matters, further effort was usually expended simultaneously on trying to develop indigenous technological capacity (Braa, Monteiro, & Reinert, 1995; Heeks, 2002; Heeks & Stanforth, 2007; Nhampossa, 2005; Odedra, 1992).

Unlike previous studies, this research focuses on a locally developed IS that originated in a highly contested context. The article uncovers actors’ interests that shaped the material forms and functions of the IS. It also explores the dynamics of role allocation and the implications they have for implementation goals, sustainability, and organizational change. The research was guided by the following questions: Which interests of actors were embedded into an IS? What are the implications and effects of embedded interests and anticipated patterns of use in adopting organizations and vice versa? How did the actors’ interests influence role delegation? What part does role allocation play in sustaining sociotechnical networks? Examining these issues would improve our understanding of IS design and enactment processes, their impact on adopting organizations, their implementation processes, and the sustainability of sociotechnical networks.

The empirical material for this research was collected in the public health sector of Ethiopia, where a number of donors wished to introduce a computer-based antiretroviral therapy—hereafter, ARTIS—in ART clinics. Some of the donors had agreements with the federal government of Ethiopia to technically support ART, while others, like HISP, did not. HISP had developed and introduced an open-source ARTIS in the capital city, Addis Ababa, in 2006, and had subsequently tried to implement it in other parts of the country. This attempt turned the IS development environment into one of competition and politics, rather than one of collaboration, which influenced the choice of development technologies, methodology, ideology, features, and functions. Ultimately, this occurrence specified the current and future patterns of use, the project trajectories, and the natures of adopting organizations. The article shows the sociotechnical dynamism of IS development in a resource-constrained and competitive context.

The rest of the paper is organized as follows: The next section discusses the conceptual foundations used in the study, drawing from the literature on IS design and translation. Then, the research context and key research methods are discussed, and a detailed description of an empirical case study on the development of an IS in the public health sector of Ethiopia is provided. This is followed by an in-depth analysis of the case study and concluding remarks with some implications for practice and theory.

2. IS Design and Translations

Although ICT has been accepted as relevant to developing countries, its application to development goals has not been always successful (Walsham, Robey, & Sahay, 2007). IS implementation in developing countries has been challenging, and the failure rate has been high (Avgerou, 2008; Heeks, 2002, 2006; Walsham et al., 2007). Some of the most commonly cited problems include country context gaps and gaps between IS designs and realities.
in implementation contexts (design-reality gap), as well as the general lack of resources and indigenous techno-scientific capacity. Context disparity could be eliminated by developing ISs locally, but understanding the problem domain and the influences of the socio-technical context remain two difficult tasks. These obstacles are the focus of this research.

During IS development, designers transform themselves into sociologists, moralists, or political scientists at different moments (Callon, 1991). Given the underlying understanding that increased knowledge of users and the environment leads to better design, they work closely with users (Pollock et al., 2007). They make both hypotheses about the entities that make up the world into which the IS is to be inserted, and concrete judgments about anticipations and restrictions of future patterns of use (Akrich, 1992; Monteiro, 2000). Akrich explains:

Designers . . . define actors with specific tastes, competences, motives, aspirations, political prejudices, and the rest, and they assume that morality, technology, science, and economy will evolve in particular ways. A large part of the work of innovators is that of “inscribing” this vision of (or prediction about) the world in the technical content of the new object. (1992, p. 208)

IS design, therefore, is an attempt to predetermine both the settings that users are asked to imagine for a particular piece of technology, and to distribute their roles properly. These two processes embed rules and resources for technical and nontechnical users (Akrich, 1992; Orlikowski, 1992). The design defines technical and nontechnical users with specific competency, morality, and ethics, as well as the space and the ways in which they are supposed to act (Akrich, 1992; Callon, 1991; Latour, 1992). Once defined, roles could be distributed to users as a function of the effort required to perform tasks (Latour, 1992; Law & Bijker, 1992). According to this logic, it would be useless to delegate tasks to artifacts or people if the effort of making sure that they perform as they ought would be greater than the original effort (Law & Bijker, 1992). For example, computers are good at handling routine and repetitive tasks; letting humans handle them would not be appropriate.

Users may not subscribe to the rules and resources of IS designs as envisioned by designers—ISs take on their true forms during their interaction with users in the actual use context (Akrich, 1992). Use contexts are complex and involve multiple internal and external actors that shape IS designs. In general, the designs and the uses of ISs are continuous sociotechnical processes that emerge in unpredictable fashions from complex interactions between the social and the technical (Cordella, 2006; Markus & Robey, 1988). For example, in her seminal work, Lynne Markus shows how the misaligned interests of different user groups in a corporation influenced the adoption of an MIS, demanding role-enactment and distribution changes (Markus, 1983). In developing countries like Ethiopia, where the research for this article took place, donors are the primary funders of various programs in the health sector, including those addressing HIV/AIDS, malaria, tuberculosis, etc. As such, they play key roles in most change initiatives, including the introduction of ISs. The developing-country health sector in general is complex and highly political (Braa et al., 1995; Braa et al., 2004).

In order to explicate the designs of ISs, it is important to consider the emergent and sociotechnical perspectives. In this regard, actor-network theory (ANT) offers the language to deal with emergent sociotechnical changes by giving due emphasis to IT artifacts (Holmström & Robey, 2005; Monteiro, 2000). ANT traces its origin primarily to the works of Michel Callon, Bruno Latour, and John Law, the scholars who initially developed the theory to help understand the sociology of science. Later applications of ANT focused on technology, and some even included IT (for a detailed review, see Walsham, 1997). The theory has become popular and relevant to the study of IT in organizations, and at times, it is used to guide empirical research on IT (Gao, 2005; Holmström & Robey, 2005; Mitev, 2009; Rose & Jones, 2005; Tatnall & Gilding, 1999; Walsham, 1997). According to ANT, social and technical stability reside in the mutual dependency between the technological properties and the social context. It deals with the social-technical divide by denying that purely technical or purely social relations are possible (Tatnall & Gilding, 1999). Heterogeneous objects only exist on the surface; in reality, everything consists of complex relations made up of both social and the technical elements. Because ANT sees the social and the technical as inseparable in this way, it argues that people and artifacts should be analyzed with the same conceptual apparatus

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Table 1. Description of ANT Concepts Adopted in This Research. (Adapted from Walsham, 1997).

<table>
<thead>
<tr>
<th>Concept</th>
<th>Description</th>
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<tbody>
<tr>
<td>Actant (or actor)</td>
<td>Both human beings and nonhuman actants, such as technological artifacts</td>
</tr>
<tr>
<td>Actor-network</td>
<td>Heterogeneous network of aligned interests, including people, organizations, and standards</td>
</tr>
<tr>
<td>Enrollment and translation</td>
<td>Creating a body of allies, human and nonhuman, through a process of translating their interests to be aligned with the actor-network</td>
</tr>
<tr>
<td>Delegates and inscription</td>
<td>Delegates are actants who “stand and speak for” particular viewpoints that have been inscribed in them, e.g., software as frozen organizational discourse</td>
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</tbody>
</table>

(Callon, 1986b). ANT attempts impartiality toward all of the elements in consideration, whether human or nonhuman, making no distinction in its approach between the social, the natural, and the technological. It uses the term “actant” to refer to both human and nonhuman network participants. This symmetric treatment of people and technologies has been the primary focus of ANT’s critics. However, it should be pointed out that ANT does not deny differences among actants; instead, it is against formulating a priori distinction and hierarchy among them (Callon & Latour, 1992; Walsham, 1997).

This research is particularly interested in the notions of actant, actor-network, inscription, and translation, which are described in Table 1. An actor-network is a heterogeneous network of aligned interests that link together actants of different types and size (Callon, 1986a, 1986b, 1991; Latour, 1991). An actant is not just a “point object”; it is an association of heterogeneous elements themselves constituting a network. As such, each actant is also a simplified network (Law, 1992; Tatnall & Gilding, 1999), a single, black-box entity that hides other actants or a network of interactions and associations until it is, itself, unpacked (Callon, 1986a; Law, 1992; Tatnall & Gilding, 1999). Hence, ANT gives the flexibility to zoom in and out on sociotechnical ensembles at different levels of granularity (Monteiro, 2000).

The stability of an actor-network would be preserved through the processes of translation and inscription, by which actants’ diverse interests become aligned with each other and embedded into technologies (Callon, 1991; Gao, 2005; Holmström & Robey, 2005). Translation refers to the mechanisms through which actants transform themselves, displacing their own identities, as well as those of others (Bruun & Hukkinen, 2003; Callon & Latour, 1981). It implies definition and involves a translator, something that is translated, and a medium in which that translation is inscribed (Callon, 1991). Translation involves enrolling activities into the network, and then controlling them to define the power that actants have in relation to others (Heeks & Stanforth, 2007). Power, in this case, is about the ability to produce and achieve collective goals (Silva, 2007). Drawing upon these notions of ANT, this research explores the trajectories of an IS design over time and location to understand their effects on adopting organizations and sustainability. To do so, the next section describes the research context and methods.

3. Research Context and Methods

3.1 Context

This research was conducted in Addis Ababa, Ethiopia, during the development and implementation of ARTIS in ART clinics. HISP initiated the ARTIS project in 2006 as part of its global R&D initiative, which was aimed at designing, implementing, and sustaining HISs in and across developing countries, using open source software (OSS) (Braa et al., 2004). ART aims to reduce the mortality rate, improve the quality of life of AIDS patients, and reduce the burden they place on society (FMOH–Ethiopia, 2005). Having reported the first two HIV cases in 1986 (FMOH–Ethiopia, 2004), Ethiopia had lost about 900,000 lives to AIDS by 2003 (FMOH–Ethiopia, 2006). The annual death rate (until 2005), the number of new HIV infections, and the country’s ART needs have been increasing year after year. For example, the number of patients who needed ART in 2004 was about 278,000, and it was projected to...
increase to 350,000 by 2010 (FMOH–Ethiopia, 2006).

The success of ART is closely linked to geographic coverage and patients’ adherence to regimens. An adherence level of more than 95% (missing no more than one dose per month) is required for patients to receive the therapy’s hoped-for benefit (FMOH–Ethiopia, 2005). Poor adherence facilitates the development of drug-resistant viruses, harming not only an individual patient’s prospects, but also the community’s as a whole, because transmission of a drug-resistant virus can ultimately lead to a superimposed epidemic of drug-resistant HIV.

To facilitate ART, especially in data collection, management, and analysis aspects, the FMOH (Ethiopia’s Federal Ministry of Health) had developed data collection and reporting forms, along with guidelines for how they should be filled out and by whom. The guidelines and forms dictate the collection of large amounts of data per individual patient, as well as duplication of them in different forms. These tasks were making accurate data collection, as well as the analysis and evidence-based service that follows from it, inordinately challenging. This became increasingly the case as the numbers of patients grew and the setting became more and more resource-constrained (Mengesha, 2007).

Stakeholders of the service at different levels had difficulties getting accurate information on time, so they were unable to plan and make informed decisions. HISP felt that introducing a computer-based IS (ARTIS) would alleviate these challenges, so it initiated a project aimed ultimately at realizing an HIV/AIDS management system that could also integrate a wide range of related services (Mengesha, 2007).

Though HISP and other local and international organizations were supporting ART, the Ethiopian federal government had mandated that four U.S.-based universities should provide the technical support for ART in Ethiopia. In 2003, the United States Congress approved the President’s Emergency Plan for AIDS Relief (PEPFAR), an American initiative to combat the global HIV/AIDS epidemic which allocated US$15 billion over five years to combat HIV/AIDS, primarily in 14 focus countries, including Ethiopia. Following PEPFAR’s approval, the Ethiopian bureau of the Centers for Disease Control and Prevention (CDC), the U.S. government entity responsible for all federal HIV/AIDS funding allocated to Ethiopia, invited and selected four American universities to provide technical support for the prevention and control of HIV/AIDS in Ethiopia. The universities were responsible for enhancing ART, developing human resources in HIV/AIDS care, and strengthening HIV/AIDS-related information systems. The second installment of PEPFAR authorized up to $48 billion for fiscal years 2009–2013.

The government of Ethiopia divided the country into four parts and gave one part to each university, demanding that all other organizations involved in ART align their activities accordingly. However, the non-existence of a coordination mechanism had created an environment conducive for the different organizations to take their own trajectories of supporting ART, especially when it came to introducing ISs. The interests of different organizations in addressing the same problem with different, but similar, solutions turned the environment into one of competition, power struggle, and politics, rather than of collaboration (Bradshaw-Camball & Murray, 1991), a phenomenon that influenced the development and implementation of ARTIS.

3.2 Methods

The research adopted the qualitative research approach (Silverman, 2005), with the underlying epistemological and ontological concepts of interpretive philosophy (Klein & Myers, 1999; Orlikowski & Baroudi, 2002; Walsham, 2002). To make sense of the development and implementation of ARTIS, it was essential to understand the intersubjective meanings and actions of actants in the ARTIS sociotechnical network. This was accomplished by examining contextual factors, and after those, the interpretative philosophy and the case study methodology (Yin, 2003), all through the lens of actor-network theory. That emergent perspective has been advocated by various researchers as a more viable means for understanding the interplay between organizations and ISs than deterministic frameworks, which hew to the notion that the uses and consequences of ISs emerge unpredictably from complex social interactions (DeSanctis & Poole, 1994; Kling, 1980; Markus & Robey, 1988; Robey & Boudreau, 1999). To focus on the dynamics, the process theory of studying change is preferred over the variance theory (Markus & Robey, 1988; Tsoukas, 2005). This study was therefore conducted in accordance with the emergent perspective and process theory.
The research employed interviews, on-site observations, formal and informal discussions, and document-review to collect data. As a member of the HISP network, the author of this paper was intensively engaged in the development, implementation, and rollout of ARTIS. He carried out field study March–August 2006, February–April 2007, and November 2007–February 2008. In these time periods, the researcher studied publications of the FMOH, surveyed and observed the work processes of ART clinics in five hospitals (Armed Forces and Military General Hospital, Tikur Anbesa Teaching Hospital, Zewditu Memorial Hospital, Federal Police Hospital, and Federal Prison Health Center), and interviewed and held formal and informal discussions with the coordinator, physicians, nurses, and data clerks in the pilot clinic. He also held several formal and informal discussions with health bureau officials in charge of ART in two regions besides Addis Ababa (Amhara and Oromiya), with the national HIV/AIDS prevention and control office (HAPCO), and with two universities involved in the government's ART mandate, all in an attempt to rollout ARTIS and learn about other initiatives. Altogether, a total of 50 interviews and discussions (for mal and informal) were conducted, as shown in Table 2.

During each interaction, the researcher took notes and summarized main points soon afterward, occasionally presenting reports to HISP coordinators and other actants. These interviews, as well as the subsequent analysis of the ARTIS design that followed, were spaced throughout the timeline of the ARTIS design process, adding a temporal perspective to the data gathered.

The analysis was centered on the pattern of iteratively reading data, identifying key themes, and then relating them to the conceptual framework. There was a need to go back and forth between the design of ARTIS, the standard practice, and the local practices of ART clinics to understand differences, gaps, and changes in role delegation and the interests of the actants as they occurred chronologically in the ARTIS development (Akrich, 1992). Subsequently, the findings of the analysis were interpreted in light of concepts drawn from ANT and the IS literature.

### 4. Development and Rollout Processes of ARTIS

ART service in Ethiopia starts by recording demographic and clinical details of AIDS patients on an intake form. Any later encounter of a patient with the clinic is recorded using a follow-up form. Filling out patient information on both forms falls under the responsibilities of physicians and nurses. After each encounter, data clerks copy data from both forms into pre-ART and ART register books, and later, aggregate and report to various recipients using pre-defined pre-ART, ART, and regimen reporting forms at different frequencies.

As indicated in Figure 1, based on the guidelines of the FMOH, many mandatory fields are duplicated, both on different pages of the same form and across forms. The intake form, for example, has seven pages, with 25 fields on each page, out of

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**Table 2. Respondents by Specialization and Frequency.**

<table>
<thead>
<tr>
<th>Specialization/Responsibility</th>
<th>Number of Respondents</th>
<th>Number of Interviews and Discussions</th>
</tr>
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<tbody>
<tr>
<td>ART coordinators</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Physicians</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Nurses</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Data clerks</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Regional health bureau officials</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Representatives from U.S.-based universities</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Developers</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>National HAPCO</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>50</td>
</tr>
</tbody>
</table>
which 10 of them were similar, mandatory fields repeated in all of the pages. Then, 17 of the mandatory fields were duplicated on the follow-up form. Furthermore, the fixed-format reporting forms did not have room for new regimens, despite their existence in practice. The identification of patients with specific appointment dates proved challenging, and as a result, follow-up was not possible. Each surveyed ART clinic had a PC with MS Office applications installed, though they did not have a computer network or an immediate plan for either networking or sharing ART data across physicians or clinics in real time. The data clerks use MS Office applications to finalize reports after collecting and analyzing data manually. HISP has introduced ARTIS to curb some of these problems. The following sections describe its development and rollout processes.

4.1 ARTIS Development

HISP approached the Addis Ababa Health Bureau (AAHB) in 2006 and proposed the development of ARTIS as a solution for the drawbacks of the manual system and to facilitate evidence-based service (Mengesha, 2007). The person in charge of ART in 2003) ARTIS with the financial and technical support of HISP.

ARTIS was developed using open source technologies (MySQL, Apache, and PHP), has a Web-based interface, and runs in both standalone and networked environments. It exhibits local features, including the Ethiopian calendar and the (nation-wide) “standardized” data collection and reporting forms and procedures. Due to these features, it was labeled a “state-of-the-art IS.” The developers stated:

Our system bases the OSS license and state-of-the-art open source technologies. Any ART facility can use it free of charge and we have been offering our services freely. We have a plan to upgrade the system in collaboration with our international partners to make it more robust. (May 2006)

Most of the manually filled-out forms in the pilot clinic were incomplete, and the unique identifier was missing in some of the cases. Given this incomplete data, designing the computer system to enforce automatic data validation, such as data existence, domain, range, and format verifications, was
not possible. If this had been done, those records with missing and wrong values, which were many in number, would not have been entered into ARTIS, hindering the system once it was implemented. As a solution, data validation—value existence, domain, range, and format checking—was delegated to data clerks rather than the computer system.

The manual system in the pilot clinic had undergone changes to the standard procedure of data collection, and had introduced new forms. For example, the data clerk was supposed to copy a patient's information directly from intake and follow-up forms into either pre-ART or ART register books. Due to the large number of patients, it had become difficult for the clerk to go through all the intake and follow-up forms for every patient and copy the data into pre-ART and ART register books. In response to this overload, the clinic had developed an abridged version of the follow-up form and asked physicians to fill in both forms with the same data. The abridged version was more convenient to collect and enter data into ARTIS than the original form, but ARTIS had been designed to the FMOH standards, so it was configured for the original follow-up form, not the abridged version.

While HISP was developing ARTIS, some of the mandated organizations and others were commissioning individual- and organization-based IS approaches, though not all of these attempts and plans bore any fruit. As part of its effort, HISP had negotiated with the university teams, the FMOH, the national HAPCO, and other regional health bureaus, demonstrating to them the nature, features, and capabilities of ARTIS. However, these efforts did not bring all of the actants on board the pro-ARTIS network, especially the FMOH, HAPCO, and two of the mandated universities. The developers stated the following:

We have demonstrated our system to different regions at different levels. We have learned that our system satisfies the needs of the end-users. We have support from the regional health bureau and end users. Nevertheless, those who are responsible for supporting ART service at a national level and those USA Universities do not support us. . . . They are trying to develop and introduce their own system. (February 2007)

HISP considered adding new functions to ARTIS, which could show the strength of local capacity and increase the applicability and importance of ARTIS, leading perhaps, in turn, to winning the competition. As a result, the developers added some functions that were not readily available in the manual system, but were desirable for ART. For example, follow-up is core in ART, but the manual system did not support it well. Having an appointment management function and more report/analysis generation capabilities would better facilitate follow-up and improve the quality of ART. Being shown the updated ARTIS, an AAHB official who had tremendous difficulty identifying stable patients using the manual system was able to do so with just a few mouse clicks using ARTIS. He stated the following:

I am very happy with the feature and functionality of the software. Besides, it does not involve us much cost. . . . Really it is very interesting to easily identify those patients who are stable using the system which otherwise could be time-consuming and cumbersome. (March 2007)

At this stage, other organizations had already developed a similar IS and implemented it in another region, and were planning to implement it in Addis Ababa as well, despite the fact that HISP's ARTIS was in place there. After evaluating all the competing ISs, the AAHB decided on HISP's ARTIS as the winner, insisting on expanding its implementation in Addis Ababa. The decision was not received well by some individuals in the national HAPCO, since they were supporting other developers. The situation highlighted the challenges of gaining acceptance on a national level and implementing a system developed in one place in other regions. The implementation of ARTIS in other regions depended on the consent of the mandated organizations—consent they were unwilling to give at the time. This situation was evident when the IS was brought to the Oromiya region, as the person in charge of ART stated:

[We] prefer to use your software than the one introduced by [the other actant]. We have seen both; yours has better functionality than the other one. Nevertheless, [the other actant] has the mandate in our Regional State to support ART . . . the agreement was made at the Federal Government level. . . . However, we keep on discussing with the concerned people on this matter. (April 2007)

HISP presented ARTIS at various local and international conferences in the presence of several
Table 3. Actants and Their Interests in the ARTIS Development and Implementation Process.

<table>
<thead>
<tr>
<th>Actant</th>
<th>Description</th>
<th>Interests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard ART Practice</td>
<td>The FMOH has developed standard forms and guidelines for collecting, analyzing and reporting ART data.</td>
<td>The standard forms and guidelines remain intact unless changed by the FMOH.</td>
</tr>
<tr>
<td>ART Clinics</td>
<td>This group refers to the local practices of ART clinics that exhibited differences in data collection procedure and forms.</td>
<td>Work practices of clinics required ARTIS to follow their path, affecting role distribution to users.</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>HIV/AIDS affects a large population and demands preventive and curative measures. AIDS patients require lifelong treatment and medication.</td>
<td>ART demands huge amounts of data collection, analysis, interaction with related services, and a high level of adherence and close follow-up.</td>
</tr>
<tr>
<td>AAHB &amp; Donors</td>
<td>AAHB allocates resources and supervises ART clinics, and had limited IT experts and financing to develop or buy ISs. Donors are those who were supporting ART and receiving reports.</td>
<td>This group was interested in making informed decisions and plans. They required accurate information on time and in the required format.</td>
</tr>
<tr>
<td>HISP</td>
<td>HISP is composed of developers/students and researchers linked together in a south-south and north-south network of R&amp;D activities. HISP set the stage for the development and implementation of ARTIS. The Ethiopian chapter of HISP was based at Addis Ababa University.</td>
<td>HISP wanted immediate entry into and domination of the ART-IS market. Wasting time was associated with detaching from ART. Developers were students and had little time. The push by others to develop a similar system was considered a threat.</td>
</tr>
<tr>
<td>ARTIS</td>
<td>ARTIS is an OSS-based data collection, management, and analysis IS developed by HISP. It runs in both standalone and networked environments, has a Web-based interface and adheres to the local context.</td>
<td>ARTIS alleviates the challenges of manual collection, management, and analysis of ART data. To realize its benefits, the IS should get support and run in the clinics.</td>
</tr>
<tr>
<td>Mandated Universities</td>
<td>These are the four universities from the United States that were empowered by the Ethiopian federal government's mandate to provide technical support for ART in Ethiopia.</td>
<td>They needed to introduce their own ISs. Some of them had already commissioned individuals and companies to develop an IS similar to ARTIS.</td>
</tr>
<tr>
<td>Others</td>
<td>This category includes organizations that did not have the backing of the government's mandate, but still supported other ART system development initiatives.</td>
<td>Using their informal influence in the FMOH, they wished to introduce another IS than ARTIS.</td>
</tr>
</tbody>
</table>

actants, including regional representatives, the FMOH staff, and others. Although regional health bureau representatives were happy with ARTIS, with the development and implementation arrangement, and above all, with its open source characteristics, the FMOH staff was not interested in using ARTIS. Through EFOSSNet (Ethiopian Free & Open Source Software Network, a group of ICT specialists promoting OSS), ARTIS and the activities of HISP were introduced to the wider OSS community in Ethiopia. EFOSSNet extended its support, and some of the members expressed their interest in working on the project, although that assistance never materialized. Table 3 summarizes the interests of the actants involved in the development of ARTIS.

4.2 Rolling Out ARTIS

Following the decision of the AAHB, ARTIS was rolled out to three other clinics in Addis Ababa. Once there, one of the mandated organizations that had not commissioned the development of a similar system agreed to test ARTIS in its sites while negotiation with the other three was continuing. As a result, ARTIS was implemented in another two clinics—Federal Police Hospital and Federal Prison.
Health Center—but their procedure was found to be different from that which was used at the pilot clinic. Due to age and patient volume, the pilot clinic had introduced a unique data collection procedure that could not be replicated by the other, similar clinics. For example, the pilot clinic had started offering ART before the introduction of intake forms, and data had been recorded into pre-ART and ART register books solely from follow-up forms. Consequently, the developers delegated the role of accepting data from pre-ART and ART register books and intake forms to the system, and that of populating the pre-ART and ART register books to human users.

Those ART clinics that started ART after the introduction of intake forms no longer needed to enter data into ART and pre-ART register books from the keyboard. Once data from intake and follow-up forms were entered into ARTIS, ART and pre-ART register books could be generated as reports, eliminating the need to reenter the same data, but requiring an update to the ARTIS system design. Hence, in the interests of data accuracy and bypassing human limitations for new patients and patients who had intake data, the system was modified such that it now delegated the role of populating pre-ART and ART register books to the computer system itself, rather than to data clerks. Figure 2 summarizes the context, the dynamics, and the resulting ART system.

The new ART sites started the service relatively late and had fewer than 100 patients. The fairly small patient population made incomplete or invalid data correction somewhat easy, and with that assumption, the developers delegated the role of data validation to the computer system. Although a role that had belonged to the data clerks was being delegated to the computers, similar to the original pilot clinic, this re-delegation was occurring in a completely different setting. Even if this procedure facilitated data entry and improved data accuracy, it did not impact the design of ARTIS at the pilot clinic, but rather, it initiated a project that was intended to cleanse erroneous data.

As of 2009, ARTIS has been implemented in 27 ART clinics in Addis Ababa, and one of the mandated universities has developed and tested a similar system in another region. Another university has clearly decided not to collaborate with ARTIS, while the other two are testing ARTIS’s capability in the sites where they are responsible. Some of the non-mandated organizations still need to develop their own system, and they have yet to show any product.

5. Analysis and Discussion

The development and implementation of ARTIS had established a network of aligned interests among the standard ART practice, HISP, ART clinics, AAHB, and HIV/AIDS. A counter-network (Braa et al., 2004; Castells, 2000) was comprised of the same non-human actants and the mandated organizations (and others) seeking to develop similar, but competing, initiatives. The counter-network was supported by individuals in the FMOH and the national HAPCO. In the course of addressing the data collection, analysis, and reporting needs of ART clinics; ensuring continuity of the sociotechnical network of aligned interests; and counteracting the counter-network, the material form and functions of ARTIS, along with the sociotechnical arrangements and development processes, embedded certain features. This section analyzes and discusses these change processes and the interests of actants as they were translated and inscribed into ARTIS, all in relation to the implementation context and the IS literature.

5.1 Inscribed Interests and Future Trajectories

ARTIS, as an inscription, embedded the interests of some of the actants and some contextual matters. The design of ARTIS considered the nationally standardized forms and guidelines despite their problems and avoided introducing a new form, despite its importance. ARTIS’S adherence to these standards and the local calendar was a prerequisite for its adoption. Along with those features, the Web-based interface, OSS characteristics, and the capability to run on both standalone and networked computers boosted ARTIS’S usefulness and potential.

Take the Web-based interface, for example: ART services would benefit greatly if all users had online access to patients’ data, with the support of analytical and visual tools, at any time and from any place. The ARTIS design makes this possible by combining the power, simplicity, and flexibility of Web interface with network capability.

Other design elements were also used as strate-
gies for establishing and sustaining the socio-techni-
cal network. The OSS approach, for example,
attracked EFOSSNet (a local network of OSS promotor), AAHB, and international partners in the HISP network. Despite its aspirations to realize evidence-
based ART service, AAHB had significant financial
limitations, so a no-cost license for ARTIS was in
accordance with the interests of AAHB. In addition
to the software, HISP had extended free services to
ARTIS users throughout the implementation process,
such as installation, enhancement, maintenance,
training, etc.

The above features of ARTIS specify not only the
current patterns of use and the ART service, but also
future patterns and expected modes of operation.
The current technical standards and protocols of
ARTIS, including the network, database, and inter-
fice, as well as the OSS ideology, would resist future
counter changes. The strength of these technical
and ideological elements to resist counter changes
would not come just from the elements themselves,
but from the network built around them. For exam-
ple, due to the involvement of various governmen-
tal, nongovernmental, national, and international
actants of different type and size in promoting OSS
adoption serving as poly-vocal systems (Chan,
2007), in general, and the academics, EFOSSNet,
HISP, developers, and beneficiaries in the ARTIS case,
the OSS ideology would resist future counter changes.

Analysis of features and functions of ARTIS in relation to the implementation context suggest that HISP introduced them mainly to gain negotiation power over the counter-network, and to build alliances with partners. Although the use of OSS ideology helped to form alliances, the idea was not mature in Ethiopia, and its aspired-to importance had not yet been practically established in developing countries. In fact, there has been an ongoing debate on the matter (bridges.org, 2005; Weber, 2003; Weerawarana & Weeratunge, 2004). ART clinics did not have networked computers or an immediate plan for sharing data across users (physicians, nurses, clinics, etc.) in real time. In practice, the capability of ARTIS to run both on standalone and networked computers had negative implications on the speed and storage space of computers. So far, ARTIS has been running on standalone computers, i.e., all the required technologies were installed on the PCs themselves. To avoid the speed and storage problems, those programs should be installed on servers instead. In effect, the non-availability of a computer network slowed down PCs and increased the demand for data storage, a problem that was difficult to solve, considering the resource-constrained setting. ARTIS could have been developed using technologies with which the end-users were already quite familiar, but which may not have been helpful in interesting other actants and bringing aboard the network. For example, the use of MS Office applications would be sufficient to address the problem, but doing so would imply cost and could downgrade ARTIS technology-wise and reflect mediocrity on the skill and knowledge of the project developers, ultimately posing difficulty to winning the competition. Considering such matters was not worthwhile. By doing so, HISP and the developers played the roles of economists, moralists, and political scientists at different moments in the course of the project (Callon, 1991).

HISP had devised diverse strategies to interest other actants and forge alliances besides exploiting the technological and ideological opportunities discussed above. The lack of indigenous technological capability has been one of the bottlenecks of IS implementation successes in developing countries (Averyou, 2008; Heeks, 2002). To develop and sustain local capacity, HISP chose to base the development of ARTIS in the local environment, to endow local developers and users with knowledge and skill through formal and informal education, and to establish local and international networks so that developers could share expertise and resources. The effectiveness of this arrangement was proven when an official from AAHB requested a new program function and was satisfied with the result. Feature and function addition was crucial to gaining the support of beneficiaries (data clerks, physicians, coordinators, and other officials), since it boosts both the usefulness of ARTIS and its reliance on local capacity.

HISP’s need for domination was addressed through being mindful of local contexts, using technologies and an ideology that attracted others, adding more functions, offering free services, and yet compromising on speed and data-storage requirements. The focus on local capacity-development, as well as on networking actions within and outside of the nation, both assured continuity and boosted the beneficiaries’ reliance on the sociotechnical arrangement. The interests of other organizations to introduce a similar system, as well as the fact that some of them had the mandate to do so, were translated into the use of “better technologies, enhanced features and functions, suitable ideology, etc.”

In this case, HISP was the dominant actant that insisted upon the definition of both the problem and the solution (Law & Bijker, 1992). HISP follows the political agenda of boosting users’ capacities and sustaining implementation through networking actions within and across developing countries, as well as between the developing and developed worlds, of iterative incremental development and implementation processes, of interesting others over time, of OSS use, etc. (Braa et al., 2004). These strategies of HISP’s were embedded in the established sociotechnical network of ARTIS. Generally, the HISP agenda of change and sociotechnical order-formation were embedded not only in ARTIS, but also in the wider sociotechnical arrangement. In principle, the mandated organizations have power over others to support ART, but in practice, HISP was more powerful than others because of its capacity to define or redefine what holds everyone together, form alliances, and produce and achieve collective goals.
5.2 Role Delegation

Role delegation to actants in the ARTIS sociotechnical network was influenced by the work practices of the pilot clinic and the need to sustain the network. HISPs interest in quickly introducing a solution, as well as the assumption that all clinics would operate similarly, in keeping with the FMOH guidelines, influenced the design and development of ARTIS by stressing a primary focus on the work practices of the pilot clinic. This decision has ultimately resulted in a design that imitates the work practices of the pilot clinic, i.e., the development of a path-dependent system that delegates rules and resources according to the pilot clinic’s model (Hanseth, 2004). The initial design of ARTIS therefore dictated that users should enter data into an intake form and register books from a keyboard and generate reports from register books. This practice obscures the need for inputting intake and follow-up data unless they are used. It further compromises data and report quality because of the method’s susceptibility to errors due to double copying—first, from intake and follow-up forms into register books, and second, from register books into ARTIS. It is not possible to produce reports directly from the intake and follow-up data, because intake data are missing for some patients who started ART with the clinic before the introduction of the intake form.

Furthermore, due to the need to ensure continuation of the established sociotechnical network, developers delegated some tasks to humans that a computer system could have performed more effectively and efficiently. Computers are superior to humans in consistently and efficiently carrying out structured and routine tasks, such as validating data availability, domain, range, and format (Kling, 1980). However, the task of data validation was delegated to human users in the case of ARTIS because of the need to sustain sociotechnical order. Given the size of incomplete data, enforcing automatic data validation would have hindered the usability of ARTIS and disturbed the sociotechnical order. The situation is an example of a time when role allocation could not be a function of the effort required to perform tasks (Latour, 1992; Law & Bijker, 1992). Rather, it could be a function of the negotiation and compromise between data quality and the overall sustainability of a sociotechnical order. In this case, actants in the sociotechnical network negotiated acceptable levels of data accuracy and service—levels that were agreed upon socially, but were neither technically nor formally perfect.

The implementation of ARTIS in another two clinics triggered design changes that were related to role delegation. The tasks of data validation and filling out register books, which initially were delegated to human beings, were now given back to the computer system. As indicated in Figure 2, the original design of ARTIS was modified so that it would automatically generate pre-ART and ART register books and validate data, a model in line with the “effort” logic of role allocation. As an efficient and effective tool to perform data validation, the computer system, a nonhuman actant, dictated design changes. ARTIS did not move to the new sites as it was, but changed according to the new contexts—simultaneously changing these new contexts, themselves. The enrolling and controlling processes facilitated the expansion of the ARTIS network through translation of interests, assuring its continuity. This occurrence also reveals that the same task was delegated to human and nonhuman actants at the same time, but in different contexts. Delegating the same task to human and nonhuman actants means equally delegating force, duties, and ethics, which would imply competency.

The role allocation dynamics were crucial to sustaining the ARTIS sociotechnical network and, hence, to its implementation. Still, they brought obstacles to achieving the goals motivating the introduction of computer-based ISs, namely enhancing efficiency and effectiveness. As an example, crafting the system to accept pre-ART and ART register books from keyboard input duplicates data, demands additional data storage, requires resources for verifying and entering data, and impacts computer speed and data management efficiency. It is also inconvenient to generate reports because of the difficulty of choosing the source—either register books or the intake and follow-up forms. Besides, the problem of accurate information generation could be amplified by the lack of appropriate data-validation mechanisms. Errors during data collection or at the time of data entry could lead the two data sources to exhibit differences, ultimately resulting in two different reports recommending completely different actions. This phenomenon highlights the deficiencies of IS designs that hamper improved decision-making and organizational effectiveness. The fact that the impact of the role allocation dynamics
on the end result of the IS was negative underlines particularly dramatically how important it is to apply frameworks—in this article, actor-network theory—that enable us to examine these dynamics in depth.

As indicated so far, the development and implementation of ARTIS in ART clinics in Addis Ababa was shaped by the nature, features, and capabilities of ARTIS; the social and political processes; and the capacity development strategy, as well as by an approach that transcended the local/global dichotomy by blending local and global experts in the HISp network. The future of ARTIS and the sociotechnical network thus depend a great deal on both the flexibility and technical capacity of ARTIS, as well as on the complex social and political environment.

6. Conclusion

The research reported in this paper investigated the interests of actants embedded in the material and functional forms of an IS, their translations, their negotiations in sociotechnical order formation, and the IS’s overall sustainability—all considered in a resource-constrained setting where competition and politics were paramount. By studying the design dynamics of an IS over time and space following an interpretative approach, the research demonstrates how the material and functional forms and the resulting sociotechnical network embody the interests, ideologies, and strategies of the dominant and powerful actant—the actant that defines both the problem and the solution, and produces and achieves collective goals—despite obstacles presented by the realities of implementation contexts. The embedded interests and features specify the current and future patterns of use of the IS, the capacity-development strategy, and the nature of current and future changes expected from adopting organizations. The features could be resistant to future counter-changes not because of their inherent strength, but due to the magnitude of actants that would stand and speak for them.

In a resource-constrained, competitive setting, choice of development technologies and ideology, role enactment and distribution, and feature and function additions aim mainly to excel others and define and reinforce a sociotechnical network at the expense of improved performance, decision-making, and organizational effectiveness. Dynamism in role-allocation to human and nonhuman actants, regard-

less of the effort required to perform the roles, for example, was essential to sustaining the ARTIS sociotechnical network, but negatively impacted informed action and organizational effectiveness. Generally, this article demonstrates that, besides addressing the primary goals of their existence, ISs carry the interests of actants, as well, and that those interests can impact performance and the future behavior and structure of organizations, and can specify the current and future environment in which the ISs will be running and the functions they can provide to current and future users, regardless of the use context.

As demonstrated in this research, actor-network theory is a powerful methodological tool used to guide identification of actants and their associations at flexible levels of analysis. Actor-network theory also supports understanding and interpretation of the mutual interactions between the social and the technical by offering the language and flexibility to zoom in and out on actants at different levels of granularity, and through symmetric treatment of the social and the technical. As has been shown, social and technical stability resides in the mutual dependency between the technological properties and the social context, something that ANT offers the language to explain.

This research suggests that IS development and implementation is a complex sociotechnical activity in which the social and the technical negotiate and evolve together. It also demonstrates that donors and their agendas play significant roles in IS development in developing countries, especially in the healthcare sector. The findings also suggest that system developers should consider the work practices of other, similar organizations, regardless of any standards that may be in place, as contextual factors do influence local practices. Furthermore, system development, besides negotiating local interests, should pave the way for the development of generic systems that could be used across settings (Pollock et al., 2007), especially where there are standards for operations. The existence of standard operational forms, guidelines, and procedures increases the similarity of practices across settings. In cases where adherence to such standards is a must, ISs should be generic enough to be used across a diverse range of organizational contexts. Therefore, developers should deal with tensions between the local and the global, so as to develop more generalizable systems.
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SOCIOTECHNICAL DYNAMICS IN IS DEVELOPMENT IN ORGANIZATIONS


Monteiro, E. (2000). Actor-network theory and information infrastructure. In C. U. Ciborra, A. Cordella, B. Dahlbom et al. (Eds.), From Control to Drift: The Dynamics of Corporate Informa-


Appendix 3: Paper 3


1 The previous version of this paper was published in the proceedings of the 31st Information Systems Research Seminar in Scandinavia (IRIS 31st) "Public systems in the future – possibilities, challenges and pitfalls" Åre Sweden, August 10-13, 2008 http://www.iris31.se/
THE ROLE OF TECHNOLOGICAL FRAMES OF KEY GROUPS IN OPEN SOURCE SOFTWARE IMPLEMENTATION IN A DEVELOPING COUNTRY CONTEXT*

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ABSTRACT
The emergence of open source software (OSS) has changed the philosophy and practice of software development, implementation and ownership; a phenomenon which also has influenced interpretations, actions and behaviors of organizational members. This research explicates the interpretations and subsequent actions of key stakeholder groups towards OSS during the implementation of an OSS-based IS in a public sector organization in Ethiopia. Drawing upon the technological frames analytical framework, the study shows that the key stakeholder groups interpreted openness of the software and the community model of software implementation differently leading them to entertain divergent actions. Users were keen to solving operational problems via readymade IS with a third party support, while the management and technologists were focusing on the strategic importance of OSS not only to their own organization but also to the nation in general. Perception differences led to alliance formation, political processes, and change of management style. The study shows that as multiple interrelated elements shape the technological frames of groups, the relationship between frame incongruence and implementation is also complex and contextual. The study proposes technological frame analysis as an integral part of OSS implementation and a carefully crafted intervention to harness frame incongruence, if any.

Keywords: Technological frames; IS implementation; open source software; library system; developing country.

1. INTRODUCTION
Technological change in organizations is often accompanied by redefinitions of organizational routines, culture, structure, skill and knowledge (Boudreau & Robey, 1999; Lin & Silva, 2005; Orlikowski, 1996; Robey & Boudreau, 1999; Tsoukas & Chia, 2002; Weick & Quinn, 1999), a phenomenon that could shape and be shaped by perceptions of the actors. The knowledge, assumption, and expectations of organizational members concerning technology (aka technological frames) either hamper or promote the development and use of technology (Orlikowski & Gash, 1994). The alignment of technological frames of key groups in organizations facilitates development and use, and challenges otherwise (Davidson, 2006; Lin & Silva, 2005; Orlikowski & Gash, 1994). Understanding how organization members interpret ISs and how that interpretation influences their actions are therefore, helpful to improve both the theory and practice of IS development and use (Davidson, 2006). Although the technological frames analysis has been applied in different technologies and organizational settings, it has not been used in OSS domain to understand how actors interpret and act towards OSS (Davidson, 2006).

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The emergence of OSS has changed the philosophy and practice of software development, implementation and ownership. The development model has shifted from company-based to community-based where individuals volunteer their time and resources both in the development and implementation activities (von Hippel & von Krogh, 2003). The OSS license dictates distribution of source code so that users can study, modify, implement and redistribute it (Raymond, 2000). OSS facilitates localization and capacity development, reduces total cost of ownership, addresses intellectual property rights enforcement, etc (Waring & Maddocks, 2005; Weber, 2003). However users themselves are supposed to customize, configure, maintain, and enhance OSS with the support of a loosely coordinated distributed developers and users (Ducheneut, 2005).

This altered philosophy and practice of software development and ownership could influence the way organizational members interpret and act towards OSS. As far as knowledge of the researcher is concerned, there is no such a research especially that explicates the interpretations and subsequent actions of users of OSS in the public sector of a developing country context. This study therefore aims at filling this gap by explicating the interpretation and subsequent actions of key stakeholder groups during the implementation of an open source software integrated library information system (OLIS) called Koha in Addis Ababa University Library (AAUL) in Ethiopia drawing upon the notions of technological frames analytical framework (Orlikowski & Gash, 1992, 1994). The study answers the following questions: what elements and processes have shaped interpretations of key stakeholder groups? What were the roles of openness of software in shaping interpretations? How interpretation differences did influence implementation and its outcome?

The remaining part of this paper is organized as follows. The next section discusses the technological frames approach and how it is used in this research followed by presentation of the research context and methods. The implementation process of an OLIS in AAUL, the case, is presented in section four. Section five presents analysis of the case followed by presentation of the discussion in section six. Finally the conclusion is presented in section seven.

2. TECHNOLOGICAL FRAMES ANALYSIS AND OSS DEVELOPMENT

This research draws upon the notions of the socio-cognitive analytical lens called technological frames (TF) for examining how stakeholders’ interpretations influence their actions related to IT development and use in organizations. The use of frame concepts in IS traces back to 1978 when Boland (1978) used it to understand the challenges of requirements specification for a new system by analyzing the existence (or not) of shared frames between system users and analysts (Boland, 1978; Lin & Silva, 2005). Lin and Silva (2005) state that even if researches did not mention the phrase technological frame specifically, the notion has been in use for long. The technological frame analysis as an analytical framework however traces its origin to the works of Orlikowski and Gash (1992, 1994) which then used by several researchers both within and outside of the IS community (Davidson, 2006; Davidson & Pai, 2004; Puri, 2006) (for a comprehensive review see Davidson and Pai 2004 and Davidson 2006). Orlikowski and Gash (1994, p178) define TF as

.... that subset of members’ organizational frames that concern the assumptions, expectations, and knowledge they use to understand technology in organizations. This includes not only the nature and role of the technology itself, but the specific conditions, applications and consequences of that technology in particular contexts.
During system adoption stakeholders draw on specific TF to make sense of new systems which ultimately shape their perceptions and subsequent actions. TF simplify and condense elements of complex technologies and their potential use enabling groups of people to interact about what they might mean (Iacono & Kling, 2001). TF are interpretive, flexible, and context specific (Davidson, 1997; Lin & Cornford, 2000; Lin & Silva, 2005; Orlikowski & Gash, 1994). Individuals may arrive at different interpretations of and conclusions about the same technology in different contexts even if they rely on the same frame. This indicates that identifying a set of structures (or domains of knowledge) and contents (values) of one’s technological frame outside the context or in advance may not be possible. TF are built up within and between social groups as they struggle over the meaning of a technology and constitute it in their discourses (Iacono & Kling, 2001; Orlikowski & Gash, 1994). Individuals belonging to a group share some common core assumptions, knowledge, and expectations. Such TF are unlikely to be accepted and shared by other groups (Orlikowski & Gash, 1994).

The alignment of expectations, assumptions, or knowledge of different groups on key elements or categories of a technology, i.e., similarity in structure (common categories) and content (common values) is known as technological frame congruence and the opposite is incongruence (Orlikowski & Gash, 1994). Frame congruence facilitates development, implementation, and use of technologies in organizations and incongruence leads to the opposite. Interventions aimed at overcoming incongruence ideally results in frame alignment and improve outcomes (Davidson, 2006). Therefore, the examination of TF helps to gain much insight into how technologies are developed, deployed, used, and changed, and even to take corrective measures in cases of incongruence (Davidson, 2006; Lin & Silva, 2005).

Subsequent to Orlikowski and Gash’s (1994) seminal work, different empirical researches have used TF framework to identify frame domains and contents in different technology and organizational settings, mainly to examine the consequences of frame incongruence (Davidson, 2006). Davidson (2006) identifies the use of the framework in four generic frame categories – such as frames related to the attributes/features of IT, potential organizational applications of IT, incorporating IT into work practices, and developing IT applications in organizations. The TF of “social groups” can be affected by several factors including purpose, context, power, knowledge base and the technology itself. This study applies the TF framework in the OSS domain to understand how people in a developing country context where OSS is believed to have great potential for increasing ICT utilization perceived and acted on it. Besides, it investigated the roles of history of the project, organizational and political matters in shaping interpretations and actions of the key stakeholder groups.

In most developing countries, which is the context for the case at hand, shortage of expertise, staff turnover, and financial resource limitations are often cited as challenges to IS implementation and utilization (Avgerou, 2008). The emergence of OSS has been seen as a viable means to alleviate some of these challenges and increase ICT utilization, bridging the digital divide and thereby changing the existing developer-consumer relationship between developed and developing countries (bridges.org, 2005b; Weber, 2003; Weerawarana & Weeratunge, 2004). However, OSS has unique characteristics and attached values that shape interpretations of key stakeholder groups in organizations differently than proprietary software systems, impacting implementation processes and their outcomes. For example, some organizations consider reputability of vendors as an element of success or failure for implementation projects. There is a tendency to give less value to OSS because of its availability of free of charge (bridges.org, 2005a). Besides the inherent nature of OSS, an automation project was going on in the library since the end of 1980s but did not achieve the stated objective of introducing computer-based library system in the library for various
reasons. The history of the automation process and the nature of community-based OSS facilitated for the key stakeholder groups in AAUL to perceive and act differently concerning the new system (Koha) and its implementation process.

By using the TF framework as a theoretical lens, this study interpreted the data, and identified and classified the assumptions, knowledge, and expectations of the key stakeholder groups about the development of an OSS. The TF was also used as a device for tracing the elements and processes that have shaped interpretations including the role of openness of the software, and making sense of the relationship between frame incongruence and implementation. Generally, the framework was used to organize and classify data and interpret it again.

3. **RESEARCH CONTEXT, BACKGROUND AND METHODS**

3.1 **Context and Background**

AAUL is composed of more than 19 branch libraries and has been the major public information resource center in the country for research and academic purposes. The library serves mainly the oldest and the largest higher learning institution in Ethiopia, AAU, and performs managerial and technical activities centrally at the main library. A Librarian is responsible for overall operation assisted by two Assistant Librarians each in charge of technical and public services. The technical services include acquisition and cataloging while public services include circulation, reference, departments and branch libraries. The library used to offer services manually and had limitations to satisfying its users. For example, the manual system did not allow searching for an item by combining keywords or subject headings. Even if the search was successful, it was not easy to locate and know the status of a book, i.e., whether a book is in circulation, on the shelf, out of circulation, etc. The user was required to undergo further steps in order to get such information. Users except in the main library do not have any other means of knowing the collection of other branches unless they go there. The Library staff cannot easily identify and circulate books, compile reports, know collection size, etc.

The library aimed at introducing a LIS in order to alleviate drawbacks of the manual system, improve services, facilitate interactions with similar libraries, and enhance its image. It has established a computer center in 1988 to facilitate the effort. The computer center step-by-step introduced computer-based services including literature search, Internet, card catalog production, and in-house databases. To reinforce the computer center, the Library established an automation committee drawing staff from its departments and branches in the second half of the 1990s. The automation committee justified purchasing a LIS as a viable means of acquisition after considering several points, mainly lack of software engineering expertise in the library and the difficulty of mobilizing them from relevant faculties/departments within the university. Following the recommendation, the committee documented the workings of the manual system, expected features of the new system, communicated vendors, and approached funding sources but did not succeed.

While acquisition was going on, the University finalized implementing a campus-wide network called AAUNet. AAUNet was entirely designed and implemented by local experts that were drawn from computer science, information science, and electrical and computer engineering departments with the support of a local vendor. In June 2002 the university and the library administrations decided to develop ILS in-house following the AAUNet’s suite, and established a library project team drawing staff from the above listed teaching departments and making it directly responsible to the academic vice president of the University. The team reviewed the works done until that time and found important to document the detail work process of the existed system and requirements for the new system. The team then has documented the work processes of the existed system, and the
technological and functional requirements of the new system in detail. The team held a one
day workshop with librarians and software engineering experts to validate requirements. The
document was modified according to the input and a design document was prepared later, and
a similar validation workshop was held to enhance the design. Before finalizing the design,
two members of the team left for short-term training and further education abroad. At this
stage, the university administration was changed.

Change of the university administration in January 2003 simultaneously changed the
mode of acquisition from development to purchase. Following the change, a local software
company approached the university’s new administration and proposed its software at a low
cost. The new administration in turn advised the project team to conduct gap analysis, fill the
gap in collaboration with the company, and implement it accordingly. The arrangement did
not proceed as it violated finance law of the country. Following this phenomenon, another
group of people from the USA came with software initially developed to catalogue museum
materials and proposed it to the library. An ad hoc team was established to study the features
and functions of the proposed software against the requirements of AAUL and suggested for
rejection. The next attempt was collaboration among one university in the USA (a professor
and his students), an NGO (co-established by the professor), the library and ICTDO (ICT
Development Office) of AAU. The plan of this collaboration was to customize an OSS called
OpenBiblio but discontinued without bearing the desired result. Until this time, the
automation team, which was established in the second half of 1990s, continued with the same
objective except changes in team composition and adopted mode of acquisition.

3.2 Methods
The research adopted the qualitative research approach (Silverman, 2005) with the underlying
epistemological and ontological notions of the interpretive philosophy (Klein & Myers, 1999;
Orlikowski & Baroudi, 2002; Walsham, 2002). The research was designed as an
interpretative case study to collect and analyze data (Walsham, 1993, 1995, 2006). Detailed
data collection was conducted through semi-structured interviews; review of minutes, reports
and memos; and observations at the research site. The researcher was employee of the
Library from 1996 to the end of 2002, until he joined a teaching department in the same
university. During this period, he served the library as chairperson of the automation team
(from August 2000 to August 2004) and systems librarian. Membership of the researcher in
the automation process facilitated access to data pertaining to history of the automation
process.

Before conducting the interview, the researcher identified the key stakeholder groups
based on his experience and a preliminary investigation. The library has two categories of
staff – academic and nonacademic. The academic staff was responsible for setting the overall
direction of the library, managing services and conducting R&D activities while the
nonacademic was responsible for daily routines. The nonacademic staff constitutes the largest
number of manpower in the library. The academic staff plays major roles concerning
decisions that involve change and take part in it. During the implementation of Koha, the
library’s management, branch library heads, project team members, and catalogers had
significant influence. Members of these groups were constituted from academic and
nonacademic staff of the Library. The management was responsible for allocating resources
to the project and negotiating with the AAU administration. Branch library heads participated
in deciding which system to adopt and participated as members of the project during
implementation. Only the cataloging and online public access catalog (OPAC) modules were
operational at the time of this research. The staff of the cataloging department was the only
user of the system from the library staff side and it was included in the study. Historically the
project was associated to the ICTDO (ICT Development Office) of the University that came
into being in January 2003 with the primary responsibility of carrying out computer networking and administration, and R&D activities. The role of the ICTDO was negligible in the full-fledged implementation of Koha hence, excluded from further investigation.

The researcher conducted 26 interviews, their duration varying from 1 to 2 hours, with Koha implementation team members, the library’s management and catalogers during February to April 2007 and November 2007 to February 2008. Most of the interviews (fifteen of them) were tape-recorded, and detailed notes were taken for the rest of the interviews. Informal discussions were also held with members of the project and catalogers over lunch and tea breaks. Reports, minutes, and memos were reviewed to get an understanding of the decisions, ambitions, frustrations, successes, and challenges of the process, and how they were perceived. The researcher paid visits to the research site during several occasions, particularly paid attention to the catalogers while performing their usual duties.

The interviews were guided by initial questions on philosophy towards technology, issues around project initiation, implementation of Koha, use of Koha, criteria of success, the impact of Koha, and relations with other groups during the implementation of Koha (Orlikowski & Gash, 1992). After the data collection, the researcher iteratively analyzed the recorded interviews and field notes in light of the technological frame analytical framework, and sorted frame domains and contents. These categories were compared against the frame categories reported in the literature, analyzed the relationship between frame incongruence and implementation outcome, and interpreted the elements and processes that shaped the TF of the key stakeholder groups.

4. IMPLEMENTATION OF KOHA

AAUL and ICTDO initiated a joint project aimed at OSS adoption in October 2004, immediately after discontinuing the previous arrangement meant for customizing an OLIS called OpenBiblio. They organized a project team drawing staff from the library, ICTDO, and computer science, electrical and computer engineering, and information science departments and assigned a project manager from the library’s staff. The team investigated extant OLIS, shortlisted OpenBiblio and Koha, and finally selected Koha for implementation. The majority of academic staff of the library including branch and department heads that have longer years of experience and better education did not favorably accept the assignment of a junior staff to manage the project. Furthermore, they did not favorably accept the decision of implementing Koha rather insisted on purchasing an ILS.

Almost all of the branch heads, department heads and academic staff of the Library were direct participants of previous attempts that did not achieve desired goals. The previous attempts revealed lack of expertise and high staff turnover in the University and indicated the challenge of relying on local staff. Therefore, this group presumes OSS adoption to be repeating the previous failure scenarios in a different fashion. They further explain that the money allocated for the project was sufficient to buy a third generation library system that was tested and operational somewhere else paving the way for knowledge transfer with the aid of vendors. They considered OSS implementation to be challenging because of the requirement to self configure, customize, upgrade and maintain the acquired system. Their friends abroad who have been working in similar a situation reaffirmed their belief. The adoption decision was discussed in a monthly academic staff meeting of the Library staff. The meeting has been a stage for deliberating major issues and happenings in the Library

† Koha is an integrated library system meant for computerizing services of a library. It was initially developed in New Zealand and distributed under the open source General Public License (GPL). Koha has modules for circulation, cataloging, acquisitions, serials, reserves, patron management, branch relationships, and has additional basic and advanced features. It was first deployed in 2000.
such as systems implementation. According to this group, the project manager was not able to convince them rather walked out and the discussion was not recorded. Since then, those who were opposing the customization of Koha were engaged in explaining the shortcomings of the decision to other colleagues in the Library.

According to the project manager and technologists however, Koha had core library functions such as cataloging, OPAC, circulation, and acquisitions that made it sufficient to AAUL. They regarded the adoption of OSS as a novel approach that paved the way for local capacity development that can serve as a knowledge hub for other libraries in the country besides AAU. OSS also believed to be a good opportunity to introduce features peculiar to Ethiopia such as Amharic script, indexing and searching Amharic materials, etc. They also tell that other libraries that used to use proprietary software were migrating to OSS. The ICTDO also supported the idea and the project arranged for a pilot phase before embarking on full-fledged implementation.

4.1 The Pilot Phase
The primary objective of the pilot phase was to test the features and functions of Koha in real-time, understand drawbacks and take corrective measures to ensure smooth operation. To do so, the team members from the library became responsible for populating Koha and evaluating its functions while the rest members configured and provided technical support. The team configured Koha, populated its database with nearly 25,000 records (bibliographic data of books) and evaluated its technological and functional features. The project manager explains that those who were opposing Koha were members of the evaluation team and held key positions in the Library, and it was challenging to deny them participation despite the danger. As he expected their contribution in the pilot phase was not constructive but learned a lesson to place them where their role will be less likely to affect the overall implementation outcome in the future. The project manager states that the pilot phase had consumed only 25% of the allocated money and the team had learnt important lessons on technical and organizational matters. Therefore, instead of investing resources on documenting and reporting results, the project manager focused on diverting the effort towards securing the support of the University administration. As a result, the result of the pilot phase was not documented and reported according to the agreement. However, live demonstrations were made to the University’s administration and other selected users. For the academic staff, however, the pilot phase did not show any result. They assumed that the management did not release the results of the pilot phase because of the intention of the latter to cover up the problems of Koha and the wrong decision made to adopt OSS.

4.2 Cataloging Module Implementation
The library took ownership of full-fledged implementation and subsequent activities of Koha after the pilot phase. The University’s administration allocated money for the project and demanded completion within two months. To do so the library organized a project team drawing only from its staff and appointed the previous project manager to manage the project. The project team was composed of deployment, retrospective conversion (recon), and training sub-teams. The sub-teams were responsible for customizing and implementing Koha, converting card catalogs into electronic format, and train staff and end users respectively. The project manager placed those who were opposing the implementation of Koha in the training sub-team with the aim to minimize their role in the implementation process and its outcome. The deployment sub-team decided to implement Koha module-by-module starting from cataloging followed by OPAC, Circulation, etc. The cataloging module allows catalogers to populate Koha with bibliographic data of books and serials. Once done, users can easily
search and locate materials regardless of location and time using OPAC and circulation of books becomes possible.

Those who were against indicated the non-practicality of implementing Koha within two months and recommended dropping the agreement, while the project manager insisted on agreeing with the timeframe because of the possibility of getting grace period. Finally, an agreement was reached between the university administration and the library with the stated timeframe without the consent of the opposition group.

While implementation was going on, the University Administration approved two assistant university librarian positions. The project manager, who was student and junior staff at the time, was promoted to one of the new positions with the recommendation of the university librarian. The action angered most of the academic staff that had better education, knowledge and longer years of experience and argued against the promotion. They became suspicious of the relationship among the project manager, the university librarian and the university administration. The appointment also created decision making problem as the project manager takes care of the day-to-day operation of the project, reports to himself, and takes corrective measures by himself. The project manager however states the following concerning the overall implementation:

The project proved the indispensability of no one. Those who believe were indispensable in the activities of the library are not thinking of it any more. The image of the library was improved due to this project; the university management was convinced that the library has the capability to run projects worth huge amounts of money.

Those who were opposing the implementation of Koha, in turn, tell that the library’s management was repeating the phrase ‘no one is indispensable’ to undermine their experience and qualifications paving the way for the promotion of a junior staff – the project manager. They also indicated that their relationship with the project manager was not bound to their professional activities; the project manager failed to talk to them when the implementation encountered any problem.

Only the cataloging and OPAC modules were operational at the time of conducting this research. The catalogers, most of whom were academic staff, were the primary users of the cataloging module. They expected the module to facilitate cataloging functions much better than before but Koha fell short of their expectations. Koha did not facilitate collaboration among colleagues and lacked required functions. As a result, they were forced to use both the old system and Koha in parallel. They say that their continued requests for inclusion of important features did not get favorable answers and complain about lack of participation in the customization process. They used to report technical problems directly to the deployment sub-team but abandoned doing so due to negative reactions and delayed solutions, if given at all. They tell that their continued reporting of technical problems was interpreted by the project manager and the deployment sub-team to be resistance and an attempt to disrupt the implementation. A cataloger states the following concerning error reporting and the overall process:

I think the technical people did not have the required expertise to give favorable response to our requests. We have learned that the same system has been running smoothly in other libraries. … In our case, however, still there are unresolved problems …. we even held a meeting concerning the implementation process. Even if we all were disappointed, what we agreed at
The end was to continue using Koha despite its drawbacks, because ultimately, what we want is to see a modern library.

The project manager and deployment sub-team tell that they were guided by the standardized nature of library work, review of the literature, and incremental system development technique to justify Koha. One of the members states the following:

Most functions of libraries are standard and the development of Koha was based on this assumption. Most of the required functions were added and bugs were already solved. Of course, there are some unresolved problems. …, in general, lack of detailed training to the catalogers made them feel uncomfortable to run it. Sometimes what they report as a problem or as missing was not a problem or was already available.

According to the deployment sub-team, some of the functions that were required by catalogers at that time such as producing card catalogs were not worth inclusion as they will soon be obsolete. While implementation of Koha was going on, the university annexed independent public colleges and institutes that dictated the continuation of the previous work in parallel with Koha beyond the expected duration according to the project manager. The project manager and the deployment sub-team equally emphasize the insufficiency of the training they had concerning the technologies of Koha to customize and configure Koha. Due to this problem, they were not able to solve all technical related problems.

4.3 Retrospective Conversion

The implementation of Koha included converting the card catalogs into an electronic format, which is called retrospective conversion. The bibliographic details of all materials acquired by the library since its establishment in 1950 needed to be entered into Koha with the exception of the details of weeded out materials. There were about 500,000 volumes of monographs and about 20,000 bound and unbound journals (Addis Ababa University Library, 2005) the bibliographic details of which were potentially needed to be converted into an electronic format. The magnitude of the task and the limited timeframe led the project to mobilize the library staff and hire additional data entry personnel to run the conversion 24/7 for three months. The arrangement to manually populate Koha with data from shelf list cards raised professional, remuneration, and data quality concerns.

According to the academic staff and users, converting the manual card catalog into electronic version lacked the necessary preparation and remuneration package. For instance, they tell, neither catalogers nor the newly hired data entry personnel were given sufficient trainings to operate Koha. The data entry personnel did not have cataloging knowledge either. The group members reflect:

It was just like a blind leading the blind when it comes to operating the system and assisting the data entry personnel. Of course, we successfully supervised them regarding the work but, it was difficult to answer simple technical questions of Koha.

The two days training program organized for the data entry personnel was not sufficient. All of them were students and due to class commitments no single student attended all of the sessions. …These people were here just to get paid. They didn’t bother about the work and its future consequences. …
According to the management and technologists, the training was not sufficient to make catalogers able to understand the detail operations of Koha. However, they had an understanding that if the catalogers were exposed to the system they can learn the rest by themselves because of their educational background and experiences. Nevertheless, what we experienced was the opposite; sometimes the catalogers bring questions the answer of which was already available in the system.

No pre-conversion preparation was made as to what should be entered into Koha and how, according to the academic staff and the catalogers. The library conducted inventory more than ten years ago. The shelf list that conveys information about inventory did not exactly reflect the collection size of the library because during the ten years period the library lost books through various mechanisms. Nevertheless, Koha was populated with data taken from the shelf list even excluding the previous inventory information present in it. This implies that the existence of a book’s data in Koha does not indicate its availability in the library. This, according to the group, violates the ethics of librarianship.

The catalogers and data entry clerks downloaded the electronic record of matching shelf list cards from a database in the USA and stored it in a temporary database, which then was entered into Koha. Due to infrastructure, bandwidth, and Koha related technical problems, the data entry process was very slow and cumbersome. For example, configuration related problem disrupted the work for a month. One of the catalogers states the following:

Due to the new technology, we were forced to conduct the usual cataloging without physically looking at books. Because of an order from the project manager, the ethics of the profession was violated. …. The library hired data entry clerks because of the top management’s lack of interest to financially benefit us.

The pre-conversion preparation was not done properly due to time pressure and the plan to clean the data later according to the project manager. One member from the library management states the following:

Pre-conversion preparation was very important but given the time required to complete the project focusing on these matters was a waste of time. If we did the conversion after inventorying the collection, it was impossible to achieve what we had achieved now. The inventory by itself takes a lot of time and disrupts work…. The issue was not about deploying the best system following best practices. Rather it was to deploy a suboptimal system and refine it through time.

Finally, the OPAC and the cataloging modules went operational on AAUNet. The catalogers have been entering bibliographic details of materials, and end users have been searching for and locating books using the system. Additional modules implementation and feature additions were continuing during this period. The implementation of Koha entertained opposing views starting from the inception stage from different groups as stated above. These opposing views and subsequent actions led to the resignation of the assistant librarian in charge of technical services and the retirement of the head of the cataloging department. The following section analyzes, classifies and discusses the data from TF perspective.

5. ANALYSIS
The library’s management, technologists, and users constitute key stakeholder groups in the implementation of Koha in AAUL (table 2 summarizes their compositions and objectives).
This section analyzes the viewpoints of these groups, elements and processes that have shaped their perceptions, and indicates how perception differences and an intervention aimed at harnessing frame incongruence shaped the implementation process and its outcome.

### Table 1: Summary of Group Composition and Objectives

<table>
<thead>
<tr>
<th>Group</th>
<th>Composition</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>University Librarian and assistant University Librarians.</td>
<td>To deploy an integrated library system that modernizes services of the library.</td>
</tr>
<tr>
<td>Technologists</td>
<td>IT technicians from the computer center of the library.</td>
<td>To configure, customize, install, and enhance the new system.</td>
</tr>
<tr>
<td>User group</td>
<td>Department and branch heads, catalogers, and academic staff of the Library.</td>
<td>To ensure the new system meets the current and future requirements of the library.</td>
</tr>
</tbody>
</table>

#### 5.1 Perceptions of the Key Stakeholder Groups

The key stakeholder groups have viewpoints that implementing an integrated library system would solve drawbacks of the manual system, change image of the library, and facilitate collaboration with other libraries. However, they have divergent views on selection and implementation of an OSS, feature and capability of the chosen software, and the processes of converting the manual routine and data into electronic versions. The management and technologists, on the one hand, and users on the other hand, promoted similar viewpoints with slight differences on these issues.

The perceptions of the management and technologists were centered on the existence of core library functions, feature and function additions through time, bypassing financial limitation through OSS customization, and long term capacity development agendas. They were convinced that the acquisition and implementation cost of an OSS is minimum, facilitates local capacity development, and assists contextualization. The management believes that once the library acquired the software, technologists (local staff) would develop the necessary expertise through training, participation in a real project and by sharing experiences with others. Then they would serve as a hub for transferring their knowledge and source code of Koha to other libraries in Ethiopia. The actions of this group were targeted at winning the support of the source of fund and quickly deploying Koha. They, gave less emphasis to documentation, reporting and convincing the rest of the library staff, and regarded some of the users as threats to the process and denied them active participation.

The user group understood OSS from the perspective of expertise requirement for customization, configuration, enhancement and administration; lack of information on practical operation of the software; lack of support from a third party (in customization, configuration, retrospective conversion and knowledge transfer); the need for immediately solving problems of the old system; and availability of all of the required functions. Users were in need of a working system that quickly solves the drawbacks of the old system. Lack of the expected pilot phase deliverables strengthened their beliefs about the inappropriateness of the chosen system and the implementation approach. Users have understood that Koha lacked some of the required functions and assumed that it could be solved through interactions with technologists. As a result, they reported bugs and technical problems to technologists on a continuous basis. However, technologists did not provide solutions and welcome requests; even technologists and the management regarded the continued requests for change as an act of resistance to the implementation. The situation has affected the existed smooth relationship between users and technologists and the management. In order not to deteriorate the already damaged relationship and due to lack of solutions for requests, users have kept silent, continued using the new system, changed the previous reporting mechanism.
and started questioning the expertise of technologists. They perceived that denial of participation in the process resulted in a system that was not up to their expectations. This group, in general, associated the functions of Koha, the level of customization, training, and supports to the expertise of technologists. They interpreted features of Koha in terms of the knowledge and experiences of technologists, responses to bugs and their timing, and participation in the customization process.

When it comes to converting the paper-based data into an electronic format, the actions of users were linked to tensions between their knowledge of the librarianship profession and the nature of the leadership. The profession dictates the data conversion to follow certain procedures and standards to do it accurately but takes time. The management also assumed that doing the conversion rightly demands time beyond the limit of the project, therefore, insisted on completion of the conversion within a short period of time acknowledging inaccuracies but aiming at cleansing them through time. The users tended towards obeying orders from the project manager rather than their profession because of its immediate effect on their career. They thought that had they not obeyed the orders of the project management, they would have risked their careers. As a result, they considered Koha and the process to be threats to their professionalism. Furthermore, the catalogers believed that hiring additional workers that had neither the knowledge of Koha nor the cataloging practice to be the manifestation for the management’s lack of interest to financially benefit them. Had these people not hired, they would have worked overtime for extended periods allowing them to earn more. The management and technologists presume that prior knowledge and experiences of catalogers were sufficient to understand operations of Koha and guide others if briefly trained while users were expecting detailed training. Table 2 presents a summary of the viewpoints and actions of the management and technologists, and users.

<table>
<thead>
<tr>
<th>OSS Selection</th>
<th>Viewpoints and actions of the management and technologists</th>
<th>Viewpoints and actions of users</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OSS Selection</strong></td>
<td>OSS customization is a novice approach; facilitates local capacity development; demands less cost; feature and function addition and customization are on demand; experiences of other libraries tell migration from proprietary to OSS. Convince the university administration to approve the plan and allocate resources.</td>
<td>OSS adoption would be problematic due to shortage of expertise and high staff turnover. We lack knowledge of practical operations of the software. The budget allocated for the customization was sufficient to purchase tested software. Vendors could perform additional basic activities such as retrospective conversion and transfer knowledge.</td>
</tr>
<tr>
<td><strong>Piloting and Implementation</strong></td>
<td>Once the project has learnt important lessons, no need for spending resources on documentation and reporting. Rather concentrate on securing the support of the university’s administration. Minimize the roles of opposition group in the process so that their impact will be limited.</td>
<td>The result of the pilot phase was not reported to intentionally hide drawbacks of the software. The pilot phase was nominal and did not bear any result. The library staff should oppose adoption of the system. The library management and the university administration have hidden agenda.</td>
</tr>
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</table>
### Feature and Functions of the New System

<table>
<thead>
<tr>
<th>Library functions are standard and Koha basis these standards. The adopted implementation process is incremental, i.e., modules and functions are added through time. Since some of the functions will be obsolete soon, there is no need for focusing on them given expertise limitation.</th>
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<tbody>
<tr>
<td>We demand all cataloging functions; not consulted on feature addition and exclusion; not enough training; problem reporting enhances the system; negative reactions averted direct reporting of problems to technologists; we want a modern library and work on the system despite problems.</td>
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### Retrospective Conversion

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<th>Catalogers have basic computer knowledge, they can learn by themselves if basic operational training is given; time was not sufficient for preparation; data can be cleaned later.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koha and the process were threats to the librarianship professionalism. Lacked remuneration package and preparation on data conversion; limited training; and authoritarian leadership reflected.</td>
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5.2 **Sources of Interpretation Differences**

The interpretations of key stakeholder groups in AAUL were shaped by the nature of the software, output and lessons from past automation efforts, the changed management style, and political processes. As indicated above, key stakeholder groups perceived openness of the software differently. The management and technologists promoted the strategic importance of OSS while users perceived it from the perspective of local resource availability and third party involvement in the implementation process to conduct some extra activities and transfer operational and technical knowhow. These perception differences were rooted in the automation history and resource availability within the library. History of automation attempts in AAUL reveal the complex nature and challenges of IS acquisition and development because of financial, political, human resource, and other limitations. These factors remained the same when the library opted for OSS adoption and directly impacted the perceptions of actors although differently. The management considered OSS customization to be a novice approach that would have a bright future prospect while users perceived it to be similar with previous failed exercises.

Furthermore, the assignment of a junior staff to manage the project and his subsequent appointment to a senior position in the library while he was a student at the same time perceived to be an act of undermining contributions of the rest staff. The two groups entertaining opposing views on the implementation of Koha were busy forming alliances with their respective peers. As a result, some of the staff who did not have either interaction with or involvement in the process developed negative attitudes towards Koha. The project management process and the changed management style played significant roles for the opposition group to be suspicious of the implementation process. The actions of the library management that was manifested in “no one is indispensable” discourse which was followed by promotion of a junior staff to a senior position, and other associated factors mentioned so far made users to perceive the new system as threat to both their professionalism and career.

5.3 **Perception Differences and IS Implementation**

The effect of frame incongruence cannot be seen in isolation from the type of intervention and local circumstances. The differing interpretations of the key stakeholder groups concerning the new system and the implementation process have challenged the development of Koha in AAUL. Because of perception differences, knowledgeable and experienced employees were denied active participation, collective decision-making style was damaged, and staff mobilization became difficult. Frame incongruence has brought difficulty to the
implementation process dictating the management to take corrective actions, which in turn resulted in negative consequences. The management minimized the roles of those who were opposing the customization of Koha. This intervention did not bring positive changes but widened the gap due to the size of the opposition group and their success in selling ideas to other colleagues. This kind of interventions might work well in cases where the size of the opposition is small, for example in the case of financial system implementation reported by Markus (Markus, 1983). Furthermore, the intervention did not go in line with the political processes going on in the library as indicated earlier. Under such circumstances, denying the participation of experienced and knowledgeable staff that was also large in number could not benefit implementation. Its harmful effects outweigh the benefits.

The implementation outcome of Koha in AAUL was shaped also by the inherent ambitions of the staff to change the image of the library to the better and due to the changed management style from participatory to authoritarian. The authoritarian management style demanded all employees to work with and deliver products using the new system despite problems. Partly due to the ambition of the employees to change the library to the better, they tended towards obeying the new style. From the management perspective, had this not been the case, Koha might not reach the level of implementation it achieved now. Lack of participation also affected the quality, in terms of feature and function of the system. Of course, it is possible to say that the management has understood the expertise of technologists and tried to block suggestions for improvements. In this case, if reporting problems and suggestions did not improve the quality of the system, blocking the communication and participation would have helped to keep the relationship between users, and technologists and the management intact but that did not happen. The following section discusses these findings in relation to the IS literature.

6. DISCUSSION
Although OSS has the potential to increase ICT utilization in DCs, its actual benefits are negotiated orders with the complex socio-technical ensembles of the implementation environment. IS implementation is a complex socio-technical process that can shape and be shaped by the complex implementation environment (Cordella, 2006; Davidson & Chiasson, 2005). This case study explicates one such element: perceptions of key stakeholder groups’ in an organization towards an OSS and its development process in a public sector organization in Ethiopia. Even if all of the key stakeholder groups perceived the OSS technology as a means to changing operations, services and image of the library to the better, they entertained opposing views on the nature, characteristics, and capability of the chosen software and its development approach. The community-based OSS implementation model, i.e., the model that does not involve an intermediary (von Hippel & von Krogh, 2003; von Krogh, 2002), dictated local staff to be in charge of customization and implementation. This phenomenon gave rise to perception differences among key stakeholder groups since the inception of the project and continued throughout. Change of management style and political processes that alienated knowledgeable and experienced staff from participation aggravated differences and affected implementation. The knowledge and experiences of the staff with previous automation efforts in the library played a significant role while interpreting the current technology and its development process.

The management and technologists especially focused on the strategic importance of the chosen software to the specific library and libraries throughout the country and promoted the potential importance of OSS similar to those reported in the literature such as the opportunity of local capacity development (Weber, 2003; Weerawarana & Weeratunge, 2004), adaptation to changing organizational environments (Gallego, Luna, & Bueno, 2008), and free from license cost and less total cost of ownership (Waring & Maddocks, 2005). They
perceived OSS adoption as a novice approach that was not tried before in AAUL and devised strategies that could go in line with the limited local resource and expertise. For example, they have focused on the existence of core functions while evaluating the new system rather than seeking for a solution that has complete functions, opted for incremental development approach and technical capacity development in the course of implementation, and planned for benefiting from the community of developers dispersed around the globe. They also perceived that once the catalogers were briefly trained on the basics of operations of the new system they would learn the rest by themselves. Furthermore, they concentrated on quickly deploying the chosen system, convincing the source of fund, escaped documentation and reporting, gave less priority to convince opponents, and adopted a strategy of cleaning data through time. These perceptions and actions of the management and technologists were not favorably accepted by the user group though.

The users gave due attention to availability of expertise at hand that would customize and deploy the system with all the required function and considered OSS customization and relying on the limited local expertise to be similar to repeating the previous failed attempts in a different fashion. They regarded the new system and the data conversion approach as threats to their professionalism and career. Furthermore, users interpreted openness of the software and the noninvolvement of an intermediary because of the implementation model as challenges while the management and technologists perceived them as opportunities. Users also perceived feature and function of the technology in light of the required and the expertise available in AAUL.

The salient technological frame domains in the implementation of Koha in AAUL revolve around feature and functions, incorporating IT applications into work practices, and developing IT applications in organizations. These frame domains are similar to the frame domains identified by previous studies, although there are content differences (Davidson, 2002, 2006; Orlikowski & Gash, 1994). For example, Orlikowski and Gash (1994) identify the nature of technology, technology strategy, and technology in use as the dominant frames in their study. The nature of technology refers to people’s images of the technology and their understanding of its capabilities and functionality. Technology strategy refers to people’s view of why their organization acquired and implemented the technology. It includes their understanding of the motivation or vision behind the adoption decision and its likely value to the organization. Technology in use refers to people’s understanding of how the technology is used on a day-to-day basis and the likely or actual conditions and consequences associated with such use.

As indicated in this study, interpretation differences can challenge implementation by leading organizational members to take different often conflicting actions similar to the ones reported in the literature (Davidson, 2006; Lin & Silva, 2005; Orlikowski & Gash, 1994). This situation calls for an intervention, but the outcome the intervention depends on its relevance and appropriateness to the situation. In the case at hand, the management denied the active participation of members of the opposition group in the implementation process with the aim to minimize their impact both on the implementation process and its outcome. The intervention did not bring positive changes in the implementation process rather deteriorated differences and counter actions increased because of the size of the opposition group, and their expertise and experiences in the library. The case at hand reveals that denying the participation of knowledgeable and experienced staff that is also large in number does not solve the problem rather deteriorates it. Therefore, interventions aimed at avoiding or minimizing interpretation differences should consider other mechanisms than denying the active participation of members depending on their size. Lin and Silva (2005) propose technological frame analysis along with requirement analysis so that user requirements reports include an assessment and description of the TF of users to design appropriate
solution earlier. A similar procedure is required during OSS customization. OSS, as explained above can be interpreted differently by different stakeholder groups and to realize its potential especially in DCs, it is crucial that projects assess the TF of stakeholder groups as early as possible and design appropriate and relevant solutions taking local and contextual circumstances in to account. The following table summarizes the key findings and implications.

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<th>Key findings and implications</th>
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<tr>
<td>1.</td>
<td>The management and technologists framed OSS as an opportunity that would minimize total cost of software ownership and a means for building knowledge hub that would serve AAUL and other libraries in Ethiopia. Users however framed OLIS implementation as repeating previous failure in a different fashion perceiving OSS from the perspective of expertise requirement and third party involvement. Users regarded the new system and its implementation process as threats to their professionalism and career. Because of perception differences, knowledgeable and experienced employees were denied active participation, collective decision-making style was damaged, and staff mobilization became difficult. Although OSS opens up new opportunities for resource constrained settings to increase ICT implementation and use, its actual benefits are negotiated orders with the socio-technical ensembles of the implementation context. Technological frame incongruence between the key stakeholder groups hampers the potential of OSS to organizations.</td>
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<td>2.</td>
<td>Lesson from past automation efforts, nature of the software, and an implementation process that changed the management style and resulted in political processes shaped perceptions of the key stakeholder groups. The history of automation attempts in AAUL testifies to the complexity of IS acquisition and development because of interrelated factors including financial, political, and human resource, which remained the same when the library opted for OSS adoption. Users interpreted the relationship between the library and the university management, and some of subsequent actions as an act of undermining their contribution and future efforts.</td>
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<td>3.</td>
<td>The management devised a strategy that denied the active participation of members of the opposition group in the implementation process with the aim to minimize their impact both on the implementation process and its outcome. However, the intervention did not bring positive changes rather deteriorated differences and increased counter actions because of the size of the opposition group. The implementation outcome was also shaped by the inherent ambitions of the staff to change the image of the library to the better and due to the changed management style from participatory to authoritarian. Measures designed to harness frame incongruence and promote implementation should be contextual. The effect of technological frame incongruence on implementation outcome could be shaped by inherent ambitions of the staff to change their organization to the better.</td>
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7. **CONCLUSION**

The research reported in this article explored the perceptions of key stakeholder groups towards OSS, the elements and processes that shaped interpretations, and effects of perception differences on the outcome and the implementation process of an OSS library IS (OLIS) in a public sector organization in a developing country context, Ethiopia. Drawing upon the technological frame (TF) framework and following the interpretative case study method, the research shows the existence of perception similarities between technologists and the management, and differences between technologists and the management, and users.
Technologists and the management perceived OSS to have strategic importance not only to the specific organization but also to the nation in general through local technological capacity development, free acquisition and further distribution of the source code, and the opportunity it offers for customization. They, in general, perceived openness of the software and the community-based development model as a golden opportunity, and as a result, their actions and plans were targeted at realizing the potential of OSS. Users on the other hand perceived OSS from the perspective of expertise requirements, concentrated on a solution that quickly and fully addresses their problems, and the participation of a third party in the implementation and knowledge transfer processes. The perceptions of users were deeply rooted in previous automation efforts in the library that did not deliver the desired output but made quite a lot of attempts. Users perceived openness of the software and the community-based model of implementation as challenging and that cannot achieve its goals. The political processes that alienated the knowledgeable and experienced library staff and the changed management style from participatory to authoritarian have also played significant roles in shaping the interpretations of the key stakeholder groups. The value placed on technology and the ambitions of the different stakeholder groups to alleviate drawbacks of the old system and improve images of the library have positively impacted the implementation.

This study points out that even if the potential of OSS in DCs is immense, its realization could be affected by several contextual factors including interpretation differences. As several elements and processes shape TF of groups, the effects of frame incongruence on implementation outcome could also be shaped by complex elements, which make it difficult to a priori generalize about the exact effect of frame incongruence. The effects are shaped by local circumstances, such as for example, the type of bureaucracy, staff motivation, and the size of the group entertaining divergent frame as demonstrated in this research. The article suggests elements to be considered while designing interventions aimed at addressing frame incongruence and emphasize the need to conduct frame analysis during OSS customization as early as possible. Such studies are helpful to understand the TF of key stakeholder groups and design appropriate strategy to embark on technological frame incongruence, if any. The study suggests that in order to reap the aspired fruits of OSS there is a need for harmonizing the technological frame of the key stakeholder groups in organizations.

Acknowledgements
I am grateful to the editors, Eric Monteiro, Petter Nielsen and Margunn Aanestad for their valuable comments on earlier versions of this article. I am indebted to HISP and staff of AAU library that participated in this research.

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Appendix 4: **Paper 4**

OSS DRIVEN ORGANIZATION CHANGE IN A DEVELOPING COUNTRY CONTEXT: CASE STUDY FROM THE PUBLIC SECTOR

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OSS DRIVEN ORGANIZATION CHANGE IN A DEVELOPING COUNTRY CONTEXT: CASE STUDY FROM THE PUBLIC SECTOR

Completed Research Paper

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Abstract

This paper investigated the organizational changes that were unfolded during the implementation of an OSS-based IS in the public sector of a developing country (DC) context and the ramifications of aspects of OSS and contextual matters on the process and its outcome. To do so, the study draws upon IS literature that views technological change as an emergent property of the complex interaction between ISs and organizational contexts, and the notions of organizational routines to explore the changes. The result of the interpretative case study suggests that although the license, openness of source code, and community (open) participation in implementation offers unprecedented opportunities for developers in DCs to develop technological capacity and collaboratively customize and implement software, these aspects could also be sources of challenges and could facilitate for routines to be extended unnecessarily in turn affecting roles and relationships. The study suggests that focusing on the notions of organizational routines helps to understand and explain organization changes and the complex interaction between the social and the technical in a specific context. Finally the study recommends points to bypass some of the challenges.

Keywords: Organization change, developing country, information system implementation, open source software
Introduction

The emergence of OSS has opened up new opportunities for developing countries (DCs) to acquire, study, adapt, and redistribute software (Li et al. 2004; Weber 2003; Weerawarana and Weeratunge 2004). In principle, adoption of OSS reduces license cost and total cost of ownership (Waring and Maddocks 2005); promotes indigenous technological development (Weber 2003; Weerawarana and Weeratunge 2004); avoids being hostage to proprietary software and vendors (Weber 2003); guarantees against buried “espionage software” (Weber 2003); advances knowledge more quickly (Câmara and Fonseca 2007); promotes adaptation to changing organizational environments (Gallego et al. 2008); and helps to set up an information economy (Weber 2003; Weerawarana and Weeratunge 2004). In practice however, technology transfer to DCs in general, and implementation of ISs, often brought from the West in particular, have been challenging and the failure rate was very high (Heeks 2002; Walsham et al. 2007). IS implementation in DCs has been challenging due to the complexity of ISs (Braa et al. 1995; Heeks 2002), impediments in DCs such as lack of resources and techno-scientific capabilities (Avergerou 2000; Meso et al. 2009; Odedra 1992), and country context differences which may lead to the development of ISs that are embedded with rationalizations, assumptions, and world views of the place of production demanding adaptation to use contexts (Akrich 1992; Heeks 2002; Orlikowski and Barley 2001). The implementation of OSS-based ISs in DCs is not immune to these challenges. Of course, the OSS philosophy has shifted the practice of software development and implementation from organization-based to individual-driven and from closing to opening source code (Feller et al. 2005).

The study of OSS often focuses on various aspects of development projects such as motivations, governance structure, modularity, socialization, etc (Ducheneut 2005; von Krogh and von Hippel 2006). Little attention has been given to the implementation aspect, especially the implementation of domain specific applications such as library information system (LIS) in general, and in DCs in particular (Waring and Maddocks 2005). Given the complexities of IS implementation, hindrances in DCs, and the altered philosophy and practice of IS development/implementation as a result of OSS, how organizations in DCs cope with OSS-based IS implementation? What are the effects of the altered philosophy and practice of software development and implementation on organization change? These are some of the questions which the OSS literature did not give much attention so far and, which this research tends to address focusing on the latter. The study explored the unfolded changes and ramifications of the OSS philosophy and practice on organization change during the implementation of an OSS-based IS in a public sector organization in a DC. The study was conducted in a public sector academic library in Ethiopia called Addis Ababa University Library (AAUL). The library introduced an OSS-based LIS (OLIS) called Kohal in 2004 and has been using the cataloging and OPAC (online public access catalog) modules ever since while additional module implementation was going on. The implementation of Koha created a new socio-technical order in AAUL that has implications both to the OSS and organization science literatures.

The rest of the paper is organized as follows. The next section explains the analytical framework adopted in this research by reviewing relevant literature on OSS in DCs and technological change in organizations. The research context and methods are presented in section three followed by a presentation on the cataloging work practices before and after the introduction of Koha and the planned cataloging in section four. Section five presents the analysis followed by presentations of the discussion and conclusion in section six and seven respectively.

OSS in Developing Countries and Organization Change

OSS in Developing Countries

Studies indicate the relevance of IT/IS to support the development agenda of DCs simultaneously emphasizing the challenges of realizing them (Heeks 2002; Heeks and Stanforth 2007; Walsham et al. 2007; Walsham and Sahay 2006). IS implementation in DCs has been challenging because of resource limitations (financial, infrastructural, and

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1 Koha is an OSS distributed under the open-source General Public License (GPL), initially developed in New Zealand and first deployed in 2000. Further information is available at http://www.koha.org/ last accessed 15 April 2010.
techno-scientific knowhow) (Avergou 2000; Odedra 1992); the nature, complexity, and context-sensitiveness of ISs (Akrich 1992; Heeks 2002); country context differences and the resulting gap between design assumptions and realities in implementation contexts (Avergou 2000; Baark and Heeks 1999; Heeks 2002); and the complex interaction between ISs and organizations (Constantinides and Barrett 2006; Markus and Robey 1988; Orlikowski 2000; Orlikowski and Barley 2001; Van de Ven and Poole 2005). The implementation of IS dictates organizations to depart from the status quo (Huber and Glick 1993; Porras and Silvers 1991) enabling new types and patterns of communication and work flows (Nance 1996). Various studies show the existence of recursive restructuring effect between ISs and organizations during implementation and use (DeSanctis and Poole 1994; Orlikowski and Robey 1991) which would result in planned and unplanned changes, and unanticipated outcomes (Doherty and King 2005; Markus and Robey 1988; Orlikowski 1996). The restructuring would be more evident in the context of IS implementation in DCs due to country differences, and the gap between design and realities in implementation contexts (Heeks 2002).

The emergence of OSS, however, has brought lots of promises ranging from bypassing financial limitations through facilitating adaptation and integration to changing the predominantly developer – consumer relationship between the developed and DCs in terms of software production and use. The OSS license dictates disclosure and dissemination of source code so that anyone with proper programming skills and motivations could study, use, modify and distribute any OSS written by anyone (Feller et al. 2005; Neumann 2005; von Hippel and von Krogh 2003). OSS development relies mainly upon individuals making choices to volunteer their time and skills to a production activity organized in a bazaar style (Raymond 2000) dispersed across organization, geography, culture and time (Mockus et al. 2005). OSS developers/contributors and users coordinate activities, deliver products, and offer field support using the Internet usually without the need for an intermediary or a vendor and a face-to-face communication, especially in the community-based OSS model, which is the concern of this research (Lakhan and van Hippel 2003; Mockus et al. 2005; von Hippel 2002; von Hippel 2005). Shorter time gap between OSS releases which not only address bugs but also incorporate additional features and functions, added with the availability of source code paved the way for continuous change.

Although OSS alleviates some of the challenges of software implementation in DCs such as related to acquisition, adaptation, learning, etc, it also poses difficulty as it shifts the implementation responsibility primarily to users (or individuals local to use contexts) that have limited or no techno-scientific knowhow in the case of DCs. In Ethiopia, the context where this research was conducted the idea of OSS was little known among IT professionals until 2005 – until the establishment of EFOSSNet (Ethiopian Free and Open Source Software Network), an OSS advocacy group. A workshop which was organized by EFOSSNet and the Ethiopian IT Professionals Association (EITPA) on 27 December 2008, revealed the immaturity of the OSS idea among IT professionals three years after the establishment of EFOSSNet. The changed practice of software implementation can have different ramifications on organization change than the other models but attention has not been given to it so far. The OSS literature focused mainly on development projects, developers’ motivations, governance structure, etc of back-end applications such as operating systems, middleware, and server software. The literature in DCs focused mainly on the challenges and opportunities of OSS (Weber 2003; Weerawarana and Weeratunge 2004). Less is known about the implementation of domain specific applications in the public sector of DCs except Lungo (2008). Lungo’s study however focused on an in-house developed software and a software brought from abroad where the core developers offered field supports to local implementers and users (Lungo 2008). Lungo did not consider the community-based OSS model. Besides, as far as knowledge of the researcher is concerned, the role of OSS on organization change is not yet studied. Thus, this research investigated the changes that unfolded during the implementation of an OSS-based IS and the ramifications of the OSS philosophy and practice on organization change drawing upon the notions of organizational routines and the emergent perspective on technological change.

Organizational Routines and Technological Change

The IS literature lacks reliable generalization about the relationship between IT and organization change due to researchers backgrounds (Markus and Robey 1988) and selective and partial focus on the aspects of technology (Orlikowski 1992). Markus and Robey (1988), for example, identify a variety of theories based on causal agency, logical structure and levels of analysis. According to Orlikowski (1992) the knowledge about technology in organization is ambiguous and conflicting because of researchers’ selective and partial conceptualization of the scope and role of technologies. Technology has been conceptualized as “hardware” and “social technology”, and to have deterministic and emergent effects on organization change. The technology imperative research conceives of technology as the primary and relatively autonomous material cause or driver of organization change with a
deterministic effect (Monteiro 2000; Orlikowski 1996). The adoption of technology, according to this viewpoint, creates predictable changes in organizations' structures, work routines, information flows, and performance (Barrett et al. 2006; Orlikowski 1996; Orlikowski and Barley 2001). This conceptualization ignores the role of human agency in shaping the design, development and use of technology, and the proactive role of human agency in organization change (Akrich 1992; Orlikowski 1992; Orlikowski 1996; Orlikowski and Barley 2001). The constructionist perspective, on the other hand, assumes almost unlimited choice over technological options and almost unlimited control over the consequences to human action (Akrich 1992; Markus and Robey 1988; Orlikowski 1992; Orlikowski and Barley 2001). This set of research is criticized for giving more emphasis to human agency and denying the material affordances and constraints of technology. The emergent perspective questions the viability of the constructionist and materialist perspectives in light of the current organizational discourses that emphasize emergence, flexibility, and self-organization.

The emergent perspective proposes the idea that neither a strictly constructionist nor a strictly materialist stance are adequate to study technologies in the workplace. It holds that the uses and consequences of information technology emerge unpredictably from complex socio-technical interactions (Ciborra and Hanseth 2000; Cordella 2006; Markus and Robey 1988; Orlikowski 1992; Orlikowski and Barley 2001). In the contemporary world, the notion of emergence is particularly relevant because, writes Orlikowski, “unprecedented environmental, technological, and organizational developments facilitate patterns of organizing which cannot be explained or prescribed by appealing to a priori plans and intentions” (1996, p. 65) (emphasis in the original). The emergence view posits technology as an external force having impacts but where these impacts are moderated by human actors and organizational contexts. Orlikowski and Barley explain that

[...] adequate accounts of technological change require hybrid explanations that weave together human action and choice, the functions and features of specific technologies, and the contexts of a technology’s use in a way that attends to the micro-dynamics of situated practice (2001, p. 150).

The micro-dynamics of change and stability in organizations can best be explained by considering organizational routine as a unit of analysis (Becker 2004). Organizational routines can be defined as “repetitive, recognizable patterns of interdependent actions, carried out by multiple actors” (Feldman and Pentland, 2003 p. 95). Routines are recurrent patterns that consist of action, activity, behavior, and interaction, which also involve multiple actors (see Becker 2004 for a comprehensive review). Feldman and Pentland unpacked the constituent parts of routines to have an ostensive (or structural) and performative (or agentic) aspects following the notions of the structuration theory and examined the changeability of routines (Feldman 2000; Feldman and Pentland 2003; Pentland and Feldman 2005). The ostensive aspect is the “abstract, generalized idea of the routine, or the routine in principle” (Feldman and Pentland, 2003, p. 101), while the performative aspect “consists of specific actions, by specific people, in specific places and time … the routine in practice” (ibid). Later works of Feldman and Pentland included the notion of IT but as part of the context within which routines are executed (Pentland and Feldman 2005; Volkoff et al. 2007). The investigation into changes in organizational routines led Volkoff, Strong, and Elmes to identify the existence of a material aspect of routines that is embedded in technologies (Volkoff et al. 2007). Unlike other artifacts, IT is an integral part of routines and gives material aspect to them and as a result could change roles, data, relationships and mindset and organizational culture (Volkoff et al. 2007). Therefore, in order to analyze the changes that were emerged as a result of the implementation of an OSS-based IS, this study draws up on the notions of organizational routines and considers the three aspects such as ostensive, performative and material as described here.

**Research Context and Methods**

**The Context**

Addis Ababa University Library (AAUL) is a public academic Library composed of more than 19 branches. It was the major information resource center in Ethiopia, particularly, for research and academic purposes. The Library serves mainly AAU, the oldest and the largest higher learning organization in Ethiopia, and extends services to external organization and individual users. The Library was organized in a centralized manner, i.e., it performs technical and managerial activities and placed the card catalogs of all of the branch libraries (or the union catalog) centrally in the main library. A university librarian was responsible for the overall operation of the Library with the help of two assistant librarians each responsible for the technical and public services. The technical services include acquisition and cataloging while the public services include circulation, reference, departments and branch libraries.
The acquisition department acquires books and other materials through purchase, gift, exchange, and donation and sends them to the cataloging department after making all the necessary checks and putting property stamps on each material. The cataloging department then catalogs and dispatches them to branch libraries. Branch libraries collect cataloged materials along with corresponding catalog cards; shelf cards and books in the right shelf in the correct order; and offer circulation and reference services to users. They are also responsible for maintaining catalog cards and ordering books and other materials for purchase in consultation with faculties. Most of these activities were performed manually and had limitations to satisfy users, and facilitate operations and communications within and outside of the library (Mengesha in press). In order to alleviate some of these problems, the library tried to acquire and introduce computer-based LIS through purchase and in-house development at different times but did not succeed. Finally, the library started implementing Koha, an OLIS, at the end of 2004 and, by the end of 2008 it was making use of the cataloging and OPAC modules. The OPAC allows users of the library to search for and locate library materials, while the cataloging module aspires to automate the cataloging routine. The cataloging function was the focus of this study as it was the only module of Koha that was serving the library staff. The cataloging function included cataloging books2, maintaining the union catalog and the shelf list, inventorying books, announcing newly cataloged books each month, and providing information on plans and performances of the department to relevant authorities (section four explains the cataloging function in detail).

AAUL was introduced to the OSS phenomenon through a failed collaboration among one university in the USA (a professor and his students), an NGO (co-established by the professor), AAUL and ICTDO (ICT Development Office) of AAU. The aim of the collaboration was to customize and implement an OSS LIS called OpenBiblio but it discontinued after two months of operation (Aug – Sept 2004) without bearing the desired result. The occasion however introduced the local team to the world of OSS, which was not well known among IT professionals in the country at the time and even until 2008. It was under these circumstances that AAUL implemented Koha; in fact AAUL has been considered to be the pioneer in implementing OSS in Ethiopia.

**Methods**

The research adopted the qualitative research approach (Silverman 2005) with the underlying epistemological and ontological notions of the interpretive philosophy (Klein and Myers 1999; Orlikowski and Baroudi 2002; Walsham 2002) to collect and analyze data. In order to make sense of the changes, it was desirable to consider the previous cataloging routine, the envisaged cataloguing, features and functions of the new library system (Koha), the implementation context and the resulted cataloging routine. To do so, detailed data collection was conducted through semi-structured interviews, review of reports and memos, and observations at the research sites. The researcher was employee of the Library for about eight years until the end of 2002 and served as manager of the library automation project from August 2000 to August 2004. The membership allowed him to gain access to all recorded documents such as reports, minutes and memos. The researcher’s library science and IT background by training and experience facilitated the sense making processes of the cataloging routine, feature and functions of Koha and their interplay. Besides, he conducted interviews and observations from February to April 2007 and from November 2007 to February 2008 for a different research. The previous research revealed the existence of perception differences among key stakeholder groups in the library with regard to the library’s adoption of OSS (Mengesha in press). The management and technologists perceived OSS as an opportunity that would minimize total cost of software ownership and a means for building knowledge hub that would serve AAUL and other libraries in Ethiopia. Users (catalogers and other librarians) however perceived it from the perspective of expertise requirement and third party involvement in the implementation process, and were against the adoption of OSS. These findings led to further investigations into the learning/sharing and collaboration processes and the changes that could emerge as a result of OSS implementation (this research).

Thus, a fieldwork specifically aimed at this research was carried out from September to December 2008. During this period a total of 16 interviews were conducted with 10 respondents, their duration varying from 1 to 1:30 hours. Most of the interviews (ten of them) were tape-recorded, and detailed notes were taken for the rest of the interviews. All of the respondents were either users of the new system (catalogers), technologists/developers, managers of the Library or project managers that had significant influence on the implementation or operation of Koha. The data

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2 Besides books, the library acquires periodicals, maps, audiovisual materials, etc but their total size is less than 5 percent of the whole collection and the procedure followed to catalog them is almost similar except few differences. As a result, the process of cataloging books is considered in this case study.
collection was meant for exploring the initial assumptions of technologists/developers, users and managers concerning the planned role of Koha, the cataloging routine before and after the introduction of Koha, and exploring the implementation process. Through iterative reading, the collected data was classified to understand the cataloging routine that was practiced before and after the introduction of Koha, the planned cataloging, the cataloging routine inscribed into Koha, and the unintended consequences of implementing Koha in AAUL. The contents of these routines were analyzed and compared with one another to understand their similarities and differences and, hence, the changes. These similarities and differences were interpreted in terms of the three aspects of organizational routines (ostensive, performative, and material). The findings were further analyzed to understand the relationship between the changes, the implementation context and the aspects of OSS such as license, code openness, and the implementation model. As Walsham notes, the researcher’s mid supplemented by the minds of others is the best tool for analysis, and this research relied mainly on the minds of the researcher supplemented by colleagues (Walsham 2006). The results of this research were presented to colleagues at different stages and refined further based on their inputs.

**The Old and the New Cataloging Routines**

The cataloging department catalogs all library materials that the library acquires centrally in the main Library and dispatches catalog cards and books to branch libraries for use. Both the cataloging department and branches perform subsequent activities of shelving and maintaining cards similarly. The cataloging department had four categories of staff – bibliographic checkers, catalogers, typists and pastors. The head of the department was responsible for overall operation and management of the department and reports to the assistant university librarian in charge of technical services on plans and performance of the staff and the department at different frequencies. Branches had at least one person responsible for shelving and maintaining catalog and shelf list cards both in the shelf list and public catalog in each branch. The shelf list card is a catalog card produced for internal use by catalogers, it is not accessible to the public, and each title has one shelf list card if it belongs to the main library, two otherwise. The catalog cards are produced for public use, to facilitate access to collections of the library. The next sections discuss the cataloging routine before and after the introduction of Koha and the routine that was envisaged by the project.

**The Manual Cataloging – the Old Cataloging**

After receiving books from the Acquisitions department, Bibliographic Checkers (BCs) make sure that they all bear the authority stamp of the Library and are not mutilated. Then they verify whether a book is new to the library or an already existing one (table 1 describes the old cataloging in detail). To do so, BCs bring books in trolleys to the public area where the union catalog was located (where users of the library also search for books) and look for a matching bibliographic record. If a matching record was found, BCs write an “add to” message on the book to guide the typist to add copy number and receiving date on the shelf list card later. If a matching record was not found, the book was regarded as new and undergoes either copy or original cataloging process. Following the verification, BCs handover books to catalogers and typists accordingly.

Copy cataloging involves adapting an already existing bibliographic data of a book from a given source to requirements of a library. Due to space and financial constraints to purchase catalog cards from abroad, AAUL limits the size of data in a card and the number of cards per book. The library subscribes to a database called Bibliofile from the Library of Congress in the USA for copy cataloging. Bibliofile contains bibliographic details of newly published books and journals in CDs; it is updated every year and offers various functions including searching, displaying, editing, printing, exporting data, etc. The major tasks of catalogers would be to search for and locate books’ data in the database, localize it according to AAUL policy and print the required number of shelf list and public catalog cards, if found. Otherwise, the second option would be to feed the CIP (cataloging in publication) data of a book into an empty data entry form in Bibliofile and produce appropriate number of cards, if the book has a CIP data. If the data of a book is not available in Bibliofile and if it does not have CIP data, catalogers perform original cataloging, i.e., they prepare catalog cards from scratch by analyzing the physical and content of a book. They fill out the data of a book in an empty paper form by analyzing a book and later feed it into an empty data entry form in Bibliofile and produce appropriate number of cards.

Once cards are produced, catalogers verify books’ data against corresponding catalog cards, correct them in case of errors, and finally deliver them to typists for physical preparation. Typists prepare book label, book pocket, book card, and due date slip and a pastor pasts them on each book. Finally, the book is ready for dispatch to branch
libraries and the cataloging department informs branches to that effect. Usually representatives from branches and the acquisitions department fill out the book exit form together, crosscheck and deliver books to respective libraries.

Besides cataloging, maintaining catalog cards that involves filing (alphabetically by author, title and call number in different card catalog files), replacing worn out cards, correcting erroneous cards, removing cards when the book is discarded and relocating them whenever there is relocation of books are the duties of catalogers. Each branch library also performs these activities separately. Each cataloger also produces a cataloger report that shows the number of books and periodicals he/she has catalogued on a monthly basis. Typists also produce reports that show the number of new title, added copies, number of card, and number of pockets produced by each typist. The department produces the list of newly acquired and catalogued books each month arranging by faculty, which is called accession list, and inventory the stock at different frequencies. Each cataloger was responsible for cataloging the books of a given faculty though their size and the size of books they purchase are different.

Table 1: Original, Planned and Emerged Cataloging Routines due to the Implementation of Koha in AAUL

<p>| ROLES                      | ORIGINAL ROUTINE                                                                                                                                                                                                 | PLANNED ROUTINE                                                                                                                                                                                                 | EMERGED ROUTINE                                                                                      |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------................|----------------------------------------------------------------------------------------------|
| Bibliographic checkers    | Receive books from acquisitions and verify their newness to the Library. To do that carry books to the public area and check their bibliographic detail against the union catalog one by one. | Catalogers carry out the activity using Koha without bibliographic checkers.                                                                                                                                  | Bibliographic checkers have been checking the availability of a book using Koha.                   |
| Catalogers                | Search for matching records in Bibliofile, adapt data and print cards according to AAUL policy. Proofread cards and correct errors if any. Send books and cards to typists for physical preparation. Verify cards for error or mismatch of data after physical preparation and correct it if any. | Avoid production of card catalog and automatically feed Koha from Bibliofile.                                                                                                                                 | Besides the original routine, catalogers add the detail of each processed book into an intermediary database, later import into Koha, add more information such as assign barcode and holding data, verify and confirm the entered data, and save into Koha database. Print barcodes and paste them on to books, and deal with barcode generation problems and the problems of the cataloging module. |
|                           | If a matching record is not found in Bibliofile and the book has CIP data, copy the data into an empty Bibliofile form and conduct the rest procedure similar to the copy cataloging stated above. | Directly feed the CIP data into Koha, if the electronic data of a book is not found in Bibliofile.                                                                                                                | The same exception where the data will be stored. Instead of entering the data into the Bibliofile empty form, it will be entered into Koha’s form. |
|                           | Perform original cataloging if bibliographic data of a book is not found in Bibliofile and if it does not have a CIP data. Scan the physical and content of the book; consult the Library of Congress Subject Heading (LCSH) list for assigning subject headings and the Library of Congress classification scheme for determining the call number; fill out the cataloging slip (a piece of paper prepared for the purpose); and copy the data into an empty Bibliofile form and conduct the rest procedure similar to the copy cataloging procedure stated above. | The same except where the data will be stored. Instead of entering the data into the Bibliofile empty form, it will be entered into Koha’s form. |                                                                                                             |
|                           | Inform receiving libraries when reasonable number of books is ready for collection. Fill out part of the material exit form and handover the books to the person assigned for the collection. | The same as the original.                                                                                                                                                                                   | The same as the original.                                                                         |
|                           | File cards alphabetically by author, title, subject or call number in public catalog and shelf list shelves. Replace worn out cards, correct erroneous cards, and remove and relocate cards when a book is discarded and relocated. | By abandoning card catalog use avoid the tasks of filing and maintaining cards.                                                                                                                               | The same as the original.                                                                         |
|                           | Produce a report listing the title of books cataloged per month. Inventory the Library’s collection as schedule by the Library.                                                                                                                                 | Automatically produce such reports with few mouse clicks.                                                                                                                                                     | Cut required data from Bibliofile and paste into an excel worksheet or word.                      |</p>
<table>
<thead>
<tr>
<th>ROLES</th>
<th>ORIGINAL ROUTINE</th>
<th>PLANNED ROUTINE</th>
<th>EMERGED ROUTINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typists</td>
<td>For an already existing book, fetch the shelf list card, and add copy number and receiving date. For new books, on all cards add the first letters of the first and second names of the cataloger and the typist, the date in which the material is cataloged, type of material: “per” for periodical and “ref” for reference, and a letter “S” and copy number if the book has more than one copies on shelf list cards. Prepare book pocket, book card, book label and due date slip based on the data on the shelf list card. Produce statistical report that indicates the number of new titles, added copies, book pocket, book card, book label and due date slip produced on a weekly basis.</td>
<td>The role of the typist is not required in a fully automated cataloging; therefore phase out the typist tasks step-by-step.</td>
<td>As usual for the typist but catalogers were required to add similar data on the new system to reflect the change in the number of copies.</td>
</tr>
<tr>
<td>Pastors</td>
<td>Paste book pocket at the back verso of the material, due date slip on the page opposite to where the book pocket is pasted, and the book label on the spine or the bottom left corner of the book. Insert the book card into the book pocket.</td>
<td>In a computerized library system, book pocket and book card may not be required, and hence, their production.</td>
<td>The same as the original routine.</td>
</tr>
<tr>
<td>Head, Cataloging Department</td>
<td>Produce accession list that lists all the materials acquired and cataloged by the department, disaggregated by Faculty and subject on a monthly and yearly basis. Produce annual report concerning the accomplishment of the department.</td>
<td>Allow head of the cataloging department to generate accession list automatically.</td>
<td>The same as the original routine.</td>
</tr>
<tr>
<td>End Users (concerning card catalog usage)</td>
<td>End users should go to the public card catalog area of each library to search for books. Users in the main library can search for a book in all of the libraries but they are required to visit the desired library to fetch the required book. If the search is successful, users go to the stack area, handover the detail of a book to a staff, and a staff fetches the book if it is available. Otherwise, users should ask the circulation desk if the book is on loan or it is under maintenance. The required book might be lost or misplaced if still not found. If you find a book, users should go to the circulation desk for borrowing the book.</td>
<td>Search and locate materials in any of the AAU libraries 24/7 from a desktop using keywords, subject headings, title, authors, editors, etc or by combining them. When the circulation module is up and running users will check the status of a book and perform some circulation activities.</td>
<td>Users interact with computer to search and locate books. They can also search for a book either in all or one of the libraries using a number of access points or a combination of them. The detail of data provided to users on a given book has also increased.</td>
</tr>
<tr>
<td>Deployment team/ Computer Center</td>
<td>Provide IT related support the Library and conduct IT R&amp;D activities.</td>
<td>Customize, implement, and maintain Koha.</td>
<td>Assure Koha runs smoothly, enhance and localize it, &amp; implement the rest modules.</td>
</tr>
<tr>
<td>Branches (regarding cataloging)</td>
<td>File cards alphabetically by author, title, subject or call number in public catalog and shelf list shelves. Replace worn out cards, correct erroneous cards, and remove and relocate cards when a book is discarded and relocated.</td>
<td>By abandoning card catalog use avoid the tasks of filing and maintaining cards and this role from branches.</td>
<td>The same as the original.</td>
</tr>
</tbody>
</table>

**The Planned Cataloging**

The automation project targeted at minimizing or avoiding the time and effort required to verify the availability of books in the library, edit bibliographic records, produce accession list, and maintain card catalogs both at the public area and the shelf list (table 1 describes the planned cataloging in detail). Card catalog maintenance such as filing, identifying, correcting, removing and relocating was cumbersome, error prone and time consuming. The project also planned to automate the works of typists, which was to select data from the bibliographic data of a book and type it on separate papers called book pocket, book card, and book label.

A book pocket and a book card are specifically designed to facilitate the manual processes of borrowing/lending books. In a computerized library system, book pocket and book card may not be required. The project planned to abandon all activities pertaining to card catalog – such as production, filing and maintenance. Because, once the
detail of a book is entered into a system, it cannot be mutilated or misfiled and if the database is connected to users’ PCs, which is the case in AAU, there is no need for producing card catalogs. Checking the availability of a book in the Library would also be carried out easily from a terminal. By avoiding card catalog, the project planned to evade the amount of hard currency incurred to purchase catalog cards, book label and other papers from abroad, abandon the roles of card catalog filing and maintenance from branch libraries, and reduce the time and effort of catalogers and the error thereof. Editing bibliographic records in the Bibliofile involves manually deleting and adding similar data elements for each book. The project planned to automate this process so that selected data could automatically be fed into Koha.

Since every branch library houses the catalog that reflects its own holdings except the main library that houses the union catalog, it was difficult for users to know the holdings of other libraries unless they go to that specific library and search the catalog. With the emergence of interdisciplinary and multidisciplinary programs, the demand for visiting multiple libraries had increased. Besides the limited number of access points (such as subject, author, title, etc) and the number of cards printed per book, the card catalog lacks the flexibility to combine access points. There is a general understanding that the higher the number of access points and the possibility to combine them for searching, the higher the chance for retrieving/fetching the relevant book from the entire collection.

Deployment of an ILS planned to offer the ability of searching for and locating materials in any of the branches 24/7, increasing the number of access points such as keywords, subject headings, title, authors, editors, etc and the ability of combining them together and perform some circulation activities to end users. The project also planned to automatically produce statistical reports that the catalogers and typists used to compile manually – such as accession list, cataloger report, and typist report.

**Cataloging with KOHA – the New Cataloging**

The library started customizing Koha after previous attempts to purchase proprietary software, develop in-house and adapt another OILS in collaboration with another partner were failed to bear fruits. The justification behind switching from purchase to OSS adoption were associated to reducing total cost of ownership and developing local expertise that would serve as knowledge hub for libraries in Ethiopia. According to project documents, vendors quoted prices ranging from 150,000 to 450,000 USD for an LIS that would run on 25 workstations each for staff and users. The quoted price excludes adaptation costs that may be incurred to make the system able to accommodate material written in Amharic script.

In the end of 2004 the Library in collaboration with the ICT development office (ICTDO) of the University embarked on a joint OILS adoption project and organized a project team comprised of the library and ICTDO staff. The alliance sought to exploit the technical expertise of the IT personnel (of ICTDO) both in customization and implementation, and developing the technical capacity of the library staff. However, the partnership was discontinued after the pilot phase and ICTDO trained some of the computer center staff of the Library on the technologies of Koha. These trained people (developers hereafter) were later reorganized as the deployment team members and took the responsibility of customization, installation and configuration of Koha in AAUL. The disassociation of ICTDO from the project caused reinstallation and reconfiguration of Koha on the library’s server that was located in the main library. One of the developers describes the situation as follows:

> The initial training was essential to acquaint ourselves with Linux and Perl but it was not sufficient to make us able to install, configure and customize Koha. We were far away from that… we were overflow by tasks related to database management system, operating system and Koha itself.

The developers customized and implemented Koha with the support of the Koha community and its documentations. The developers posted inquiries about the design of Koha, installation and configuration issues, fixing bugs, switching operating systems, upgrading to new releases, and interfacing Koha with other systems among others and, made use of the responses. They also studied the email archives of Koha’s developers and users mailing lists and other documents to implement Koha in AAUL.

The implementation of Koha in AAUL changed the practice of cataloging and the way users interact with the Library (Table 1 presents the new routine in detail). Users of the Library could search for books using computers (and Koha) either in one or all of the libraries using a number of access points or a combination of them. The detail of data provided to users on a given book was increased because of the insignificant cost of adding further data per book. The bibliographic checkers no more carry books to the public card catalog area and manually compare records to verify whether a book is new to the library or not. They were doing it from their desktops using Koha.
The implementation of Koha increased the workload of catalogers and nothing was changed for the typists. Besides conducting the previous cataloging routine, catalogers were required to feed Koha with bibliographic data, assign barcode numbers, add holding data, and verify and confirm entered data. After producing card catalogs using the old system, catalogers add the detail of each processed book into an intermediary database, and later import and save into Koha database. As an additional task, they print barcodes, paste them on to books and deal with barcode generation problems and the problems (bugs, improvements, missing functions, etc) of the cataloging module of Koha in general.

Koha did not help catalogers to produce statistical reports such as the titles of newly cataloged books in a given month, the number of books cataloged by a cataloger, and accession list. They were aware of the possibility and flexibility of producing reports once data is captured. Moreover, they were not getting favorable responses to bugs; often bugs remained unfixed altogether; they operated another function of Koha that they were not allowed to do so; etc. All of the catalogers had information about the smooth running of Koha in another local library and some of them had paid a visit. Most of the catalogers were doubtful of the smooth running of Koha in AAUL and insist on using the old system instead. The following two excerpts exemplify their frustrations:

The good side of Koha is that you cannot leave the call number field blank; in the rest, you can write whatever you want and the system never complains. Retrieving data using specific barcode returns lots of unnecessary hits and no one explains why. ….

I sometimes operate the circulation module, which I am not allowed to do so. Technically, nothing prevents me from operating the circulation module as of now. Lending books to users or changing the status of unreturned books to “returned” is possible. This tells me how loose the configuration is and how far behind our system’s configuration is compared to what it should be.

The working relationship between the cataloging department staff and the developers started to deteriorate when inquiries of the catalogers failed to get favorable answers. As a result catalogers started to question the knowledge and expertise of the developers. The following excerpt reflects some of their anxieties:

… we were individually approaching the deployment team members for solutions when we encounter any problem. … Due, in part, to the negative reactions of the developers and delayed solutions, if solved at all, we abandoned directly reporting problems to them but through our coordinator.

I used to report problems with the view to improving Koha but I stopped doing it after I was regarded as a person who is trying to ruin the implementation. … The error reporting process destroyed the smooth relationship between us and those who are responsible for debugging.

I think the technical people did not have the required knowledge and skill. That is why they refuse to give us favorable response to our requests. … We know that Koha is running smoothly in another library and I would suggest them to ask for support.

Furthermore, Koha did not favorably support collaboration between catalogers. If a cataloger assists fellow cataloger, the assisted had to collect catalog cards and then either type or retrieve the detail of each cataloged book from Koha and cut and paste it on MS word or Excel worksheet to prepare reports. There was a time gap between making the detail of a book available online and making it ready for service in a given library because the place where the book is processed and used were separate. It took some time before reaching the user library and nothing denotes this time gap. This might misinform users as the detail of a book is visible to users despite readiness the book for use. In another respect Koha has been policing unnecessary requests. Branch libraries occasionally requested for the re-cataloging of books and complain to users that they did not receive books while they actually have it. Koha arbitrates such conflicts mostly in favor of catalogers.

Due to the above reported problems catalogers developed negative attitude towards Koha, the developers and the implementation process and ultimately the full-fledged utilization of Koha. The implementation process also affected the working relationship between branch library heads and the project manager who later was promoted to the assistant university librarian position. Some of the branch heads regarded their usual duties as par-time and engaged in other activities that were nothing to do with the duty they were paid for. The relationship made them not to be accountable to their responsibilities. One of the branch heads said “some of us considered the other work as our primary duty. It was a good opportunity for us to increase our income but heavily impacted the library’s work.”

For the developers and the project manager, some of the functions that the catalogers required such as producing card catalog will soon be obsolete and including it in Koha was not advisable. They explain that even the use of Bibliofile will cease when the Internet bandwidth allows for faster downloading and uploading over time.
Furthermore, the circulation module was not yet automated and demands production of card catalog and related cards. While implementation of Koha was going on, the university annexed independent public colleges and institutes that dictated continuation of previous work in parallel with Koha beyond the expected duration according to the project manager. He also relates interfacing and other technical problems to the knowledge and skill of the developers. New stable versions of Koha were released 11 times since it was introduced in AAUL but AAUL managed to change three times only (from 2.2.9 to 2.2.4). Since the middle of 2007 the project was ceased and dealing with Koha became the normal routine of the computer center that was reorganized and staffed for the purpose (see table 1 for the detail).

Analysis

The implementation of Koha in AAUL created a new socio-technical order that was unfolded overtime as a result of the interaction between Koha and the socio-technical ensembles in AAUL. The cataloging routine that was practiced after the introduction of Koha was different from the old, the envisaged and the inscribed (into Koha) cataloging as described in table 1. The implementation of Koha changed the cataloging routine, relationships and mindsets of the staff. This section analyzes these changes and the roles of aspects of OSS (license, openness of source code, community-based implementation model) and contextual factors in shaping the unfolded changes.

Changes in the Cataloging Routine

The implementation of Koha in AAUL required the harmonization of contents of the cataloging routine inscribed into Koha, the actual work practice and the planned cataloging. The higher the gap among the contents of these routines, the higher the change and the risk of failure would be especially in a DC context (Heeks 2002). In AAUL, the ostensive aspect of the cataloging routine, the routine in principle, i.e., the process of making books easily accessible to users remained stable. As usual, cataloging receives books from acquisitions, prepares means of access, delivers to branches, maintains the means of access on a regular basis and produces various reports. However, the specific practices of making books accessible to users, the performative aspect of the cataloging routine, were changed. Koha changed the old performative aspect of cataloging by giving material forms to the different roles and activities of the cataloging routine, digitizing the paper-based data, and streamlining embedded activities with the influence of contextual elements and the nature of the software.

The planned routine abandoned the use of cards, and hence, filing and maintenance activities and the staff involved in these activities both at the main and branch libraries by giving material forms to these activities and roles. BCs could verify the existence of a book’s detail in the library from a desktop without the need for carrying them to the public catalog area. Doing so saves money and resources that would otherwise be spent on cards, personnel, equipments and related activities. The routine inscribed into Koha also considered this model of cataloging except the mechanism of capturing data. Koha automatically fed its database by fetching records from online sources and required an Internet connection with a reasonable speed while the planned cataloging demanded interfacing with Bibliofile, i.e., except the data sources the two routines gave material forms to the activities of searching and importing records. The role of a cataloger upon receiving a book would be to retrieve its record, adapt the record according to the AAUL policy, produce barcode and paste it on the book, and add the record into Koha’s database. For books the record of which was not available in Koha’s bibliographic database, Koha was supposed to automatically search and download the record from online sources (in case of Koha) or from Bibliofile (in case of the plan). The procedure for adding the record of a book into Koha was the same in both cases if the record of a book was not found either in online sources or in Bibliofile – it is a manual process in both cases. The plan demanded the production of different reports, while Koha was able to produce only some of them. Both the planned cataloging and Koha gave material forms to the roles of BCs, typists, and pastors.

The difference between the routine inscribed into Koha and the planned cataloging therefore was small. However, there was a huge difference between the two systems (Koha and the plan) and the old cataloging routine. As described in table 1, BCs verified the existence of records of a book by carrying them to the public catalog area and searching for a matching record of each book. Then, catalogers search and download the record of a book from Bibliofile (by inserting and removing at least two Bibliofile CDs into a PC CD drive for a book), adapt it according to the AAUL policy and print the required number of cards if the record was found. Otherwise, they copy cataloging in publication (CIP) data of a book into an empty Bibliofile form and perform the rest activities as the previous one. In case a book did not have such detail, catalogers analyze the physical and content of the book and fill out the detail on a sheet of paper, then input to an empty Bibliofile form. Typists prepare book pocket, book card, book label and

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due date slip for each book to facilitate circulation, while pastors paste them in an appropriate location in the book. The cataloging department staff produces reports on individual activities at different frequencies to the head of the department who in turn produces summarized reports to the assistant university librarian.

Although the difference between the old and the other two routines (Koha and the plan) was huge, it would be of great advantage to the efficiency and effectiveness of the routine had either Koha or the plan were implemented properly. However, the resulted routine, the performative cataloging was a mixture of Koha and the old routine, or simply, Koha was running on top of the old routine without any automatic interaction with artifacts and activities of the old routine. For example, Koha was not able to deal with card catalog production; did not automatically interact with Bibliofile; and did not produce required reports. The failure of Koha to give material forms to these activities made it neither stand by itself nor able to automatically interact with the old routine. The failure of Koha to produce card catalog necessitated for the use of Bibliofile, the old system, and its inability to automatically interact with Bibliofile necessitated for the intervention of catalogers (manual activities). The interaction between Koha and Bibliofile was mediated by an intermediary database with manual activities of exporting and importing data to and from these databases.

The manual procedure of exporting and importing data from and to the three databases, and performing both the old and the new systems in parallel extended the practice of cataloging, demanded extra efforts of catalogers, and affected their mindset. Furthermore, bugs in the cataloging module, late delivery of fixes and dissatisfaction with functions, severely affected the relationship between developers and catalogers. As a result, catalogers challenged the expertise of the developers and developed negative attitude towards the use and full-fledged implementation of Koha. However, catalogers were happy with an unprecedented function of Koha that arbitrated conflicts with branches in their favor. The implementation increased the size and type of data that can be captured per individual book, increased access points and changed the location of data and the type of storage device. Book data was simultaneously kept electronically and on paper.

The project tended towards modifying the old cataloging routine to resemble the routine inscribed into Koha due to the influence of the plan and the opportunity provided by Koha. For example, even if there was demand for card catalog production, developers did not make Koha able to deal with card catalog due to the plan to abandon cards in the near future and lack of expertise. Again, partly due to the opportunity provided by Koha to abandon the use of proprietary database for cataloging, developers gave less priority to interfacing Koha with Bibliofile even if it was the plan to do so. Furthermore, various contextual elements such as availability of technoscientific knowhow, limited knowledge and experience of local developers with OSS and the specific technologies of Koha, resource and infrastructure constraints, lesson from previous failed attempts, the demand for card catalog production, etc., contributed a lot towards the result. For example, even if the plan abandoned cards, the developers tried to interface Koha with Bibliofile and make Koha able to deal with card catalog production mainly to meet the demands of catalogers but without success. The changed philosophy and practice of software implementation also affected the process and contributed its share towards the result. The following section analyzes the effects of the license, openness of the source code and the community implementation model on the unfolded changes.

**The Role of aspects OSS in Organization Change**

Openness of source code, the license and the community model of implementation (open participation) are the core characteristics of OSS. These characteristics had both constraining and enabling ramifications in the implementation of Koha in AAUL and shaped the implementation process and the outcome differently than what would have happened had it was closed code (proprietary) software. The OSS license offered the library to acquire Koha free of charge and gave the freedom to study, modify and implement it (Neumann 2005; von Hippel and von Krogh 2003). The community model facilitated for developers and users (of Koha) around the world to involve in the implementation of Koha in AAUL. The local implementation process attracted and made use of the involvement of local and international developers and users. The developers in AAUL downloaded Koha, studied its designs and technologies, posted inquiries to the Koha community, made use of responses, studied the email archives of both the developers and users mailing lists, upgraded their knowledge and skill of Koha and related technologies, and finally, implemented Koha. They also benefited from local IT experts that trained them. These results suggest that the license, openness of the source code and the community model of implementation set an environment conducive for local developers to freely acquire OSS, and learn technologies and the tricks of installation, configuration, customization and fixing bugs among others. These enabling aspects of OSS were also sources of challenges in AAUL.
Implementation of ISs in organizations is a socio-technical process that involves both the social and the technical and where both are supposed to evolve together (Cordella 2006; Heeks 2002; Monteiro 2000). The outcome of the process would be an order negotiated between the two in a specific context in time. The implementation outcome and reactions of users of Koha in AAUL suggest the influence of local circumstances and the aspects of OSS. The AAUL were using technologies that were obsolete in the developed world such as card catalog; it was not using an automated system; it cannot make online financial transactions because it was not yet started in Ethiopia; and the library required facilitating access to materials written in the Amharic script. Furthermore, the Internet bandwidth was so limited that downloading a record from online sources located abroad was difficult. Making Koha to download records from abroad therefore was futile and increasing the bandwidth of the Internet connection was beyond the capacity of the library. Besides, Koha did not deal with card catalog and the Amharic script, and the library could not abandon the use of cards. These requirements necessitated for further streamlining activities such as making Koha able to deal with card catalog and the Amharic script, and to automatically interact with Bibliofile. These contextual elements simply demanded giving material forms to some of the cataloging activities. Lack of techno-scientific knowhow in general, and OSS in particular among IT professionals of the country including the AAUL developers was another contextual element that contributed towards the unfolded changes. The AAUL developers were novice to OSS and the technologies of Koha. Furthermore, the philosophy and practice of OSS, especially the community-based implementation model, shifted the responsibilities of localization and implementation to these inexperienced and less skilled local developers. As a result, embedding the functions of dealing with card catalog, Amharic script and Bibliofile into Koha became difficult. Furthermore, lack of technical expertise and the plan to implement an ideal system, led the project to give less emphasis to intermediate steps of solution provision. Finally, manual activities of importing and exporting data to and from three databases, the use of the old system to deal with card catalogs, doing extra activities due to the new system such as pasting and dealing with bugs, etc extended the cataloging routine.

AAUL was using obsolete technologies; did not use automated systems; cannot conduct financial transactions online; the Internet bandwidth was limited; needed to deal with locally produced materials; lacked techno-scientific knowhow, OSS and its technologies; planned to implement an ideal system, etc. These contextual elements demanded working around the cataloging routine inscribed into Koha but due to the aspects of OSS and some contextual elements, effecting the required changes were challenging and as a result the performative aspect of the cataloging routine was extended.

Discussion

The implementation of Koha in AAUL resulted in a new socio-technical order that was determined neither by the social nor the technical but the complex interactions between the social and the technical with the influence of contextual elements and feature and functions of the software. Some contextual elements dictated for the adaptation of the new system to the use context while others hampered the process. For example, the need to continue working with card catalog and the limited Internet bandwidth demanded adaptation of Koha so that it automatically deals with card catalog production and interacts with Bibliofile. However, due to lack of techno-scientific knowhow, and limited knowledge and experience of local developers with OSS and the specific technologies of Koha, it was not possible to effect the changes. The nature and feature of the software played constraining and promoting roles in the implementation process and shaped the outcome accordingly.

The noninvolvement of license cost for OSS opened up new opportunities for individuals and organizations to acquire, study, modify and utilize software (Gallego et al. 2008; von Hippel and von Krogh 2003). The adoption of OSS also avoids the often lengthy bureaucratic negotiations and associated corruptions apparent in the public sector. Unlike donated ITS that ended up in locked rooms in DCs due to lack of local skilled personnel, problems with western consultants and ineffective capacity development strategies (Odedra 1992), OSS offers new opportunities and mechanisms for capacity development, localization and implementation. Openness of source code coupled with open participation paves the way for developers to study source code, learn technologies and the tricks of customization and implementation through practice and with the active involvement of developers and users around the globe regardless of geographical, organizational or time barriers. The email archives of developers and users also provide significant support to solve technical problems in the course of implementation. Openness of source code facilitates for integrating a given OSS with others as well. Furthermore, OSS makes it easy to make use of changes made elsewhere and continuously improving systems. Improvisation in OSS is supported by frequent releases that would not only solve technical bugs but also introduce new features and functions. Thus, openness of source code,
the license and the community model of implementation (open participation) open up a window of opportunity for learning, localization, overcoming financial constraints, making use of international resources, etc.

Although code openness, OSS license and open participation facilitate learning and capacity development, these could also be sources of implementation challenges depending on the context. As various studies have pointed out, the success of implementation, utilization, scalability and sustainability of technologies brought from abroad depend very much on the existence or the development of local capacity (Braa et al. 1995; Heeks 2002; Odedra 1992). Different arrangements have been made to this effect. For example, in the case of proprietary software, vendors often customize and implement systems, provide technical support after implementation, and train end users and technical experts on how to operate systems, administer them and solve technical problems. Such arrangements do not exist in the case of community-based OSS implementation as described in this case study. The community-based OSS implementation practice demands local users/developers to play the anchor roles in all activities of localization, implementation, enhancement, etc. In the context of DCs, it means that the major responsibility of customization and implementation rests upon resource constrained organizations and inexperienced developers in an environment where techno-scientific knowhow in general, and knowledge and experience with OSS (in this particular case) are lacking.

The implementation of ISs in DCs, especially those brought from the West including OSS, demand translation to use contexts due to country context differences and the gap between design assumptions and realities in implementation contexts (Akrich 1992; Heeks 2002). The translation in turn demands resources and techno-scientific knowhow. For example, the AAUL was required to adapt Koha due to some peculiar characteristics such as, for example, the need to deal with card catalogs and limitation in the Internet bandwidth. However, due to lack of expertise and the plan to move directly to an ideal system by phasing out the old system, materializing the required adaptation was not materialized. These contextual elements (with the support of the changed implementation practice) dictated for the old and the new systems to run in parallel with each other for longer periods. As a result, the cataloging routine was extended to fulfill the requirements of the old and the new systems and interaction between them, i.e., the introduction of Koha extended performative aspect of the cataloging routine.

The performative aspect of the cataloging routine was extended (changed) partly due to the inability of developers to give material forms to some of the required activities such as interfacing, report production and dealing with card catalogs. Some of the activities are core and center in the cataloging routine while others are in the periphery accounting to prototypical and non prototypical categories of routines as suggested by Tsoukas and Chia (2002). Conceptual categories have radically structured members where the center is occupied by more representative, stable and prototypical members that account for the stability with which the category is often applied (Tsoukas and Chia 2002). There is an unstable part, consisting of nonprototypical members, which accounts for the potential change in a category. For example, robins are more central to our understanding of the category “bird,” than ostriches are. Similarly, routines in organizations have stable core and peripheries that derive their meaning from the broader web of background assumptions, experiences, and understandings shared in a culture (Feldman 2000; Tsoukas and Chia 2002). The extended performative cataloging routine included activities that lied in the periphery, non prototypical activities such as manually importing and exporting data to and from databases. The extended performative routine affected the relationship between developers and those who were performing the activities. The catalogers undermined the knowledge and skills of the developers and developed negative attitude towards the full-fledged implementation and use of the new system. These changes and the implementation also affected roles and relationships.

Even if, in principle, OSS paves the way for continuous change, it could be hampered by local circumstances such as availability (or not) of expertise. Heeks (2002) argues that developing countries may not be able to improvise systems and organizations mainly due to resource limitations and local circumstances and insists upon onetime appropriation and implementation. However, the onetime implementation could be problematic in an environment where the interaction between the technology and its context is a continuous process. This study demonstrates the difficulty of implementing ISs at once leaving the rest aside as stated by Heeks (2002), especially in a resource constrained setting.

**Conclusion**

The research reported in this paper investigated the organizational changes that were unfolded due to the implementation of an OSS-based IS in a DC context and the ramifications of aspects of OSS and contextual matters on the process and its outcome. To do so, the research draws upon the emergent perspective on the role of
technology in organizations and the notions of organizational routines. The research designed as an interpretative case study analyzed the contents of the old, the planned, the inscribed (into technology), and the emerged routines, the implementation context and the nature and functions of the software in order to make sense of the changes, and their ramifications. By attaining to the interaction among human action and choice, functions and features of the system, the implementation context and the resulted socio-technical order, the study indicates that aspects of OSS (code openness, license and community-based implementation) could both promote and constrain implementation in DCs. These aspects of OSS set an environment conducive for local developers to freely acquire OSS, learn technologies, solve local problems in collaboration with developers around the globe, and implement software. However, the community-based implementation makes resource constrained organizations and inexperienced developers in an environment where the idea of OSS was not well known (at least in the case at hand), to be in charge of customization and implementation processes. The shift in responsibility together with the requirement for adaptation of the system to the use context coupled with lack of techno-scientific knowhow unnecessarily extended the existed routine (work practice).

The emerged changes were mainly related to the difficulty of giving material forms to some of the activities, data and roles, i.e., embedding them into the technology, and streamlining the existing ones. As a result of the difficulty, the specific activities of the cataloging routine were extended to include additional ones that can be considered as unnecessary. The extensions affected roles, relationships and mindset of those who were performing activities. Further to the skill problem, the plan that tended towards implementing a radical change without considering a step-by-step transformation played significant roles in the process. The organizational changes that resulted due to the implementation of OSS-based IS, following the community-based implementation model in a DC context where resources and techno-scientific knowhow is limited could be different from other models, for example, for proprietary system implementation because of skill and expertise differences, and differences in implementation approach.

This study shows both the facilitating and constraining ramifications of aspects of OSS on OSS-based IS implementation processes and organizational changes in a DC context. The challenge would be to overcome its constraining effects and making the best out of it. The study also enriches the OSS literature by considering the under explored implementation aspect of end-user OSS-based IS. Furthermore, it empirically shows the relevance of the notions of routines in investigating organizational changes and the complex interactions between the social and the technical in a certain context. Considering organizational routines helps to understand the micro-dynamics of situated practices thereby helping to grasp the complex interaction between the social and the technical in a specific context with the influence of the nature and function of the software.

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Appendix 5: **Paper 5**

Technology Capacity Development through OSS Implementation: The Case of Public Higher Education Institutions in Ethiopia

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Abstract

The Open Source Software (OSS) literature gives little attention to the study and practice of domain specific end-user OSS implementation in general and in the public sector of developing countries (DCs) in particular. This paper, however, investigates the trajectories of two OSS-based information systems (IS) implementation projects in a developing country (DC) context with the aim to uncover the practice-based learning and resource sharing evident among locally situated and globally dispersed developers and users. The result of the interpretative case study research shows that the OSS philosophy and practice of software development, implementation and ownership, facilitates for the emergence of practice-based learning from the sharing of implementation accounts and artifacts without sharing the same context of work. Thus, the paper argues in favor of an implementation approach that focuses on distributed practice-based experience, knowledge and resource sharing, and learning with the mediation of the information infrastructure in order to facilitate and sustain OSS-based IS implementation in DCs. The paper contributes both to the OSS and IS implementation literatures by showing the mechanisms of developing the technological capacity of indigenous groups and using the trans-situated learning model as a means to understanding the learning dynamics in OSS implementation.

Keywords

Open source software; developing country; capacity development; trans-situated learning
TECHNOLOGICAL CAPACITY DEVELOPMENT THROUGH OSS IMPLEMENTATION: THE CASE OF PUBLIC HIGHER EDUCATION INSTITUTIONS IN ETHIOPIA

1. INTRODUCTION

Information and Communication Technology (ICT) has been deemed by many as a viable means to facilitate socio-economic developments in developing countries (DCs) even if realization has been challenging to date (Câmara & Fonseca, 2007; Heeks, 2002; Heeks & Stanforth, 2007; Sahay & Avgerou, 2002; Walsham, Robey, & Sahay, 2007). The advent of open source software (OSS), however, is believed to open up new opportunities and possibilities to this end (Kogut & Metiu, 2001; Weber, 2003; Weerawarana & Weeratunge, 2004). In principle, adoption of OSS reduces license costs and total cost of ownership (Waring & Maddocks, 2005); promotes indigenous technological development (Weber, 2003; Weerawarana & Weeratunge, 2004); avoids being hostage to proprietary software and vendors (Weber, 2003); guarantees against buried “espionage software” (Weber, 2003); advances knowledge more quickly (Câmara & Fonseca, 2007); promotes adaptation to changing organizational environments (Gallego, Luna, & Bueno, 2008); and helps to set up an information economy (Weerawarana & Weeratunge, 2004). In practice, however, these advantages are not well established (bridges.org, 2005a). The extant OSS literature also focuses mainly on development projects, developers, products, organization and governance structure, and innovation emphasizing back-end applications such as server software and middleware (von Krogh & von Hippel, 2006). The implementation aspect of domain specific end-user OSS such as library and health information systems (ISs), in general, and in DCs, in particular, has not been given much attention except for a few studies (Fitzgerald & Kenny, 2004; Lungo, 2006; Waring & Maddocks, 2005).

The emergence of OSS has changed the philosophy and practice of software production, implementation, and ownership from copy right to copy left, from closing to opening source code and from organization-based to individual-driven production and implementation (Feller, Fitzgerald, Hissam, & Lakhani, 2005; Raymond, 2000; von Hippel & von Krogh, 2003). The production and implementation relies more on loosely coordinated globally distributed developers/users with the mediation of the information infrastructure. These changes have direct ramifications on IS implementation in general, and in DCs in particular, given context-sensitivity of ISs, complexities of IS implementation and hindrances in DCs (Avgerou, 2008; Heeks, 2002; Sahay & Avgerou, 2002). DCs lack techno-scientific knowhow and the public sector has been dwarfed by brain drain (Avgerou, 2000; Waring & Maddocks, 2005). Arrangements that allow for situated learning such as acquisition of equipment, technical assistance, education and training, and direct foreign investment were unsuccessful to make DCs able to adapt, enhance and maintain ISs (Odedra, 1992). The altered philosophy and practice, however, makes less experienced developers in DCs to be forerunners and in charge of customization and implementation activities with an open participation of developers/users around the globe. These changes can have different ramifications on implementation activities in DCs. This research investigates the micro-processes of an end-user OSS implementation in public higher education sector in Ethiopia in order to uncover the practice-based learning and
resource sharing practices evident among locally situated and globally dispersed developers and users. The research seeks to answer the following questions: How can distributed computing environments be used to facilitate end-user OSS implementation in the public higher education sector of Ethiopia? How can the public higher education sector develop technological capability through OSS implementation? What is the role of information infrastructure in stimulating the learning process?

The research investigates the trajectories of OSS implementation projects in the Addis Ababa University Library (AAUL) and the College of Telecommunications and IT Library (CTITL). The libraries were introduced to OSS in different circumstances, downloaded a similar OSS-based library information system (OLIS) called Koha from the Internet, followed diverse trajectories and implemented Koha with the support of partners. Sections four and five describe the implementation processes of Koha in AAUL and CTITL respectively, following the presentation of the study’s research methods documented in section three. The next section (section two) discusses the learning processes that can emerge from the sharing of accounts of related practices without sharing the same context of work and the lens used to understand such learning – the trans-situated learning (TSL) model – the notion adopted in this research. The analysis of the cases in light of the TSL model are presented in section six followed by a discussion in section seven. Finally concluding remarks are presented in section eight.

2. OSS, DEVELOPING COUNTRIES, AND TRANS-SITUATED LEARNING

Open Source Software

OSS has changed the philosophy and practice of software development and ownership and impacted implementation. OSS development and implementation rely mainly upon individuals making choices to volunteer their time and skills to a production activity organized in a bazaar style (Raymond, 2000) dispersed across organization, geography, culture and time (Mockus, Fielding, & Herbsleb, 2005). The license dictates disclosure and dissemination of source code so that anyone with proper programming skills and motivations could use, modify and distribute any OSS written by anyone (Neumann, 2005; von Hippel & von Krogh, 2003). OSS developers/contributors and users coordinate activities, deliver products, and offer field support using the Internet usually without the need for an intermediary or a vendor and face-to-face communication (Lakhani & von Hippel, 2003; Mockus et al., 2005; von Hippel, 2002, 2005). This form of implementation, the community-based OSS implementation model, invites the voluntary participation of anyone interested.

The philosophy and practice of OSS impacted implementation of back-end applications (such as operating systems, server software, etc) and domain specific end-user applications differently. Often IT professionals are the primary users of back-end applications and they are able to understand and change source codes. Development and use of such systems is like “scratching own itch” as stated by Raymond (2000). In the case of front-end applications, however, users may not be computer experts, and hence, unable to configure and use systems by themselves (Ducheneut, 2005). The implementations of such systems require IT experts that mediate users’ requirements, systems capabilities and local circumstances. These IT experts might not have domain expertise. Furthermore, such systems embed local idiosyncrasies of the place of
production (Heeks, 2002; Pollock, Williams, & D’Adderio, 2007) demanding for adaptation to use contexts.

**Developing Countries**

Some DCs have already set up programs and legislations prioritizing OSS in the public sector and are reaping the fruits while others are following a similar suite (Chan, 2007; Waring & Maddocks, 2005; Weerawarana & Weeratunge, 2004). For example, the governments of China, India, Peru, and Brazil have set up programs and regulations to encourage the growth of OSS through distribution of OSS, education, and government procurement preferences and tax benefits for OSS firms (Chan, 2007; Subramanyam & Xia, 2008). In Africa countries such as Angola, Benin, Djibouti, Kenya, Senegal, South Africa, Tanzania, Uganda and Zambia have formulated OSS specific policies or references to OSS or open standards in publicly available documents (bridges.org, 2005b). Transferring systemic technologies, regardless of license, to DCs has been complex and challenging because of adaptation requirements and the need to transfer operational and technical know-how (Braa, Monteiro, & Reinert, 1995; Nhampossa, 2005; Odedra, 1992). Some authors (Braa et al., 1995; Braa, Monteiro, & Sahay, 2004; Heeks, 2002; Nhampossa, 2005) state that ISs cannot be transferred and be put to use exactly as planned during design, especially from the north to the south and propose the notion of translation instead of transfer. Researches also attest to the use and consequences of ISs to emerge unpredictably from complex interactions between the social and the technical in a specific context in time (Markus & Robey, 1988; Orlikowski, 1992, 1996). The unpredictability and restructuring would be more evident in the context of IS implementation in DCs because of country context differences and the resulting gap between IS designs and realities in implementation contexts (Heeks, 2002). DCs may not have economic resources and indigenous techno-scientific capabilities (Avgerou, 2000; Heeks, 2002) that can facilitate the co-development of the social and the technical that is evident during IS implementation (Monteiro, 2000). Furthermore, DCs have been dwarfed by brain drain and western experts that are new to implementation contexts often fail to deliver expected outputs (Heeks, 2002; Odedra, 1992). And yet, the OSS phenomenon renders the responsibility of customization and implementation to the locals and avoids situated practices.

Vendors provide technical and operational supports and trainings to clients when they are involved in implementation activities. Their services also continue for a certain period of time depending on service level agreements. Such situated arrangements and service level agreements do not exist in a community-based OSS implementation practice. Hence, the potential advantages of OSS to DCs depend on the development or the existence (or not) of local capacity that could configure, customize, and implement OSS. For example, Odedra (1992) indicates how ITs donated by the west to DCs failed to be operational because of lack of local skilled personnel, problems with western consultants and ineffective local capacity development strategies. The fate of OSS in DCs could be the same as donated technologies unless the locals are able to assimilate it. In this respect, unlike in the case of other arrangements, the community-based implementation itself, opens up new opportunities for local developers to develop the technological capability and improve IS implementation through a distributed practice-based voluntary participation of experts around the world. This trans-situated form of learning/capacity development is the concern of this research, and the next section explains its essence.
Trans-Situated Learning (TSL)

OSS facilitates learning and software development and coordination of activities in a loosely coordinated distributed environment (Hossain & Zhu, 2009; von Krogh, 2002). Studies indicate that networking among actors of aligned interests assists learning and IS implementation (Braa et al., 2004; Heeks & Stanforth, 2007). For example, by using local/global network model, Heeks and Stanforth (2007) explain that in e-Government implementation projects in DCs there are a ‘global’ set of resource providers and a ‘local’ set of implementers, and the degree and balance of participation in this network determines success. In order for local intervention to be robust and sustainable, skill is required to be transferred from where success is achieved to new sites, which could be possible through networking and formation of alliances. Braa, Monteiro, and Sahay explain that “[e]stablishing networks creates opportunities for sharing experience, knowledge, technology, and value between the various nodes of the experience” (2004, p. 341). The networking is not about growing the size to reach the level of critical mass but to facilitate the necessary learning process, which they say, is pre-requisite to sustainability.

Such practice-based learning and sharing is possible among people that share physical context or are separated by multiple boundaries such as functional, geographical, or organizational. The situated learning theory and the associated communities of practice (CoP) analytical device capture the learning dynamics among people engaged in similar practices and have frequent occasions to interact with each other often face to face (Brown & Duguid, 2001; Vaast & Walsham, 2009). However, it fails to capture the practices of people who share occupational interests but who are not working together and who cannot interact face to face (Brown & Duguid, 2001; Vaast & Walsham, 2009). The emergence of IT, particularly the Internet, facilitates “the acquisition and generation of new knowledge and competences based on similar practices and experiences, and beyond the confines of shared locations or of institutionalized educational settings” (Vaast and Walsham 2009: p. 547). Brown and Duguid (2001) introduced the concept of a “network of practice” (NoP) to describe people that are not necessarily collocated and may never have met face to face but engaged in similar practices. Considering this notion, Vaast and Walsham (2009) propose a trans-situated model of learning (depicted in Figure 1) that makes use of an information infrastructure and supports networks of practices. Trans-situated learning refers to

[P]ractice-based learning dynamics that are not limited by the bounded context of CoPs, […] Such learning processes may emerge throughout NoPs, i.e., among people who share a certain degree of similarity in their practices but who lack the ability to interact directly with each other on a regular basis. (Vaast and Walsham 2009: p. 547)

The trans-situated learning model builds upon the notions of CoPs, NoPs and an information infrastructure. Newcomers to a practice learn from old timers through an apprenticeship like processes of legitimate peripheral participation (LPP) and by increasing access to other CoPs’ practices. Resources move among CoPs, and members engage with peers based on shared practices transcending geographical, organizational and functional boundaries being conditioned and supported by an information infrastructure.

Likewise, the development and implementation of OSS has been realized through the practices of individuals and communities imbedded in local contexts, and dispersed across boundaries.
through experience and resource sharing. Sharing beliefs, values, communications, artifacts and tools among OSS developers/users enables not only cooperation, but also provides a basis for shared experience, camaraderie, and learning (Scacchi, 2005). This study analyses the trajectories of two OSS implementation projects in light of the trans-situated learning (TSL) model to find out the processes of indigenous technological capacity development in a resource constrained setting.

RESEARCH METHODS

The research adopted the qualitative research approach (Silverman, 1998, 2005) with the underlying epistemological and ontological notions of the interpretive philosophy (Klein & Myers, 1999; Myers & Avison, 2002; Orlikowski & Baroudi, 1991; Walsham, 1993, 1995, 2006). The interpretive tradition presumes a social constructionist perspective on reality and the construction of knowledge; it rejects the possibility of an ‘objective’ or ‘factual’ account of events and situations. The interpretative approach has become more interesting and relevant as the focus of IS research shifts from being purely technological to the one that includes behavioral and organizational aspects, consequently when more interest was placed on the interaction between context and innovation (Benbasat, Goldstein, & Mead, 2002; Galliers & Land, 2002). The case study research is particularly well suited to IS research (Lee, 1989; Myers & Avison, 2002) because it facilitates the study of IS in a natural setting and allows the researcher to answer ‘how’ and ‘why’ questions (Benbasat et al., 2002). The research involved two separate contexts leading to a multiple-case study design (Yin, 2003). The case study method suggests data collection through multiple means from various sources including documents, archival records, interviews, direct observation, participant observation, and physical artifacts (Benbasat et al., 2002; Yin, 2003). However, Walsham argues in favor of the interview as an important data source for interpretative case studies (Walsham, 1995, 2006). Thus, as an interpretative case

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study, this research employed multiple data collection techniques such as interviews, discussions, observations and analysis of email archives.

The researcher was employee of AAUL from 1996 to the end of 2002, until he joined a teaching department in the same university. During this period, he served the library as chairperson of an automation team (August 2000 – August 2004) and as systems librarian. The automation team was tasked with computerizing services and facilitating IT utilization in the library. The library started OLIS customization (the concern of this study) at the end of 2004, after the researcher left the automation team as a project manager and the library as an employee. However, he was closely following the process partly for a research purpose. The researcher made several field visits and conducted interviews for researches that had different themes during the course of Koha’s implementation in AAUL. Fieldwork specifically aimed at this research was conducted from September to December 2008 in both AAUL and CTITL.

In AAUL, two developers were responsible for the technical aspect of Koha, i.e., configuration, customization, enhancement, and maintenance activities. A project manager, who was later appointed to a senior position in the library, was in charge of the overall aspects of the project. Only the cataloging and the OPAC modules of Koha were operational at the time of this research, and it meant that catalogers were the only users of the new system from the staff side. Therefore, developers, the project manager, and catalogers in AAUL were sources of data for this research. The researcher interviewed the two developers, the project manager, and three of the catalogers for about 1:30 to 2:00 hours each. The interviews with the developers and the catalogers were recorded and detailed notes were taken while interviewing the project manager. Furthermore, the researcher observed activities of the staff in the cataloging department while they were performing the usual activities and discussed with them about different aspects of the new system such as, including but not limited to, improvements in work practices, challenges, and overall perceptions.

One person was responsible for customization, implementation and subsequent activities of Koha in CTITL. This person was in charge of the library as well as for implementing and enhancing Koha in CTITL. The researcher interviewed the only developer to understand the implementation and enhancement processes of Koha in CTITL. The interview was recorded and lasted for about 2 hours. In addition, the researcher made on-site observation and informal discussion with another librarian in CTITL to understand his views about the new system especially concerning improvements in work practices, challenges, and overall perceptions.

The developers in both libraries exchanged emails with the Koha community and studied email archives to solve configuration, customization, and enhancement problems. The researcher reviewed the mailing list archives of Koha developers and users; specifically, examined the emails exchanged between local developers in the two libraries and the Koha community between December 2004 and February 2010. December 2004 was the time when AAU started customizing Koha. Table 1 summarizes the data collection methods.

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<th>Site</th>
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The analysis was centered on the pattern of iteratively reading data, identifying key themes, and then relating them to the conceptual framework. The researcher summarized the field notes soon afterwards the interview and listened to the recorded interviews extracting themes focusing on learning, skill development, improvement in implementation, etc especially focusing on the chronology of events and in light of the trans-situated learning model. The same iterative procedure was followed while analyzing the emails exchanged between the locals and the Koha community. Once the data of each site was analyzed separately, comparison was made between the two sites and subsequently, the findings of the analysis were interpreted in light of the IS literature. As Walsham notes, the researcher’s mid supplemented by the minds of others is the best tool for analysis, and this research relied mainly on the minds of the researcher supplemented by colleagues (Walsham, 2006). The results of this research were presented to colleagues at different stages and refined further based on their inputs.

**LIBRARY SYSTEM IMPLEMENTATION IN AAUL**

Although the history of education in Ethiopia traces its origin back to the fourth century AD, Western education system began taking shape in the second half of the nineteenth century with the arrival of missionaries (Zewde, 2002). The first public school and university were opened in 1908 and 1950, respectively. Formal education expanded ever since while the system and its contents were changing to serve the needs of different regimes and interests. The current education system offers 10 years of general education consisting of 8 years of primary education and 2 years of general secondary education (9-10) with the second cycle of secondary education (11-12) which prepares students for continuing to higher education (FMOE – Ethiopia, 2010). The statistics of the government of Ethiopia indicates growth in major education indicators, including education budget and expenditure relative to the total government expenditure (FMOE – Ethiopia, 2010). The number of higher learning institutions also started to grow rapidly very recently. In 2006/07 alone the government opened 12 new universities bringing the total number of government universities to 23 (FMOE – Ethiopia, 2010). The universities collectively had a total of 9,496 teaching staff and enrolled a total of 263,979 students in both undergraduate and graduate programs in 2008/09. Although the number is increasing, the higher learning institutions have been suffering from lack of trained manpower and educational resources.

AAU is the oldest and the largest higher learning institution in Ethiopia which was founded in 1950. It has contributed a lot towards, among others, the expansion of education, including higher learning institutions in the country. Its library, the AAUL is the first academic library in Ethiopia which was founded in 1961. Although the history of modern libraries in Ethiopia begins...
in 1930 with the opening of a public reading room and have grown in number throughout the years, their collections and services were very limited (Gupta, 1995; Pankhurst, 1988). AAUL was the major public information resource center in the country, especially for research and academic purposes. The library was composed of more than 19 branches and serves mainly the AAU community, and extends services to external organization and individual users. The Library was organized in a centralized manner, i.e., technical and managerial activities were performed centrally at the main library. A university librarian was responsible for overall operation of the Library with the help of two assistant librarians each responsible for technical and public services. The technical services include acquisition and cataloging while the public services include circulation, reference, departments and branch libraries.

The library used to face challenges because of shortcomings of a manual library system and had financial limitation to implement a computer-based library system. The manual operations of the libraries had limitations to satisfying the needs of users and staff. For example, it did not allow searching for an item by combining keywords or subject headings. Even if a search is successful, locating the material was difficult, i.e., knowing whether the material is in circulation, on the shelf, out of circulation, etc. The Library staff faced difficulties to know the collection size, circulate books to users, compile reports, etc. By introducing library information system (LIS), the libraries aimed at improving services, alleviating drawbacks of the manual system, facilitating interaction with similar libraries, and enhancing their images. The LIS would automate the processes of acquisition of books and serials, cataloging and circulation functions, and facilitates report generation. Using OPAC (online public access catalog), users could easily interact with the libraries, search collections, and operate some circulation activities, for example, extend loan periods.

AAUL started customizing an OLIS at the end of 2004 after previous attempts to purchase and develop a library system failed to bear fruits. In 2004 while preparation for purchase was going on, collaboration between AAUL, ICTDO (ICT Development Office) of AAU, a University in the USA (a professor and his students) and an NGO (co-established by the professor) had initiated a project to customize an OLIS called OpenBiblio. ICTDO was established to manage a University wide computer network (AAUNet) and carry out ICT related R&D activities. Insufficient IT personnel demanded the Library to form an alliance with ICTDO that had a pool of IT experts which were drawn from teaching departments of AAU (computer science, electrical and computer engineering, and information science). To promote sharing of knowledge and experience, the international arrangement mixed local and global members together in groups and started the project but did not go further the planning stage. Despite its failure to deliver the expected product, the arrangement introduced the local team to the world of OSS.

The justification behind switching from purchase to OSS adoption was associated to reducing total cost of ownership and developing local expertise that would serve as knowledge hub for libraries in Ethiopia. According to project documents, vendors quoted prices ranging from 150,000 to 450,000 USD for a LIS that could run on 25 workstations each for staff and user. The price excludes adaptation costs that may be incurred to make the system able to accommodate materials written in Amharic script. Therefore, immediately after the discontinuation of OpenBiblio implementation, AAUL and ICTDO initiated a joint OLIS adoption project in October 2004 and organized a project team comprised of library and ICTDO staff, and appointed a project manager from the library. The alliance targeted at exploiting the technical expertise of
the IT personnel both in customization and implementation, and in developing the technical capacity of the library staff. The objective of this project was to explore and identify OLIS and proceed accordingly. To this end, the team shortlisted OpenBiblio and Koha, finally selected the latter for implementation, and planned to make the library’s catalog online by October 2005. The project team met once every week for at least two hours to discuss problems, suggest solutions, evaluate progress, and discuss and approve plans.

Once Koha was approved, the technical group downloaded and made version 2.0.1 ready for testing on AAUNet while the nontechnical group analyzed its functions against requirements of AAUL. According to the project manager, the team piloted Koha before embarking on full-fledged implementation and learned about technical problems, scalability, performance and organizational issues such as coordination and management. During the pilot phase ICTDO trained some of the technical staff of the Library on Linux and Perl (the language used to develop Koha) and made them to participate in technical aspects. These technical people did not have library science education but worked in the library for at least two years. They were serving as an interface between requirements of the library and the ICTDO staff. AAUL has dropped its partnership with ICTDO after the pilot phase and full-fledged implementation continued under the Library’s ownership. The previous project manager retained his position but required to staff the project from within the library only. He then organized a team composed of deployment, retrospective conversion (recon), and training sub teams to customize and configure Koha, convert card catalog into electronic format, and train staff and end users respectively. The plan was to implement Koha module by module in such an order cataloging, OPAC, circulation, acquisitions, etc.

The training team organized hands-on trainings on computer basics and operations of Koha mainly to the Library’s staff. The retrospective conversion team populated Koha with bibliographic data of books and serials that were written in Latin script. The deployment team (hereafter developer) had two members who were trained on Linux and Perl by ICTDO and were anchor to making Koha up and running. The new arrangement demanded reinstallation and configuration of Koha on the library’s server that was separately located in the main library. One of the developers describes the situation as follows:

The initial training was essential to acquaint ourselves with Linux and Perl but it was not sufficient to make us able to install, configure and customize Koha. We were far away from that…. we were over flown by tasks related to database management system, operating system and Koha itself.

The developers downloaded Koha version 2.0.1 and other required software from the Internet and installed on Unix Solaris operating system, and posted the first ever message to the Koha mailing list on 6 November 2004. The message briefly introduces the guy, the library and the version of Koha in use and asks “[…] IS THERE A DOCUMENTATION FOR THE KOHA DATABASE, IF SOME ONE HAS ALREADY DEVELOP IT? OR IS THE POSSIBILITY TO GATE ANY DOCUMENT THAT TALK ABOUT KOHA DATABASE?” The next day someone from France posted

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1 Koha is an integrated library system meant for computerizing services of a library. It was initially developed in New Zealand and distributed under the open source General Public License (GPL). Koha has modules for circulation, cataloging, acquisitions, serials, reserves, patron management, branch relationships, and has additional basic and advanced features. It was first deployed in 2000. Further information can be found here [http://koha.org/](http://koha.org/).

2 The quotations are directly taken from the emails.
“www.koha.org/wiki is the place where you will find all our documentations.” On 8 December 2004, the same developer posted a similar message “[…] Can any body help me on Koha database design? That is, Is there a documentation for KOHA DATABASE DESIGN? How it looks like?” and another respondent posted on the same date “You asked this question yesterday. If you did not like the answer [Mr. A] gave, perhaps you should be more specific.” Then the developer asked how to interface Koha with a cataloging database and someone else posted the experiences of one library in the USA that uses the same cataloging database.

Besides posting practical information in how to solve a given problem, members of the list advised newcomers in various respects. The following posting is an example response to an inquiry posted by a developer from AAUL “[…] are you sure that's all it says? Look above that line in the log and you should see something more informative. Let us know what it says :-).” The developers in AAUL changed the operating system from Solaris to Redhat and one of them posted “[…] Is there a problem of using Koha 2.2.0 on Redhat 9 Professional Edition?” The advice was as follows:

As far as I know Koha should run fine on Red Hat 9.0. However, I would advise against it unless you know how to install security updates aside from the packaging system (support for Red Hat 9 has ceased). Fedora Core 3 is an option, as is Debian Woody or Sarge, or any other supported distro.

The developers later changed the operating system from Redhat to Debian Linux (Sarge) following the advice. Besides posting inquiries, the developers studied archives of the Koha mailing list and other related materials in order to solve problems and advance their understanding of Koha and its technologies. Sometimes an inquiry posted to the list may not get a response but the job could be done, and a job might not be done also despite advices. For example, despite the advice Koha does not interact with the cataloging database.

Besides solving own problems the developers in AAUL were posting various solutions both to local and international partners. For example, on August 15, 2006 and July 16, 2008 the developer posted the following solutions to a guy who was implementing Koha in another library in Ethiopia:

It is fine to hear words of success in instakking and configuring Koha. […] add the following line at the end of the apache2.conf file […] Now go to the koha-httpd.conf file which is located at /etc directory and the virtual host name as follows […]

If you are behind a proxy, Z39.50 may not work. I have tried this feature […] You need to talk to network administrators to release the ports that you are using for Z39.50. […] Regarding the barcode try this if you didn't do before: attach the koha server with an ordinary printer and reboot the system. And try again. […]

Since the middle of 2007 the project ceased and dealing with Koha became the responsibilities of the reorganized and re-staffed computer center of the library. AAUL started with Koha 2.2.0 and was using version 2.2.4 in June 2009. The last stable release of Koha in June 2009 was 3.0.1, i.e., Koha was changed 11 times after it was introduced in AAUL. Failure to migrate to new releases impacts support as it concentrates on new releases than older versions. The following postings reveal the level of difficulty AAUL faced in migrating to new releases.

I found the guideline on the koha wiki to upgrade from koha 22 to koha 3.0) lacks many details and couldn't helped me. I am loooking for some who did this successfully. (February 12, 2009)
Recently, we have tried to upgrade [Koha to] the current stable version [3.0.1] and faced some difficulties. So, we would like to outsource it and seeking for an expert who can provide commercial support for the upgrade and other minor customizations […] (June 3, 2009)

From the beginning of the project in November 2004 until February 2010 AAUL posted a total of 15 questions and 5 solutions. And until the end of 2009 it was utilizing the cataloging and OPAC modules only. Users were searching for availability of a material using the Koha regardless of location and time. Catalogers have been populating the database of Koha with bibliographic data of books but have lots of complaints. They explain, Koha is not properly configured and customized to facilitate their activities and produce reports. The following two excerpts exemplify their problems.

One of the good side of Koha is that you cannot leave the call number field blank. In the rest of the fields, you can write whatever you want and the system never complains. Retrieving data using specific barcode returns lots of unnecessary hits and no one explains why. […] Koha is not well configured here in our library and I do not recommend it for use unless these problems are resolved.

I sometimes operate the circulation module, which I am not allowed to do so. Technically, nothing prevents me from operating the circulation module as of now. Lending books to users or changing the status of unreturned books to “returned” is possible. This tells me how loose the configuration is and how far behind our system’s configuration is compared to what it should be.

Due to, partly the above problem, both the old and the new system were running in parallel. As a result of the experience with Koha, one of the developers was actively engaged in the development of an OSS digital library called Greenstone. Various officials from local universities also visited the library and asked for support to implement Koha in their libraries.

**LIBRARY SYSTEM IMPLEMENTATION IN CTITL**

The college of telecommunications and information technology (CTIT) was established in the first half of the 2000s with the sponsorship of the state owned Ethiopian telecommunication corporation. The CTIT Library (CTITL), which was established together with the college, has two branches – the graduate school and telecommunications training libraries and serves about 1000 users composed of students, faculty and employees. It had a collection of around 100,000 materials composed of books, journals and others. The library used to face similar challenges with that of AAU because of the shortcomings of manual operations and lacked of resources to implement a computer-based library system.

The Head librarian (the developer hereafter), who was Librarian and IT expert by training, was central in implementing Koha in CTITL. He was unaware of OSS altogether until he learned about the introduction of Koha in AAUL. Following a brief conversation with the project people in AAUL, he downloaded Koha version 2.2.0 and redhat Linux, and started installation. But he encountered several problems with the operating system before proceeding further, and as a solution he changed from redhat Linux to Fedora. Furthermore, he expected the operating system to install everything that Koha required but found out that it was not the case; identifying the sources of bugs (operating system, database management system or Koha) was problematic; and where and how to ask questions was also among the problems that he encountered during the project. As a manifestation, on August 10 and 12 2005 he has posted messages to the Koha mailing list without content but the term help appearing in the subject field.
In order to solve customization, installation and configuration problems and advance his understanding, the developer has studied documentations of Koha and its technologies (MySql, Linux, and Perl), and got support from developers and users. He also mentions that outdated and incomplete documentations of Koha created inconvenience in making use of latest release. However, he explains

Users provide valuable information comparable to formal education. Each question and answer of the forum has been educational not only on Koha but also on operating systems and the whole implementation process. I have been learning a lot about Linux, bug fixes, how to implement fixes, etc besides carrying out customization and implementation.

Finally, after intensive work on installation and configuration, and with the support of the community, Koha went live in CTITL in February 2005. Once it was operational in full, succeeding activities concentrated on keeping up-to-date with new releases, dealing with problems that arose as a result and enhancing features. For example, on October 11, 2005 the developer posted an inquiry which says “I update my Koha 2.2.3 to 2.2.4. I think it looks good.” mentions the problem he encountered and inquires for a solution. Later, on May 10, 2007 he posted “[…] Koha z39.50 was working until I upgraded to koha 2.2.9. […] the error log looks like the following…” and got the following response “This one is not related to dates. It's related to mySQL that is off. I think you can't do anything with Koha atm ;")”. The following inquiry and response on March 29 2007, for example, deals with adding features and localizing Koha further.

I want to translate the template to Amharic (Ethiopian official language). Do you know whom I should contact if it is acceptable? I want to contribute. I want also to link my bibliographic records to full-text pdf file. […]

First off, welcome to the Koha community. Glad you're interested in contributing. I've set up an Amharic OPAC translation instance at http://translate.koha.org. This is a Beta translation site, so if you have any difficulty or have suggestions for how to improve it let me know. (Response)

Since then Koha has been in translation to the Amharic language with the support of other developers from Ethiopia. Koha was fully operational on the college’s Intranet since February 2005 with bibliographic details of books, journals and monographs, and also hosts digital books. The developer was continuously upgrading Koha whenever there were new releases, but migration from 2.2.9 to 3.0.1 required major shifts than previous migrations. He further explains that in the past he used to run a command to effect changes but now more shifts that need detailed study are required. In general, the developer was happy with OSS and Koha.

Mostly we talk about cost implication of OSS but it has additional advantages beyond freely acquiring the software. It is flexible for customization and the magnitude of people that take part in such projects is huge which facilitates enhancement and learning. For example, Koha has been changed six times within a short period of time; had it been proprietary it would have not been changed several times within such a short period.

Because of the implementation success of Koha in CTITL, presidents and librarians of various local universities had visited the Library and asked the developer for consultation and support. He advised local librarians on best practices, technologies, learning processes, and networking, etc. CTITL started with version 2.2.3 and was using version 2.2.9 in June 2009 while the latest stable version at the time was 3.0.2. This means that Koha has been changed 8 times after it was introduced in CTITL. From the beginning of the project in January 2005 until February 2010, the
The developer has posted 9 messages to the Koha community mailing list and received 6 solutions. The following table summarizes some of the core points in the implementation trajectories of the two organizations.

<table>
<thead>
<tr>
<th>Feature</th>
<th>AAU Library</th>
<th>CTIT Library</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea and software</td>
<td>Unsuccessful previous OSS adoption initiative introduced the locals to OSS.</td>
<td>AAUL was the source for both the idea of OSS and the specific library software.</td>
</tr>
<tr>
<td>Acquisition</td>
<td>The Internet was source of the software.</td>
<td>The Internet was source of the software.</td>
</tr>
<tr>
<td>Implementation</td>
<td>Initiated the project with the support of the University. The</td>
<td>The head librarian had initiated and carried out the</td>
</tr>
<tr>
<td>Environment</td>
<td>project manager was member of the Library administration. There was no</td>
<td>implementation with the support of the College. There was no</td>
</tr>
<tr>
<td></td>
<td>external financial support.</td>
<td>external financial support.</td>
</tr>
<tr>
<td>Implementation</td>
<td>A pool of IT experts involved in initial installation and configuration,</td>
<td>The Librarian had prior knowledge of some of the</td>
</tr>
<tr>
<td>Related</td>
<td>and training technical staff of the Library.</td>
<td>technologies of Koha and was anchor to the implementation.</td>
</tr>
<tr>
<td></td>
<td>Focused on mailing list archives for past information, posted inquiries,</td>
<td>Focused on mailing list archives for past information, posted</td>
</tr>
<tr>
<td></td>
<td>utilized responses, and studied documentations of Koha and its</td>
<td>questions, utilized responses, and</td>
</tr>
<tr>
<td></td>
<td>technologies including from other sources.</td>
<td>studied documentations of Koha and its technologies including from other</td>
</tr>
<tr>
<td>Future aspects</td>
<td>Re-established the computer center &amp; hired staff making them</td>
<td>No specific plan was adopted.</td>
</tr>
<tr>
<td></td>
<td>responsible for Koha.</td>
<td>The same guy was responsible for all activities.</td>
</tr>
</tbody>
</table>

Although AAUL and CTITL have implemented Koha, its implementation level in the two libraries was different. CTITL implemented in full and was utilizing all of the functions of Koha except the acquisitions module because of the non-existence of online transaction in Ethiopia. Moreover, CTITL was able to include full-text materials besides bibliographic data and customized Koha as its own website. AAUL however was utilizing only the cataloging and OPAC modules. Even the cataloging module was not properly configured and customized to facilitate cataloging and report productions. Koha was changed 11 and 8 times after it was introduced in AAUL and CTITL respectively. These frequent releases demanded the libraries to frequently change Koha to keep abreast of developments and improvements, and benefit from the active support of the Koha community. Upgrading, however, demanded capacity. AAUL was using the older version than CTITL which might mark for the existence of capacity problem in keeping up-to-date with developments and fixes. This problem finally led AAUL to announce for a payment-based support from the Koha community. The developers in both libraries have extended their support to other local libraries although it was in a limited scale and several local university officials visited their respective libraries and demanded support. One of the developers
in AAUL engaged in another related OSS development project because of his experience with Koha. The developer in CTITL considers the frequent release of Koha as a sign of strength and the whole implementation exercise as an entertaining and educational comparable to formal education.

CROSS-CASE ANALYSIS

The implementation of Koha in AAUL and CTITL was the result of a collaborative effort among locally co-located and globally dispersed actors that shared experiences, knowledge, technology and value. This form of IS implementation, the community model, is contrary to the traditional practice where often vendors render installation, configuration and training services to customers in their vicinity. Unlike most widely practiced back-end OSS, a LIS is domain specific and contextual. Initially, the Librarian in CTITL and the IT people in AAUL lacked the required expertise to understand the technologies of Koha and install, configure and customize it by themselves. The need to make use of Koha in their respective libraries triggered practice-based learning processes involving local and global actors with the mediation of the information infrastructure. This section analyzes the learning and sharing processes and the elements that were shared among co-located and globally dispersed actors in the courses of implementing Koha in AAUL and CTITL.

Situated Socio-Technical Ensembles and Practices

As depicted in Figure 2, there were three important co-located groups in the technical development of Koha in AAUL – the pool of IT experts (ICTDO staff), and developers and catalogers from the library. The weekly meeting of the project team brought these groups together and created an environment conducive for sharing experiences, collectively solve problems, and discuss and monitor progress. It was a learning occasion for all of the project team members as none of them had a complete knowledge of Koha, library practices and integrated system development and administration. The developers learned the tricks of installation, configuration, customization and administration of Koha through a formal practice-based training offered by ICTDO on the technologies of Koha and by working together with the ICTDO staff on the technical aspect of Koha until the end of the pilot phase.

Koha is an ensemble by itself which is composed of database management system, operating system, and inscribed work processes at a higher level of abstraction. Developers were supposed to learn each of them to make Koha up and running in AAUL. Even if the ICTDO staff was expert in IT and integrated systems, they were novice to the logic and design of Koha. Since the logic is related to library functions, developers from the library were filling in that gap. The pool of IT experts and the developers in the library shared experiences, knowledge, documents and other artifacts about the technologies, installation, configuration and management of Koha, and library practices. The developers have studied the cataloging practice with the support of the cataloging staff while documenting requirements and later on to fix bugs and streamline functions. As indicated in the figure, developers and catalogers shared the tricks of cataloging, best practices, solutions and requirements even if it did not continue throughout the project period.
As indicated in the bigger circle in Figure 2, the developers were embedded in a local socio-technical context and dealt with various social and technical matters including project plans, requirements, technical expertise development, adaptation of Koha, dealing with opposition groups, etc. The exchanges of practice-based experiences, knowledge and artifacts among co-located local groups upgraded the knowledge and skills of developers but were insufficient to make them able to understand and implement Koha in AAUL. Disassociation of AAUL and ICTDO, and lack of comprehensive knowledge on Koha necessitated local developers to interact with the developers and users of Koha through email and to study the email archives. The next section elaborates on the interaction between the local and global actors in an attempt to fill up the required skill and knowledge gap.

In CTITL one person, who was imbedded in the local use context, was responsible for the whole process of adaptation and implementation. This individual who is labeled as developer in Figure 3 had library and IT expertise especially on related technologies to that of Koha. The developer learned about OSS, Koha, its source, best practices, etc from AAUL. Further activities such as learning more on the specific technologies of Koha and dealing with installation, configuration, customization, and administration demanded further efforts. Unlike developers in AAUL, the developer in CTITL did not benefit a lot from local partnerships rather sought advice from the developers of Koha by posting inquiries and studying email archives. This trans-situated form learning is discussed below.

**Distributed Practice-Based Learning and Sharing**

The essence of OSS lies in the development of software and coordination of activities in a voluntary-based distributed environment (Ducheneut, 2005). Hence, the developers in the two libraries exploited the voluntary support of Koha developers and users that were dispersed across

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**Legend**

The broken arrow indicates discontinuation or infrequent interaction.
space, organization and time in the course of understanding, localizing and implementing Koha in their respective libraries. The developers posted inquiries and studied archives of mailing lists to advance their understanding, improve local practice and solve problems. The mailing list archives convey past information exchanged among users and developers concerning the features and functions of Koha, bugs, solutions, suggestions, etc. As indicated in figures 2 and 3, code, guidance, best practices, advices, value, norm, inquiries and solutions were exchanged between local developers and Koha communities.

Analyses of the postings from and to the local developers suggest that the locals have learned the technologies of Koha, and the tricks of customization, implementation and enhancement trough time. The level of detail, relevance and completeness of inquiries that the local developers posted were also improved over time. The solutions posted to inquiries of the local developers asked further detail on the nature a problem, directed to solutions, detailed best practices, provided detailed solutions, suggestions, advices, etc. The first ever posting from AAUL, for example, inquires for Koha’s database design documentation, which was basic to deal technically with Koha. Succeeding inquiries however dealt about interfacing Koha with other databases, migrating to new operating systems, making use of new releases and fixing bugs that arose due to new release implementation. Furthermore, a developer from AAUL posted detailed practical and localized solutions to inquiries from another local librarian that followed the footsteps of AAUL. These exchanges mark improvements in the knowledge and skill of local developers and were manifested in the customization, implementation and enhancement of Koha in AAUL.

However, there are advices and suggestions that the AAUL developers did not implement. For example, interfacing Koha with the cataloging database was essential to facilitating cataloging but not implemented despite advices from the community. The cataloging module, which was one of the modules in use so far, was not properly configured to support the cataloging practice as required by catalogers. Even if Koha was changed 11 times after its introduction in AAUL,
AAUL has managed to upgrade five times only from version 2.2.0 to 2.2.4 while the new release at the time was 3.0.2. AAUL has finally announced to the Koha community about its intention of outsourcing the tasks of customization and migration.

The first ever posting from CTITL to the Koha user community was an empty message with the term help appearing in the subject field. Later postings however dealt about migration to new releases, fixing bugs that arose due to new release implementation, adding full text besides bibliographic data and translating Koha into one of the local languages. CTITL has been utilizing all functions of Koha in the Ethiopian context even by including full text materials and customizing Koha as its own web site. It was keeping abreast of new releases relatively faster than AAUL. Translation of Koha into one of the local languages, which was started by the developer, attracted other developers that were not based in either of the libraries but the progress was limited. The developer finally learned how to post relevant inquires, was able to understand and implement fixes, customized Koha according to local needs, implemented Koha, incorporated additional features, changed the look and feel of Koha, and migrated to new releases whenever new versions were out. He also advised some local libraries on best practices, technologies, and OSS in general although it was in a limited scale. The exchanges of accounts and resources among locally situated and globally dispersed developers were possible because of the information infrastructure – the Internet.

DISCUSSION

The developers who were imbedded in the local context acquired an OSS, studied the code, and upgraded their knowledge and skill through the voluntary support of developers and users dispersed across geography, organization and time because of the OSS license and the community-based OSS implementation model. The association of local and international partners and the sharing of experiences, knowledge, code and best practices were crucial to making Koha up and running in the two libraries. The noninvolvement of license cost for OSS opened up new opportunities to acquire, study, modify and utilize software (Gallego et al., 2008; von Hippel & von Krogh, 2003), specifically a LIS in AAUL and CTITL. As it does not involve cost, adoption of OSS avoids the often lengthy and hectic bureaucratic processes, negotiations and associated corruptions apparent in public sector organizations. Even if the noninvolvement of license cost allows organizations in DCs to easily acquire software, local circumstances including the existence (not) of expertise and an environment conducive for its assimilation impact implementation and subsequent action. As various studies have explained, implementation, utilization, scalability and sustainability of technologies brought from abroad depend very much on the existence or the development of local capacity and the networking of sites where success is achieved to the new ones (Braa et al., 1995; Braa et al., 2004; Odedra, 1992).

The responsibilities of implementation and subsequent activities lie on the hands of clients in the case of community-based implementation. This form of implementation opens up new opportunities for learning and developing capacity through practice being imbedded in the local context. To be imbedded in the local context paves the way for understanding local conditions of practice. Individuals can learn by participating in shared activities in situated and trans-situated contexts both within, and beyond, the contexts of formal schooling, education and training, especially in the workplace and in occupational communities (Fox, 2000; Vaast & Walsham, 2004).
2009). The two cases disclose that by participating in shared OSS implementation activities, local developers can learn technologies and the tricks of adaptation, implementation and enhancement, i.e., the study shows the possibility of technological capacity development through a distributed loosely coordinated OSS implementation environment. The local developers acquired knowledge and skill through a situated participation in a local context, by accessing the resources of other communities that are engaged in related practices, and by directly accessing members of other CoP. The participation of the local developers in the development process was shifted from the periphery to the center through practice, learning and interaction with the old timers. However, the level of centrality was different for the two groups of developers which can be apparent considering adaptation and implementation levels of Koha and the reactions of users in the two libraries. Although AAUL started the implementation process earlier than CTITL, it managed to implement only two modules of Koha; even one of the modules did not meet users’ requirements. CTITL however implemented Koha in full, localized it further and met the requirements of users. As explained by Heeks (2002) one of the obstacles of IS development in DCs is lack of hybrid expertise that can understand both the context and the technology. The cases show that CTITL was benefited from the hybrid expertise of the developer who was librarian and IT expert by training.

Furthermore, the cases disclose that even if OSS implementation facilitates the development of indigenous technological capacity, it demands a certain level of previous knowledge and skill. The previous knowledge and skill of the developer in CTITL in related technologies helped him to learn the technologies of Koha faster than developers in AAUL. This suggests the importance of giving due attention to develop local capacity that can be able to absorb and work with local and global peers. The arrangement in AAUL to make use of local IT expertise was a good strategy to introduce developers to the technologies of Koha through formal training and practice. Besides making use of Koha in their respective libraries, the local developers were serving as knowledge hub for local libraries, although the sharing of experiences and resources among the locals was limited.

The two cases indicate the importance of participation of local developers both in the global and local arenas to facilitate implementation and develop technical capacity. Localization, contextualization and further deployment could be possible and easier if more local developers are involved in the process, and shared their experiences, knowledge and solutions both among themselves and with the global community. Networking successful actions facilitates the movement of best practices, knowledge, learning, technology, value and norm (Braa et al., 2004) paving the way for successful implementation as well as indigenous technological capacity development. The role of the information infrastructure was paramount in supporting the process. The infrastructure facilitated for the development of a repository of email exchanges as well as access and further communication with peers around the globe.

CONCLUSION

The research reported in this article explored the trajectories of two OSS implementation projects in the public higher education sector in Ethiopia to uncover the practice-based learning and resource sharing practices evident among locally situated and globally dispersed developers and users. The study was aimed at exploring the learning and resource sharing dynamics among and between locally co-located and globally dispersed users and developers drawing upon the notions
of trans-situated learning. The findings of the research designed as an interpretive qualitative case study show that the OSS license facilitates resource constrained organizations to acquire software free of charge along with the freedom to study, modify, and re-distribute it, bypassing the often lengthy bureaucratic process and corruption apparent in the public sector. Although the license facilitates for software acquisition, the community-based OSS implementation model shifts the responsibilities of customization and implementation to less experienced and unskilled local developers impeding subsequent activities. Nevertheless, the implementation model itself creates an environment conducive for local developers to learn the technologies of the specific software and the tricks of installation, configuration, customization and enhancement. The implementation brings together voluntary developers/users around the world transcending organizational, geographical, and functional boundaries paving the way for sharing advices, best practices, products, information, etc. The participation of local developers in a locally situated implementation activity, their access to email repositories held elsewhere and the possibility to exchange ideas, advices, solutions, and values with communities engaged in similar practices regardless of geography, organization, and function, facilitates implementation as well as the development of technical capacity of the local developers. The information infrastructure plays an important role in supporting these distributed processes. The Internet facilitates and realizes the distributed implementation and learning processes by enabling the development of and access to email repositories which accounts for the experiences of developers and users while developing, implementing and utilizing systems in different parts of the world. The study, in general, shows the processes in which a practice-based learning emerges from the sharing of implementation accounts and artifacts without sharing the same context of work.

This study has implication to resource constrained settings in general, and DCs in particular, as they are suffering from similar challenges. The study suggests DCs to embrace OSS, focus beyond the license, and device mechanisms for local developers to participate both locally among co-located peers and globally dispersed developers. The community-based distributed and loosely coordinated OSS implementation model is a viable means to develop indigenous technological capacity simultaneously facilitating IS implementation in DCs. Strong and vibrant participation of local developers both in the global OSS development arena, and local implementation and networking aspects is a requirement and it increases the prospect of realizing the potential of OSS in DCs. The study suggests OSS practitioners in DCs to devise appropriate mechanisms towards this end.

The study also shows the relevance of the trans-situated learning model as an appropriate lens to understand the learning dynamics in OSS implementation projects. The model offers us with the vocabulary both to explore and analyze the learning dynamics evident among loosely coordinated distributed developers/users that are engaged in similar practices. However, further research is required to clearly understand the local universality and embeddedness of the information infrastructure with other infrastructures, as it was not evident in this study and fine-tune it further.

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