

Digitalization Trajectories of Health Information Systems and the Role of Governance in Development Projects

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PhD Thesis

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Abstract

Development projects have emerged as dominant modalities for bringing about digitalization in the developing country health sector. However, the practice of their implementation and the nature of partnership between NGOs and government institutions remains an area in need of further investigation. In particular, little is known about how development project practice affects their performance and how politics is enacted within such projects. In line with this, two core challenges are identified which have theoretical, methodological and practical implications.

First, a deeper understanding is needed around what transpires during the implementation of a digitalization project, particularly as it pertains to state and NGO partnerships and how this influences project performance. In other words, what is it about a digitalization project's inner workings and dynamics that affect its developmental potential? Secondly, and in relation to the above point, there is a gap in our understanding of how politics is enacted in digitalization projects and its implication for governance interventions. In line with this, the research questions guiding the research are: (i) what are the causal mechanisms that concomitantly drive digitalization trajectories in the developing country health context? and (ii) what implications do the causal mechanisms have for IT-based development project practice and governance?

Using a critical realist perspective, this dissertation investigates these knowledge gaps through analysis of a NGO-led digitalization project in the Ethiopian health sector. Methodological, an autoethnographic case study approach was adopted with aims of exploring and systematically analysing the inner workings of a development project by drawing on the researcher's experience within the project. Additionally, supplementary data was collected through interviews, project document reviews and surveys.

The study set out to uncover the underlying causal dynamics at play by developing a mechanism-based explanation of digitalization. This was grounded in Margaret Archer's morphogenetic approach (1995) and informed by an analytical approach from development sociology called 'social interfaces'. Four generative mechanisms of HIS digitalization were identified: projectification, informatization, embedded inscription and scaling. By uncovering these mechanisms and, in turn, the complex socio-technical-political dynamics that constituted the project, the work explains how the project's trajectory emerged.

Theoretically, the findings and analytical approaches used in this dissertation offer insights that are relevant to both ICT4D and development management researchers. Combining Archer's structural theory and the social interface analysis, the study constructs an analytical narrative of the digitalization process by revealing the structures of generative mechanisms. This offers two theoretical benefits. First, it is useful for establishing contextual contingency, namely, understanding the relationship between the broader context and digitalization events at the level of social structures and cultural systems. Second, it can help researchers analyse and account for the micro level socio-political subtleties of such projects. Together, researchers can untangle the macro-micro dynamics by conjecturing sets of multi-level mechanisms. Navigating the macro-micro analytical domains in this way is particularly valuable for developing understanding on how particular digitalization trajectories emerge and how the developmental potential of projects in this context are generally shaped.

Practically, the identified mechanisms highlight important management and developmental gaps of digitalization projects in this context. The lack of state ownership and asymmetric partnership in digitalization projects has led to overreliance on NGOs and has seen the continued decline of state institutions. The contribution from this work aims to inform local ministries and development practitioners who are undertaking digitalization initiatives and who are looking to bring about organizational transformation in the development context. In line with this, the study proposes strategic and practice guidelines on how governance norms and practices in digitalization initiatives can be cultivated.

Chapter 1

Introduction

1.1. Personal motivation

Development practice and discourse of the twenty first century has become a contested and complex phenomenon. For me, development was an oversimplified romance whose ideology had subconsciously been engrained in me throughout my childhood. Dinner table conversations between my parents centred on public sector politics in my father's work as a researcher in the agriculture field and my mother's work with marginalized women which was entangled in UN bureaucracy. In whatever spare time they had, they also managed to establish and run an orphanage. They were among an early generation of young foreign-educated Ethiopians who had returned to build a stagnant nation in the early 80s. Though the nuances of what they discussed and the challenges they faced were too complex for me to understand at the time, I felt a sense of pride in their efforts to build a nation that was being ravaged by communist rule.

Perhaps fuelled by this ideology, I too moved back to Ethiopia years later to pursue the same type of work my parents were involved in. I was a fresh graduate, motivated and naïve as I joined the NGO world. But, I soon found myself managing the implementation of a large-scale IT project. However, it was not long before the development ideology I had espoused and the passions which it unleashed as a kid began to collapse. My experiences in this role, which I explore in this thesis, have been instrumental in reframing my perspective on development practice and the general notion of development.

Despite all that has been researched, written and done in the name of development, it still remains an ideal whose attainment has been problematic. Perhaps "grasping for the wind" is not a farfetched characterization of over half a century of development efforts. To this day, development remains a contested notion. While some have argued for economic growth as a primary catalyst, researchers such as Amartya Sen's conceptualization of development as freedom have gained great traction. Sen puts forth relevant arguments for human development and the expansion of people's capabilities. However, despite Sen's influence on development debate and policy, a question remains; are they being enacted in practice?

Uvin (2010, p. 168) contends that "this is where we encounter the limits of Amartya Sen's major contribution to development. There is no politically grounded analysis for what stands in the way of his approach". One area where we fail to see Sen's concepts applied in practice is in various NGO-led development projects. These initiatives are not only sites of socio-political contestation but in recent years we have seen the rise of NGOs and the decline of state institutions. The mainstreaming of a partnership-based approach in development practice between NGOs and states continues to be an elusive ideal. How a developmental state can partner with NGOs to foster lasting structural transformation is a key issue that this dissertation grapples with.

Partnership entails: “a working relationship that is characterized by a shared sense of purpose, mutual respect and the willingness to negotiate” (Buchanan, 1994, p. 9). Such an approach emphasizes a process of reciprocal accountability, joint decision-making and two-way exchange of information (Postma, 1994). Although these ideologies are often touted by development agencies, these same organizations are often unwilling to pursue genuine partnership with their local counterparts. NGOs often remain shrouded in secrecy and are generally unwilling to openly share information, as they exercise little accountability and transparency with their local partners (Schemeil, 2013). It is also here that one can see power and self-preservation at work. Consequently, development agencies themselves fail to respect and fulfil the very means by which development aims are pursued, refusing or perhaps unable to question their own motive and behaviour. Currently, commonly exercised forms of development partnership can be likened to politician Godfrey Huggins’ colonial vision of partnership characterized as “the partnership of rider and horse”. In light of these concerns, the “how” of development practice continues to elude us. It is with this overarching motivation that I pursue this research of an IT-based development project in the Ethiopian.

1.2. Challenges of digitalization in the development context

This study engages with understanding the process of digitalization in the developing country health sector and its implication on the governance of IT-based development projects among collaborating agencies. Digitalization initiatives and in particular health information systems (HIS) implementation, has become an important management and policy instruments in the drive towards achieving the Sustainable Development Goals (SDGs). These digitalization efforts aim to address the various challenges that local governments face in managing their health systems. These initiatives are expected to reduce cumbersome documentation and paperwork and increase the efficiency and quality of data collation and analysis routines to support timely decision-making in the push towards key development outcomes.

The term ‘digitalization’ is used throughout this thesis to refer to the development and implementation of ICT systems and concomitant organizational change (Tilson, Lyytinen, & Sørensen, 2010; Yoo, Lyytinen, Boland, & Berente, 2010). Digitalization extends beyond the mere conversion of manual data into digital format (i.e. digitization) (Tilson, et al., 2010). Rather it involves the transformation of socio-technical structures formerly mediated by non-digital artifacts into ones mediated by digitized artifacts (Yoo, et al., 2010). As a result, the process of digitalization is a socio-technical process the outcome of which can lead to the digitization of content and ensuing reconfiguration of roles, practices and organizational structures (Tilson, et al., 2010). Yoo, et al. (2010, p. 7) reiterate that this “process of digitalization is dynamic, chaotic, multipath and expansive”.

In the endeavour towards digitalization in the developing country health sector, development projects have become key modalities by which development initiatives are being carried out (Heeks & Stanforth, 2014). Generally, the development context has had a long standing reliance on project-based approaches to development. Edwards (1989, p. 119) iterates that there is a “dangerous obsession with ‘projects’ that characterizes the work of most development agencies”. However, from a sustainability and effectiveness point of view, development projects have been problematic often due to the ways in

which NGOs and states collaborate in project activities and the general lack of accountability and regulatory oversight around these initiatives (Gugerty, 2008; Lewis, 1998; Lewis, et al., 2003).

With the ascendancy of development projects has also come the dominance of NGOs and the decline of the state under neoliberal ideologies (Nega & Schneider, 2014). NGO-led projects have become generally accepted arrangements for bringing about development impact, especially in the ICT domain. However, such arrangements have raised concern that NGO are replacing the predominant role that the state should play (Mosse, 2005; Nega & Schneider, 2014). Although state ownership and state-led development are deemed necessary for structural transformation and sustainable development, they have largely been neglected in development projects (Nega & Schneider, 2014). These concerns around development practice and partnership raise a fundamental issue about the governance of development projects.

Various governance interventions have recently been pursued by the international community to address this challenge. The Sector-wide Approach (SWAps) and the Rome and Paris Declaration on Aid Effectiveness are both examples of efforts to foster better partnership through coordination and alignment among state and NGO constituents (OECD-Paris, 2005; OECD-Rome, 2003; Walford, 2007). However, despite the appeal of such interventions, they have been difficult to operationalize (Fidler, 2007; Walford, 2007).

The partial success of such interventions highlights the difficulties of contending with the multi-level context of development. Development projects are influenced by both their local context and the broader socio-political and economic milieu in which they operate (Lewis, 1998; Lewis, et al., 2003; Lister, 2000). Locally, the realities of development project practice is one that is political and contested (Lewis, 1998; Lewis, et al., 2003). Studies have found that improvisation, negotiation, politicking and individual relations are all facets of digitalization projects in this context (Sahay, Monteiro, & Aanestad, 2009a, 2009b). At the global level, projects such as those in the health sectors are embedded in the broader context of global health and its governance and financial instruments. Walsham, et al. (2007, p. 324) reiterate that research topics in this field are typically “deeply intertwined with issues of power, politics, donor dependencies, institutional arrangements, and inequities of all sorts... critical work can ‘open up the black box’ of accepted ways of doing things as an aid to deeper understanding”. How these dynamics influence the governance and trajectory of digitalization project requires a renewed sensitivity to a multi-level perspective that adequately accounts for local practice and contextual conditioning.

Overall, the aforementioned issues can be summarized into two core challenges. First, a deeper understanding is needed around what transpires during the implementation of a digitalization project, particularly as it pertains to state and NGO partnerships and how this influences project performance. In other words, what is it about a digitalization project’s inner workings and dynamics that affect its developmental potential? Secondly, and in relation to the above point, there is a knowledge gap in our understanding of how politics is enacted in digitalization projects and its implication for governance interventions (Heeks & Stanforth, 2014).

Analytically, this line of inquiry calls for investigation of the interrelationship between context, action and outcome that constitute digitalization projects in developing countries and which traverse the

macro-micro analytical domains. ICT4D researchers have called for research that attempts to navigate these multi-level dimensions (Avgerou, 2010). Walsham, Robey, and Sahay (2007) and Avgerou (2008) especially criticize ICT4D studies for neglecting to account for the multi-level social and political contexts in which projects are implemented often producing a depoliticized knowledge of development.

In answer to this call, the dissertation develops a causal explanation of the complex process of a digitalization projects in Ethiopia by identifying generative or causal mechanisms that influenced its trajectory and outcomes. By explicating generative mechanisms and their relational entities an analytical narrative is developed that explains the dynamic link between context, action and outcome in order to produce practical insights into development project practice and governance interventions (Avgerou, 2013; Heeks & Stanforth, 2014).

1.3. Research questions

The research questions guiding the research are:

- I. What are the causal mechanisms that concomitantly drive digitalization trajectories in the developing country health context?
- II. What implications do the causal mechanisms have for IT-based development project practice and governance?

1.4. Empirical setting

The study took place in Ethiopia; the second-most populous country in Africa which is experiencing one of the fastest growing economies in the world (World-Bank, 2016). In recent years, the implementation of the government's Growth and Transformation Plan has seen extensive investments in physical infrastructure and e-government initiatives. These ICT-based transformation efforts have also been taken up by Ethiopia's Federal Ministry of Health (FMOH) in the efforts to modernize its HIS.

The case examined in this dissertation is of a digitalization initiative called the eHMIS/PHEM (Electronic Health Management Information Systems/Public Health Emergency Management). The eHMIS/PHEM is the first national ICT implementation of its scale in the Ethiopian health sector. It is a strategic system in the Ministry's effort to digitalize the recording and reporting of public health information. These efforts are part of a comprehensive 20-year program; the Health Sector Development Program, which aims to improve health service coverage and service utilization (FMOH, 2010).

1.5. Summary of selected papers

Four papers have been included as part of this thesis. The papers cover different aspects of the phenomenon and contribute to the overall theoretical and practical aims of the study. They include:

Paper 1: Gebre-Mariam, M. & Bygstad, B. (). Digitalization mechanisms of health management information systems in developing countries. (*Revised and resubmitted to Information and Organization*).

Summary: The developmental potential of IT in developing countries continues to be confronted by enduring problems that hamper both the sustainability of digitalization initiatives and the realization of their expected benefits. Using a critical realist perspective, this paper examines the underlying causal chain of health management information system (HMIS) digitalization in a developing country. The study develops a mechanism-based explanation of the digitalization process drawing on Archer's morphogenetic approach (1995). Four generative mechanisms of HMIS digitalization were identified: projectification, informatization, embedded inscription and scaling. Theoretically, the paper demonstrates the joint value of Archer's structurational theory and the dynamics of interrelated causal mechanisms of digitalization. We offer three insights for ICT4D practice: First, projects as primary modalities for digitalization have created partnership asymmetries between NGO and local institutions hindering sustainable development. Second, lack of formalized arrangements around multi-stakeholder collaboration has led to poor accountability and regulatory environments. Finally, total dependency on external partners as NGO assumes a gap-filling role thereby replacing rather than building local institutional capacity.

Paper 2: Gebre-Mariam, M. (). Navigating socio-politics and governance in ICT4D projects: A social interface analysis. (*Revised and resubmitted to Information Technology for Development*).

Summary: ICT4D projects are key modalities by which current development initiatives are being carried out. However, the inherent socio-political dynamics that constitute ICT4D projects and how this is implicated in the governance of development project practice is under-researched. This paper investigates these knowledge gaps through analysis of an ICT4D project in the Ethiopian health sector. To do this, the study adopts a theoretical perspective from development sociology field called 'social interfaces'.

Drawing on the analysis, the enactment and confluence of four key interfaces are discussed. These interfaces are identified as critical junctions where formal and informal networks of decision-making and brokerage intersect to produce conflict, negotiation and structural enactment influencing the trajectory of the project. The paper concludes by discussing the implications of this analysis to the governance of ICT4D projects and proposes the interface approach as a useful analytical device that can provide insights for development project practice.

Paper 3: Gebre-Mariam, M. and Fruijtier, E. (2017). Countering the 'dam effect': the case for architecture and governance in developing country health information systems. *Information Technology for Development*.

Summary: This paper presents a case for enterprise architecture (EA) and IT governance for driving techno-organizational change and coordination of health information systems (HISs) in developing countries. We support our claim with analyses of a large-scale electronic HIS in Ethiopia by tracing the logic of actors' decisions and conduct within and beyond the organizational boundaries of the Ethiopian Federal Ministry of Health to understand how the

information system innovation process is designed, legitimized and imposed by internal and external organizational forces. In the absence of formalized institutional arrangements throughout the HIS development and implementation, an international development agency fills a key gap forming an obligatory passage point which is conceptualized as the “dam effect.” Drawing on actor-network theory, we identify three important implications of EA and IT governance: (1) to help achieve an alignment of interests within the enterprise; (2) to serve as a tool for protecting the interests of the enterprise in external negotiations; and (3) to serve as a pragmatic approach to carrying out techno-organizational change.

Paper 4: Gebre-Mariam, M. (2018). Governance lessons from an interorganizational health information system implementation in Ethiopia. *Electronic Journal of Information Systems in Developing Countries*

Summary: The paper focuses on the broader socio-political context of global health governance and its influence on the adoption of interorganizational systems (IOS) in developing countries. It argues that a comprehensive understanding of the IOS adoption process should include the study of the interorganizational context and its stakeholders who exhibit complex social and political attributes that influences the process and trajectory of IOS. This paper charts this course by examining the key governance dimensions of coordination and alignment. It also challenges the viability of the unstructured development modalities in health information system (HIS) strengthening in developing countries, largely facilitated by international NGOs and leveraged on ICT, as the dominant approach for fostering development in the HIS domain. The paper concludes by discussing the implications of the study. These include: (1) the influence of unstructured interorganizational relations, at both the organizational and sector levels, on IOS adoption; (2) how the social and political behaviour of opportunistic interorganizational participants are implicated in the IOS adoption process; and (3) the role of strategic alignment, largely driven by the informal interorganizational relationship and social dimensions, on the prioritization and fit between IOS technological and organizational components.

An overview of the key components of the dissertation is outlined in Table 1.

Table 1. Overview of Research Design

Component	Description	Paper
Problem situation (P)	The dissertation grapples with the decline of state institutions and the rise of NGOs as a force in IT-based development projects.	Paper 1, 2, 3, 4
Area of literature (A)	HIS digitalization and governance of ICT4D projects (Literature: ICT4D, HIS, development management)	Paper 1, 2, 3, 4

Conceptual Framework (F)	<ul style="list-style-type: none"> • Morphogenetic approach (Archer, 1995) • Social interface approach (Long, 1989) 	Paper 1, 2
Method (M)	Autoethnographic case study of how an NGO in partnership with a developing country ministry of health carried out a national digitalization project.	
Research question	<p>I. What are the causal mechanisms that concomitantly drive digitalization trajectories in the developing country health context?</p> <p>II. What implications do the causal mechanisms have for IT-based development project practice and governance?</p>	
Contribution to P	<ul style="list-style-type: none"> • Insights into the developmental limitations of the informal collaboration and technocratic orientation of current ICT4D initiatives • Strategies and practice guidelines on how local ministries of health and development practitioners can cultivate governance norms and processes to foster development partnerships in IT projects 	Paper 1, 2, 3
Contribution to A	<ul style="list-style-type: none"> • A detailed empirical account of development practice with analysis of how digitalization trajectories are shaped by their macro and micro dynamics • Governance lessons informed by the conceptualization and synthesis of socio-politics in ICT4D initiatives • A way of tracing contextual contingency by uncovering mechanisms at the level of social structures and cultural systems • An approach to navigate the macro-micro analytical domains drawing on the morphogenetic approach and by conjecturing generative mechanisms 	Paper 1, 2, 3, 4

1.6. Outline of Thesis

The outline of the chapters of the dissertation is as follows:

Chapter 2: a review of related research is presented regarding the perspectives of digitalization in developing countries. Key research streams that engage with digitalization in this context are discussed.

Chapter 3: Outlines the realist theoretical underpinning of the research. Archer's (1995) Morphogenetic Approach is introduced as theoretical basis for the conceptual framework of the research.

Chapter 4: The research design is presented including the data collection and data analysis techniques employed and the researcher's reflections on the ethical consideration of the research.

Chapter 5: The case study overview is described providing a basis for the subsequent chapter on the findings. The case narrative provides an insider's perspective of the digitalization process highlighting the role and collaboration of key stakeholders, decision-making practices, and the technical and political challenges that emerged during digitalization.

Chapter 6: Summary of findings is outlined drawing on summary and synthesis of the results from the published papers and drawing back to the conceptual framework to piece together the process of HIS digitalization.

Chapter 7: Discussion of the case study findings and practical and theoretical contributions are outlined.

Chapter 8: Overview and conclusion of the thesis are presented.

Chapter 2

Related Research

This chapter provides a review of ICT4D research on IS implementation and management. This is also the area of discourse this dissertation aims to contribute to. Particular focus is given to the key areas that relate to the key issues highlighted in the previous chapter, including: the role of context in digitalization (Avgerou, 2010; Walsham, et al., 2007), the socio-political digitalization process in development practice (Heeks & Stanforth, 2014) and the governance perspectives of digitalization in this context. To inform these areas, perspectives from development management and global health governance are also adopted.

2.1. Context and digitalization in development

Unique and theoretically relevant insights for understanding the process of digitalization have been garnered from ICT4D studies. Digitalization in developing countries has been studied as a transformative process that is linked to its broader social context, namely, the global political and economic conditions that impinge on developing countries (Avgerou, 2010; Ciborra, 2005). Studies of large-scale digitalization initiatives in the developing country health sector have found that they are influenced by electoral processes, governance structures, telecom policies, funding arrangements, donor policies and other macro level conditions (Sahay & Walsham, 2006; Silva & Hirschheim, 2007).

Walsham, et al. (2007) and Avgerou (2008) stress the influence of broader country-specific social and political dimensions affecting ICT projects in developing countries. They highlight that ICT deployment initiatives can be influenced by political events taking place in regional and national contexts. For example, the study by Silva and Figueroa (2002) describes how post-war crisis in a Latin American country influenced the outsourcing of an administrative information system. Similarly, Silva and Hirschheim (2007) in their case study of a digitalization initiative in two of the largest hospitals in Guatemalan discuss how change of key personnel resulted in the termination of implementation efforts because of the poor relational ties between the implementers and the newly designated personnel.

Narrowly situated accounts which do not explore socio-structural, cultural and historical aspects of a case fail to provide a complete picture of the digitalization process. Studies that undertake the analysis of context propose various approaches including: developing a multilevel perspective (Alvarez, 2003; Avgerou, 2001; Pettigrew, 1985); engaging with the dimension of time (Njihia & Merali, 2013); and developing a critical account of contextual factors in IS implementation (Walsham, et al., 2007).

First, researchers carrying out contextual analysis have called for a multi-level perspective (Alvarez, 2003; Avgerou, 2001; Pettigrew, 1985). Previous studies engaging with the broader context in the IS literature have emphasized consideration of different levels of context, such as organizational, national and international levels in order to assess political, economic and social factors that impinge on ICT projects (Alvarez, 2003; Avgerou, 2001; Ciborra, 2005; Kimaro & Sahay, 2007). These approaches draw on

Pettigrew (1985) who suggests identifying levels of analysis based on their empirical and theoretical association. Such an approach requires carrying out a processual analysis which involves the description of the sequential unfolding of historical events and a vertical analysis which traces the interconnections of key constructs between higher and lower contextual levels, namely the level of the organizational or sub-national, national and international organizational contexts within which the IS innovation unfolded (Avgerou, 2001).

Drawing on these perspectives, researchers in ICT4D have given particular attention to the layered context in which digitalization is embedded (Alvarez, 2004; Braa, Hanseth, Heywood, Mohammed, & Shaw, 2007; Sahay, Sæbø, Mekonnen, & Gizaw, 2010). For instance, Braa, Hanseth, et al. (2007) discuss how the political context of post-apartheid South Africa influenced the initial standardization of health management information systems and the eventual acceptance and scale-up of the DHIS. The broad contextual influence of macro-level actors and politics on digitalization is also relayed in two studies that examined digitalization initiatives in the health sectors of India (Sahay, et al., 2010) and Guatemala (Silva & Hirschheim, 2007). In both studies, change in political parties and ensuing change in personnel resulted in the termination of project implementation because of the poor relational ties between the newly elected officials and the implementing organization/individuals.

Secondly, in dealing with the broader context, studies in the ICT4D literature also identify the significance of the time dimension (Njihia & Merali, 2013). Here, the analysis of not only historicity but timing has the potential to provide a useful lens for zooming our focus on key sets of variables and contextual conditions (Ancona, Goodman, Lawrence, & Tushman, 2001). Drawing on such an approach, Njihia and Merali (2013) present a longitudinal account of ICT4D initiatives in Kenya in which the interplay between agency, structure and culture are examined over a 43 year period. They identify time and temporality as key elements that underpin the evolutionary process of digitalization. They identify the role of timing in relation to cultural and structural systems which open up opportunities for agential action shaping the trajectory of systemic change in ICT deployment efforts in Kenya. They also identify global normative pressure, polity, national socio-economic conditions, and the multi-stakeholder participation as key forces that influenced the trajectory of public sector ICT4D project initiatives in Kenya.

Lastly, in the ICT4D literature, a critical analysis of contextual factors has been sparse. A prominent critique of this gap in the ICT4D literature has come from Walsham, et al. (2007) who call for ICT4D studies to be “explicitly critical... and to draw on appropriate critical theories” (p. 324). They argue that “critical work can ‘open up the black box’ of accepted ways of doing things as an aid to deeper understanding” (p. 324). An example of such a critical perspective is the study by Ciborra (2005) on an e-government initiative in Jordan. Despite the alleged benefit of e-government projects, namely in providing efficiency and accountability, his study critically reveals the motivation for these initiatives emerging from the interests of world powers as opposed to the aims for development. In the same vein of critical and deconstructive approaches such as Escobar (1995), Ciborra’s study uncovers underlying global politico-strategic forces that drive such e-government initiatives. He concludes that these e-government initiatives are driven by the purpose of ‘governance at a distance’ by western countries.

However, despite the increased awareness of context, the field faces theoretical challenges with regards to contextual analysis. In particular, systematically theorizing how the broader context enables or constrains digitalization actions and ideologies remains unclear to ICT4D researchers (Avgerou, 2010). Avgerou (2010) argues that broad categorizations of context (i.e. nations, sectors, formal organizations) are not adequate, in and of themselves, to generate insights on how they constitute values and actions in ICT projects. Therefore, there is a need for theorizing in order “to identify what is relevant context for each case of ICT innovation, and how it matters” (Avgerou, 2010, p. 11). This line of analysis demands the conceptualization of context as a relational process where the macro and micro-level components are mutually engaged in and become outcomes of each other (Njihia & Merali, 2013). Furthermore, how a particular contextual condition matters demands an investigation of the processes of development (Hayes & Westrup, 2012).

2.2. The process of digitalization in development

2.2.1. Transfer and diffusion oriented views of digitalization

ICT4D research has generated broad empirical insights into the digitalization process in the development context. One stream of ICT4D research that provides insights into digitalization draws on a process-based explanation of technology and knowledge transfer (Avgerou, 2010). These studies often adopt system development approaches and best practices, although adapted to the context-specific demands of the developing countries. Many of these studies drawn on theories of technology innovation and diffusion/adoption such as Roger’s Diffusion of Innovation Model (DOI) and Technology Acceptance Model (TAM), which have been dominant in the ICT4D literature (Zheng, 2015).

Within the health sector, various studies have made the case for the adoption of management theories such as strategic alignment (Odit, Rwashana, & Kituyi, 2014) and strategies for standardizing and integrating HIS (Braa & Sahay, 2012; Sæbø, Kossi, Titlestad, Tohouri, & Braa, 2011). Other studies emphasize the transfer of technologies such as data warehouses (Braa & Sahay, 2012), health information exchange (Crichton, Moodley, A. Pillay, Seebregts, & Gakuba, 2013) and the emulation of the organizations and eHealth strategies of developed countries (Mudaly, Moodley, Pillay, & Seebregts, 2013).

Studies in this strand present a number of advantages. Since the findings are practice oriented, they enrich our knowledge of technology implementation and management practice by proposing adapted and context-specific methods. These studies also challenge the decontextualized application of generic methods and practices that may not fit the context of developing countries while maintaining the underlying aims and rationality of the models (Avgerou, 2008).

However, these transfer and diffusion oriented studies often fail to adequately highlight the underlying forces at play in such digitalization initiatives. They tend to neglect such issues as power and politics that impinge on the adoption and use of ICTs (Zheng, 2015). They also assume the voluntary capacity of actors and fail to account for the influence of social structures that impose on the autonomy actors.

These are key areas that need consideration in digitalization as it grapples with the intricacies and fundamental challenges of the developmental process.

2.2.2. Social and political perspectives of digitalization

In another regard, the digitalization process is viewed as occurring through socially embedded action, primarily studied from the perspectives of social construction and situated action (Bijker & Law, 1992; Ciborra & Associates, 2000). Among ICT4D research that fits within this perspective, studies in the health sector have examined how social interests, interpretations, conflicts and the process of negotiation aimed at attaining legitimacy and consensus influence digitalization (Sahay, et al., 2009a; Silva & Hirschheim, 2007). Extensive research in this area has also come out of the Health Information System Program (HISP) which has been involved in implementation of the District Health Information System (DHIS) in various developing countries (Braa, Monteiro, & Sahay, 2004; Braa, Monteiro, Sahay, Staring, & Titlestad, 2007; Sahay & Walsham, 2006). These studies carry out context-specific analysis dealing with a broad set of areas in the digitalization process including institutional, sociological and technical issues drawing on socio-theoretical approaches. Accordingly the process of socio-technical change is understood as being driven by its social and political construction (Avgerou, 2008; Sahay, et al., 2009b).

A number of studies have examined the social and political construction and use of IS (Sillince & Mouakket, 1997; Silva & Hirschheim, 2007). A political perspective on digitalization emphasizes the importance of attaining, maintaining and increasing the political and institutional legitimacy and support for particular change agents and their systems (Sahay, et al., 2009a). Within the health sector, various studies have also provided a political perspective of the digitalization process (Alvarez, 2004; Chilundo & Aanestad, 2005; Sahay, et al., 2009a; Sahay, et al., 2010; Sahay & Walsham, 2006).

Chilundo and Aanestad (2005) found the heterogeneous interests of multi-level actors as a key challenge in the development of integrated HIS in Mozambique. The political tensions due to varying rationalities between peripheral health facilities and higher level government health institutions and donors was identified as key factor that superseded technical aspects of integration.

The capacity for change agents to gain legitimacy with local stakeholders is also a key facet of the socio-political process in IS innovation (Sahay et al., 2009; Sahay et al., 2010). A digitalization case from Tajikistan (Sahay, et al., 2010) demonstrates that the mere technical superiority of a solution is not necessarily sufficient to enforce change but requires the nurturing of strong ties with powerful entities. Sahay and Walsham (2006) also discuss a case in the health sector of India where digitalization efforts initially gained momentum leveraging on buy-in and rapport with key government officials. However, the initiative was halted, despite early success, due to elections which resulted in the change of key personnel who had previously championed the initiative. Without strong ties with officials of the new administration the project was not able to make headways.

A common characteristic that runs across the aforementioned studies is the central role of interorganizational relations and brokerage in digitalization. The relations between multiple agencies (ministries of health, local health institutions, donors and NGOs) have important inferences for the

analysis and governance of digitalization projects in this context. Alvarez (2004) in his study of a national HIS project in Ecuador addresses this challenge, he states that: "conceptualisation of IS implementation as the inter-play of diverse professional and technical groups, which may hold conflicting or competing agendas and ideologies, has important implications for the management of IS projects" (p.13). What is also commonly recognized by development practitioners is that the relationship between organizations is not structured but rather dependent on the relationships of organizational leaders (Lister, 2000).

Overall, this stream of research presents a number of advantages for our understanding of the digitalization process as a "locally socially constructed course of action" (Avgerou, 2008, p. 3). These studies highlight the nitty gritty of the complex challenges involved in instituting techno-organizational change in this context, which can otherwise be oversimplified. Their rich descriptions in these studies also provide a lucid picture of local meaning and the dynamics of various moving parts in the digitalization process.

2.3. Governance in the development context

Although governance has been widely explored in the IS literature, its role in development practice has received limited analytical and theoretical attention in the ICT4D literature. Governance generally refers to "all mechanism within an organization that broadly determine how organizational resources are used to move the organization forward and resolve conflicts between its various stakeholders" (Mair, Mayer, & Lutz, 2015, p. 716). More specific to IT, Weill and Ross (2004, p. 2) define IT governance as: "the decision rights and accountability framework to encourage desirable behavior in the use of IT". They highlight three key questions that IT governance should systematically addresses, namely, who makes each type of decision (a decision right) and who has input to a decision (an input right), what decisions are being made, and how decisions are being made.

However, as discussed in the previous section, the development context presents a unique set of conditions that have governance implication. For this reason, governance has become a topic of keen interest in international development (Buse, Hein, & Drager, 2009; McCourt & Gulrajani, 2010). Insights from these research domains, in particular the global health governance and development management research have potential relevance for our understanding of ICT4D project governance. Perspectives from these domains are briefly discussed below.

2.3.1. Governance in ICT4D

Despite the emphasis and engagement with socio-politics in ICT4D, studies that explicitly consider its governance implications have been limited. The multi-level socio-political context of development projects has implications to three broad dimensions of governance in ICT4D: structural, relational, and processual (Peterson, 2004).

- *Structural governance* relate to formal devices which include institutional arrangements comprising formal positions, groups, management teams and macro inter-organizational structures that oversee the activities of project stakeholders.

- *Relational governance* refers to the participation and cooperation of stakeholders or organizations. This aspect is the least formalized and is based on the voluntary and collaborative behaviour of actors.
- *Process governance* refer to formal and informal governance processes that ensure IT decision-making and monitoring practices follow specified rules and standard procedures.

Structural aspect of governance

The institutional context of developing countries is influenced by its formal arrangements. These include structural organizational arrangements which ICT4D projects traverse and include formal positions, work teams and management arrangements (Peterson, 2004). The structural arrangements, in the health sector, also constitute the ICT4D project environment of global health.

Governance has featured as an overarching focus in the National eHealth Strategy Toolkit developed by the World Health Organization (WHO) and the International Telecommunication Union (ITU) (WHO-ITU, 2012). The Toolkit is intended to provide practical guidance to government ministries on how to advance their eHealth efforts. The report identifies governance as part of an enabling environment for eHealth and makes up one of seven eHealth components. The study emphasizes the need for appropriate governance structures and procedures which includes: “a core team with technical knowledge, analytical ability and excellent communication skills” (WHO-ITU, 2012, p. 12). The suggested governance arrangement proposes a reporting and accountability structure made up of a committee, a council, and a task force responsible for oversight and steering, project management, subject-matter expertise input, stakeholder engagement and communications management. The report also outlines the particular governance functions, responsibilities and composition of the various groups. Although the reports puts forth a general guideline, how the suggested interventions should be carried out remains to be discussed in much depth. Additionally, the report adopts a relatively instrumental and rationalist perspective.

Relational aspect of governance

Relational aspects of governance rely on actors’ voluntary collaboration. Therefore, they are often intangible and tacit and cannot be entirely programmed (Peterson, 2004). This is perhaps where socio-politics in development projects is most prevalent in shaping project trajectories (Braa, et al., 2004; Sahay, et al., 2009a; Sahay, et al., 2010). From a micro-politics perspective, studies address the relational aspect of governance that involves active participation and collaborative relationships among project stakeholders (Sahay, et al., 2009b). These relational capabilities have been found to be necessary for manoeuvring the informal aspects of developing country institutions (Sahay, et al., 2009a, 2009b).

A study by Madon (2005), who investigates telecentre in Kerala, India uses the sociology of governance approach as a theoretical lens to examine the sustainability of telecentre projects. She identifies key issues underpinning the project’s sustainability that deal with how interactions and exchanges among various groups of stakeholders have been managed. We revisit this perspective in a later section.

In line with the relational perspective of governance, studies have discovered that relational ties can also be a key determinant of projects success (Braa & Hedberg, 2002; Braa, et al., 2004; Sahay, et al., 2009a).

Relational ties depend on the voluntary and collaborative behaviour of various actors to clarify differences and solve problems in order to carry out collaborative efforts. Relational ties are fostered through informal contacts, lobbying, negotiation, and through incentives and rewards (Peterson, 2004). The study by Sahay, et al. (2009a) demonstrates how changes in asymmetric power relations, which ensued after change of key personnel among implementers and local administrators, shifted the trajectory of the project. The project was ultimately halted despite offering a free and configurable technology that had achieved successful initial implementation.

The macro-level socio-political context can also impinge on the relational dimension. A classic case from the HISP is the DHIS project in South Africa (Braa, Hanseth, et al., 2007; Braa & Hedberg, 2002; Braa, et al., 2004). In the case, the project's development and implementation leveraged strongly on the post-apartheid political climate of South Africa that was pushing for health sector restructuring (Braa, et al., 2004). The alignment of local DHIS implementers with the anti-apartheid struggle was also found to be instrumental in their ability to gain legitimacy with local stakeholders.

Implications of country-level political change on the relational ties of project stakeholders was also evident in the DHIS project in India (Sahay, et al., 2009a). In this case, state elections which led to administrative change at the state level resulted in resistance and the eventual termination of the DHIS project which had been initiated under the support of the previous state Minister. These studies highlight the need for ICT4D project governance that is sensitized to not only the broader context in which these projects are embedded, but also the ensuing relational dynamics which can affect project trajectories.

Processual aspect of governance

The processual aspect of governance deals with the formal and informal governance processes by which people or organizations are held accountable. Poorly defined or ad hoc coordination and decision-making process in inter-agency partnership can open up projects to struggles for control and overall ineffectiveness. The report by WHO-ITU (2012, p. 5) describes this aspect of governance as “establishing governance mechanisms to provide improved visibility, coordination and control of eHealth activities that are occurring across the country's health sector”.

A reoccurring challenge of ICT4D project governance in health is the coordination and integration of formal and informal decision-making processes across different project stakeholders. Kimaro and Sahay (2007), in their study of the process of HIS decentralization in Tanzania, found that reforms were difficult to achieve due to the complexities of the institutional context. They identify the disparity between the formal rules and informal practices that governed the reform process as a chief cause for unsuccessful outcomes.

Similar findings are presented by Chilundo and Aanestad (2005) who highlight the tensions in rationalities between facility-level staff and higher level actors such as policy makers, administrators, donors and NGOs as a key challenge in the governance process. Related issues have also been identified by studies that explore how data standard development and system design processes should be governed to accommodate the competing needs of not only local-global actors but also vertical-

horizontal programs (Braa, Hanseth, et al., 2007). The difficulties of negotiating these tensions highlight a key challenge in governance processes in this context. Overall, the structural, relational and processual aspect of governance pose a number of governance issues that require rich empirics and a relevant theoretical framing to help us untangle them.

2.3.2. Governance perspectives from global health

Governance has been a longstanding focus of global health researchers. It has experienced renewed interest given the emerging trends in the global health landscape over the past two decades (Buse, et al., 2009). A key focus of governance in global health is the increasing state of institutional plurality which has resulted in the development of complex hybrid organizations that have come to represent contradictory strategies and tactics (Fidler, 2007; Schemeil, 2013). Hybrid organizations are characterized by organizations that: include a range of stakeholders; pursue numerous and at times conflicting goals and can engage in inconsistent undertakings (Besharov & Smith, 2014). This state of global health has been referred to as “unstructured plurality” (Fidler, 2007). The desire to bringing order has led to the reform agendas which call for a governance intervention (Dodd & Hill, 2007).

Much of the global health governance research has previously focused on the desirable arrangements and processes of governance among diverse global health organizations. The debate is dominated by two predominant positions. On the one end, there is an argument for a state-centric approach where governance and accountability is located in a single institution (Dodgson, Lee, & Drager, 2002). The second perspective is one that embraces a less linear and a more networked form of governance. It asserts that both state and non-state actors should have access to the governance space, although in a more structured way (Dodd & Hill, 2007; Fidler, 2007). Finding the balance between a strong center and the anarchic reality of multiple actors, processes and structures is a paradox of global health governance that continues to generate wide debate.

Global health governance reform efforts have focused on two key dimensions of governance: coordination and alignment (Buse & Walt, 1996; Dodd & Hill, 2007; OECD-Paris, 2005). Consequently, various approaches for coordination and alignment have emerged, a predominant of which has been the sector-wide approach (SWAp) (Cassels, 1997; Walford, 2007). SWAp as a concept emerged in the 1990s with two main aims. First, to ensure alignment and harmonization among policies, budgets, and institutional arrangements. Second, to foster better coordinated interaction and information sharing between government and donors (Cassels, 1997). These overarching objectives were bolstered by the Rome and Paris Declaration on Aid Effectiveness (2003, 2005). These declarations reaffirm commitments at the global and country levels to coordinate and align aid delivery and implementation (OECD-Paris, 2005; OECD-Rome, 2003). The fundamental governance principles of these agendas include:

1. *Alignment*: Donor countries should align behind developing country set strategies and objectives and use local systems
2. *Harmonization*: Donor countries should coordinate, simplify procedures and share information to avoid duplication

3. *Managing for results*: Developing countries and donors shift focus to development results and results get measured

Despite these efforts, coordinated management of aid and development activities of numerous donors and NGOs in the developing country health sector continues to be a challenge (Fidler, 2007; Szlezák, et al., 2010). Coordination involves tasks, protocols, and decision mechanisms designed to ensure aligned actions between interdependent actors. Coordination has become a key health policy agenda for a number of reasons (OECD-Paris, 2005). First, to manage the increase in the number and diversity of international development agencies whose initiatives and activities have been incoherent (Cohen, 2006). Secondly, to address the escalated complexity, confusion and the potential for conflict (Cohen, 2006). Thirdly, to mitigate the proliferation of projects that have become a burden on recipient ministries and local institutions by shifting from a project focus to sector assistance (Garrett, 2007)

However, successful adoption of these agendas has been limited to a few developing countries (Dodd & Hill, 2007; Walford, 2007). These initiatives have been common mantras in global health's push for development effectiveness that have not had tractions on the ground (Walford, 2007). The limited success of these efforts reflects underlying contradictory institutional forces among donors, within states and between donors and states (Dodd & Hill, 2007; Hill, 2002). Despite this, global health continues to retain a conceptual appeal to the aims of coordination and alignment.

Overall, there is a concern among global health researchers that governance research can be dominated by structural perspectives that exclusively focuses on broader institutional arrangements (Buse, et al., 2009). Hein, Burris, and Shearing (2009) argue that purely structural conceptualizations can limit our understanding of the nuances of development practice. Therefore, these global health scholars have also drawn on ideas from the sociology of governance and the perspectives of social interfaces (further discussed in Chapter 3).

2.3.3. Perspectives from development management

The challenges of development practice and development projects have been a primary focus for development management researchers. Development management (DM) is the faction of development studies that applies management concepts to development (Mowels, 2010). It promotes the use of management and analytical tools adapted from various fields in social science including; strategic management, organization development, and political science. Concepts from these fields have been used to address knowledge gaps in development project research that deal with issues such as project practice (Umas, 2012); project trajectories (Struyk, 2007) and project impact (Bebbington, Lewis, Batterbury, Olson, & Siddiqi, 2007).

Different perspectives of development management have also emerged classified under critical development management (Gulrajani, 2010). Critical development management fundamentally criticizes development management practices for being 'managerialist' and normative (McCourt & Gulrajani, 2010). In this regard, researchers have argued for an orientation of DM that focuses on 'management *for* development', which emphasizes the key task of DM as being the promotion development values and the interest of the poor (McCourt & Gulrajani, 2010). On the contrary, 'management *of* development'

supports the efficient management of resources in line with organizational aims. Lastly, 'management *in development*' promotes the adaptation of management models and good practices to local contexts.

The DM literature provide insights on a number of key issues which emerge in this thesis: namely, politics and power in the practice of development agencies (Lewis, 1998; Lewis, et al., 2003; Lister, 2000; Mosse & Lewis, 2006; Mowles, 2010), management of development projects and their performance (Lewis, et al., 2003; Mosse & Lewis, 2006), and the governance challenges of development project implementation and management (McCourt & Gulrajani, 2010).

Politics and power in inter-agency partnership

Development projects involve multiple organizations working together toward a common objective. Understanding how they work and the process of multi-agency partnership between NGOs and government agencies can help explain project performance and trajectories (Heeks & Stanforth, 2007; Lewis, 1998). However, the analysis of multi-agency partnership in development practice have been criticized for being instrumental and for failing to consider the role of power and politics (Lister, 2000; Mowles, 2010).

An emphasis on partnership between NGOs and government agencies emerged in the late 1980s in Africa (Postma, 1994). The key motivation of partnership was to facilitate institutional development fostered through the transfer of needed skills to government agencies. In the early 1990s these agendas of partnership and institutional development were strongly promoted and eventually popularized. This concept of partnership is founded on the ideologies of a shared sense of purpose among development agencies and government institutions. Successful partnership is thus understood as cultivating mutual trust, complementary strengthens, reciprocal accountability, joint decision-making and the sharing of information (Postma, 1994). Other aspects of partnership include: clearly articulated goal, performance indicators and procedures to measure and monitor performance, and clear division of responsibility (Lister, 2000).

On the one hand, the partnership mandate was born out of a disappointing decade of development in the continent. There was a growing frustration with government agencies whose poor management of resources, corruption and overall ineffectiveness saw little impact of foreign aid (Mosse, 2005). On the other hand, concerns of dependency, mistrust and paternalism in development efforts that were dominated by NGOs was challenged for the mismatches of power that existed in the partnerships (Postma, 1994).

Researchers argue that power imbalances in development projects has hindered such partnership from cultivating effective development (Lewis, 1998; Mosse, 2005). For one, active partnership in inter-agency projects were found to be difficult to create and maintain in a context where there was resource dependency (Lewis, 1998). Studies have highlighted that power and agency are implicated in partnership cultures (Lewis, et al., 2003). The particular values that prevail in a development project are byproducts of the balances of power among the stakeholders involved in the project. Such power asymmetries produce fragmentation of cultural norms among diverse project organizations influencing its

performance. In light of these asymmetries, well-intentioned dialogue or transparency may not necessarily facilitate authentic organizational partnership (Lister, 2000).

Part of the disproportional partnership between NGOs and government agencies was also attributed to the arrangement of project-based approaches to development. Mosse (2005) shares a case from UK's Department of International Development (DFID) in India. In the early 1990s, DFID primarily relied on an approach that funded projects that operated outside of state institutions. However, the proliferation of projects was found to have very little impact on national plans and government reforms to improve their effectiveness. This triggered a move away from isolated and small-scale projects towards supporting government agencies and sector-wide programs.

Another problem noted by Mosse (2005) was that projects were often not scalable. He notes that only governments possess the capacity to deal with the scale and continuity needed to generate meaningful impact. DFID's strategic focus was driven by what they called 'high impact aid'. This involved active engagement with government institutions and higher-level partnerships based on shared objectives and responsibilities (Mosse, 2005). Nevertheless, facilitating genuine partnership and building institutions in developing countries is inherently political and contentious, shaped by the competing interest and influence of individual actors. In light of this, development management has come to be viewed as an "embedded socio-political practice" (Gulrajani, 2010, p. 82).

In the partnership relationships between NGOs/donors and local government, power was exercised through three means: individual relationships, discourse and structure (Lister, 2000). Lister (2000) identifies that partnership relationships among agencies was based on personal friendships and not through institutionalized means and this was where power was exercised. The downside of partnerships being managed by organizational leaders is the possibility of changes in personnel which can compromise the project and the projects susceptibility to the particular attributes of individual leadership. However, power was not limited there; it was inherent in the structural frameworks of dominant development discourse on partnership. Lister (2000, p. 235) contends that: "the discourse on partnership... serves to hide the fundamental power asymmetries within development activities and essentially maintain the status quo".

Lister (2000) study provides a number of insights. Practically, she suggests moving away from purely considering structural relationships between agencies to consider the "processes of institutionalizing relationships" (Lister, 2000, p. 237). Secondly, much of the models being developed by NGOs with regards to institutional development, capacity building, and scaling need to consider a more actor-oriented approach.

Governance as interactions

Given the socio-political realities of development, governance has emerged as an importance focus of development management (McCourt & Gulrajani, 2010). These approaches draw on the actor-oriented approaches which attempts to develop "an ethnographic understanding of the 'social life' of development projects" (Long, 2003, p. 14). Based on an interactionalist perspectives, one perspective of governance that speaks to the typically informal associations that prevail in development projects comes

from the sociology of governance (Kjaer, 2004; Kooiman, 2003). This strand of literature views governance as interactions that transpire at macro and micro-levels. At the macro-level, the interactions between implementers and development projects are the primary focus of analysis (Evans & Rauche, 2000). At a micro-analytical level, governance is conceptualized as the complex set of relations between social and political actors and the sum of the permutations and combinations of all interactions between them (Kooiman, 2003).

Rhodes (2007) views governance as interdependencies between organizations involving continuous interactions who exchange resources and negotiate shared objectives. He describes governance as: “continuing interactions between network members, caused by the need to exchange resources and negotiate shared purposes” (Rhodes, 2007, p. 1246). He describes the type of interactions as a: “game-like interactions, rooted in trust and regulated by rules of the game negotiated and agreed upon by network participants”(Rhodes, 2007, p. 1246). Analysis of these interactions has implications for governance by generating insights into how the strategies, interests and power relations of inter-organizational actors play out during development projects.

Kooiman (2003)in particular attempts to conceptualize interactions in governance. He defines interactions as “mutually influencing relations between two or more actors or entities” (Kooiman, 2003, p. 13). He distinguishes between two levels of interaction: structural and intentional. The structural level refers to material, social and cultural context which can include institutions, social constructs, modes of communication, or power relations in which interactions occur. The intentional level focuses on actors and their interests and objectives (Kooiman, 2003). Additionally, he identifies three types of interactions: ‘interferences’ (fairly open, flexible and spontaneous interactions such as self-organization of private governance), ‘interplays’ (horizontal, semi-formalized interactions as in networked forms of co-governance) and ‘interventions’ (vertical, formalized interactions as in hierarchical governance). We consider the theoretical implications of these perspectives in Chapter 3.

Theoretical Framework

3.1. Theoretical challenges of digitalization in ICT4D

Building on the related research, this dissertation aims to make a contribution by bringing insight to key practical problems while offering unique theoretical insights. This dissertation engages with the following practical challenges which guide the theoretical approach adopted:

- The practice of informal politics in development projects
- Lack of regulatory and accountability environments in ICT4D projects and potential effects on:
 - issues of disproportionate institutional partnership and NGO dependency
 - project's performance and developmental potential

Theoretically, these issues broadly highlight a fundamental challenge dealing with the relationship between macro-level contextual conditions, micro-level action and the ensuing outcomes. Accordingly, analyzing these macro-micro dynamics has been a key theoretical focus raised by ICT4D researchers and is also an important theoretical challenge this thesis engages with (Avgerou, 2010; Hayes & Westrup, 2012). Avgerou (2010) draws on a review of ICT4D research to highlight the need for a theoretical grounding that allows researchers to navigate these macro-micro analytical dimensions. To do this, Avgerou (2010, p. 12) suggests breaking down the macro-micro analysis into two related theoretical areas: context-based theorizing of IS phenomena and theorizing on ICT-enabled development outcomes.

The first area deals with theorizing contextual contingency. Understanding the interrelationship between the broader context and digitalization has been a longstanding focus of the extant ICT4D research. However, exactly where one starts in their analysis of the broader context (e.g. social, political, cultural and economic) is often a matter of judgment in a particular context. Avgerou (2010, pp. 11,12) argues that: "theory is needed to identify what is relevant context for each case of ICT innovation, and how it matters... More systematic theorizing efforts are needed to understand how the socioeconomic context enables or constrains". The primary contextual conditions in ICTD studies can broadly be grouped under cultural and structural systems (Avgerou, 2001; Njihia & Merali, 2013). These may include socio-political, geo-political, technological, institutional, and usage contexts. In this regard, there is a challenge of explicating how the specific contextual conditions influence agency in ICT4D phenomenon.

The second theoretical challenge deals with developing theoretical foundations for linking ICT projects with ICT-based development outcomes (Avgerou, 2010; Heeks & Stanforth, 2014). The role of ICT4D projects on institutional effectiveness, improvement of public services and its overall implication on those that are marginalized is an important pragmatic and theoretical concern. In this regards, development researchers have emphasized the need for deeper understanding of development practice as it relates to its performance and outcomes (Heeks & Stanforth, 2014; Lewis, et al., 2003; Mosse &

Lewis, 2006). This line of analysis requires a theoretical approach that explicates development processes and the entanglement of not only actors and institutions but the material properties of technology.

3.2. The morphogenetic approach

Drawing on the aforementioned theoretical challenges, the dynamics between the broader context (i.e. structure & cultural systems), agency and its systemic outcomes are identified as a key theoretical focus. While there is an increasing awareness of the relationship between structure and agency in IS research, studies tend to emphasize one or the other (Horrocks, 2009). This leads to a propensity to conflate, treating either agents or structures as byproducts of the other (Archer, 1995). Therefore, it is worthwhile to consider a non-conflationary theoretical approach that gives equal prominence to structure and agency. For this, I draw on the morphogenetic approach of Archer (1995).

Archer's morphogenetic approach, which falls under the critical realist umbrella, provides a useful underpinning for analysing the interplay between structure, culture and agency. While there has been an increasing acknowledgment of the importance of agency and structure in ICT4D studies, the scope of research in this domain has tended to lean to either one or the other and has not been able to adequately account for culture in this analysis (Walsham, et al., 2007). I would argue in line with Archer (1995, p. 274) that the interplay between structure, culture and agency "remains hopelessly indefinite unless the interplay between them is unravelled over time to specify the where, when, who and how – otherwise we are left with the vagaries of mutual constitution". Njihia and Merali (2013, p. 883), one of few studies that draw on the morphogenetic approach in ICT4D, assert that: "MA [morphogenetic approach] is... a tractable, comprehensive approach within which we can model and theorize ICT4D change in complex contexts".

The fundamental focus of the morphogenetic approach is to examine the relational process of change. According to Archer, social change occurs through a three-stage morphogenetic cycle (Figure 1) in which structure, culture and agency interact with each other to produce intended or unintended consequences. A principal effort of research then is to examine how these three parts that makeup social systems "emerge, intertwine and redefine one another" (Archer, 1995, p. 76).

These three phases of the social system are distinguished by the unique attributes of their components which give rise to distinct emergent properties. These relate to three types of emergent properties - structural emergent properties (SEPs), cultural emergent properties (CEPs) and people's emergent properties (PEPs), which presuppose three types of generative mechanisms or causal powers. SEPs are defined as "those internal and necessary relationships which entail material resources, whether physical or human, and which generate causal powers proper to the relations itself" (Archer, 1995, p. 177). Structures are relatively enduring systems whose change primarily depends on material resources. Therefore, SEPs relate to the allocation of resources, roles, institutional arrangements, and social systems.

On the other hand, CEPs are properties of the cultural system and encompass the world of ideas, beliefs, theories and values, which can be espoused by people or contained in particular discourse. Lastly, PEPs are where human agency is exercised. This is also where agential relations produce emergent power in

two ways; “they modify the capacities of component members (affecting their consciousness and commitments, affinities and animosities) and exert causal powers proper to their relations themselves vis-a-vis other agents or their groupings (such as association, organization, opposition and articulation of interests)” (Archer, 1995, p. 184).

The emergent and transformational interplay between structure, culture and agency allows for the analysis of distinct causal mechanisms that link actions and systemic outcomes (Mutch, 2010; Njihia & Merali, 2013). Methodologically, vital to such analysis is analytical dualism, where the categories of agency and structure, although ontologically intertwined, are separated for the purpose of analysis (Archer, 2010). A key focus then is unravelling the process of emergence whereby structure, culture and agency mutually transform each other over time producing social-material outcomes (Mutch, 2002).

The morphogenetic cycle consists of three analytical phases: *structural/cultural conditions* (a specific structure which conditions but does not determine); *social interaction* (actions and interactions of people organized in various ways as agents); and *structural/cultural elaboration* (transformation or reproduction of structural properties) (Archer, 1995). Morphogenesis occurs when social interactions result in transformation of pre-existing structures; while morphostasis is the condition where the interactions reproduce the existing structures (Archer, 1995).

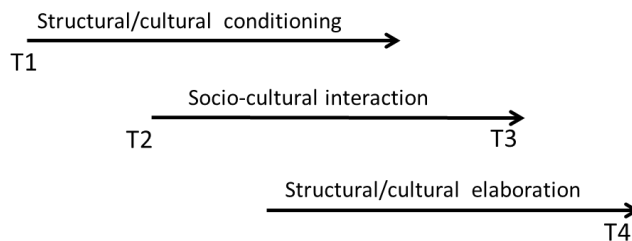


Figure 1: The Morphogenetic Cycle (adapted from Archer, 1995, p.193)

Archer contends that:

...every morphogenetic cycle distinguishes three broad analytical phases consisting of (a) a given structure (a complex set of relations between parts), which conditions but does not determine (b), social interaction. Here, (b) also arises in part from action orientations unconditioned by social organization but emanating from current agents, and in turn leads to (c), structural elaboration or modification—that is, to a change in the relations between parts where morphogenesis rather than morphostasis ensued. (Archer 1995, p. 91)

Time is a critical dimension in the morphogenetic approach. The sequence of the morphogenetic/static cycle begins at T1, which relates to prior structural conditioning of existing social systems. The subsequent period, T2 and T3, relate to the mediating action of agency through social interaction. Subsequently, emergent change results in structural elaboration by T4.

Given that Giddens' structuration theory also deals with the relationship between structure and agency, it is useful to distinguish the two approaches to better understand why the morphogenetic approach is selected as a relevant theory for this study. Although both approaches fundamentally agree that structure and action presuppose one another, they have underlying differences. In Giddens' structuration, structural properties of social systems are produced (reproduced) by actors in interaction drawing on rules and resources in action contexts (Giddens, 1984). Therefore, structures are understood as a set of rules and resources that have a virtual existence, held as memory traces and which are instantiated in practice (Giddens, 1984). Accordingly, there are no external structures, as such, that are outside of humans' knowledge and enactment of them.

Archer argues that this is a conflation of structure and agency, object and subject, and man and society, which does not lend itself to analysing and theorizing the unfolding relationship between the two entities over time (Archer, 2010). In Archer's morphogenetic approach, a theoretical separation is made between structure and human action over time. Social interaction, the second phase of her morphogenetic cycle, is where agents, embedded within structural conditions, interact and take action to structure (re-structure) pre-existing social systems (Archer, 1995).

According to Archer, structural properties refer to the collective consequences of previous action and can comprise rules and resources including those in institutional and organizational contexts (Archer, 2010). Structure can also extend to broader contexts – the political, cultural and socio-economic conditions that constrain and facilitate agency. The constraining and enabling effects of structural conditions on social actors exist despite their awareness or enactment of them (Mutch, 2010). Additionally, structural elaboration, the reproduction or production of structural conditions, is the result of previous interactions of social actors (Archer, 1995).

However, a criticism of the morphogenetic approach is that material properties of technology remain unaccounted for (Mutch, 2010). Archer does not engage with the use and impact of technology in her work (Mutch, 2010). More recent work by Mutch (2010) has proposed a morphogenetic approach to technology. Drawing on analytical dualism, Mutch (2010) argues that the morphogenetic approach provides a useful apparatus to link organizational change that involve technology to broader social and political structures (Mutch, 2010). This is especially relevant for understanding the broader context of ICT projects and implementation in the developing country context.

This study draws on the aforementioned theoretical concepts of the morphogenetic approach to examine the digitalization process based on empirically based analysis. To do this, technology is incorporated into the morphogenetic cycle, namely in the analysis of social interactions and in the mediation and elaboration of structure (Mutch, 2010).

3.3. Conceptual framework

The conceptual framework of the research (Figure 2) is grounded in the morphogenetic approach and engages with three main questions: what are the entities that define the research field, what are their relationships and what are their powers and tendencies? Accordingly, the arrows linking the key entities in the conceptual framework are intended to be explicated through causal mechanisms.

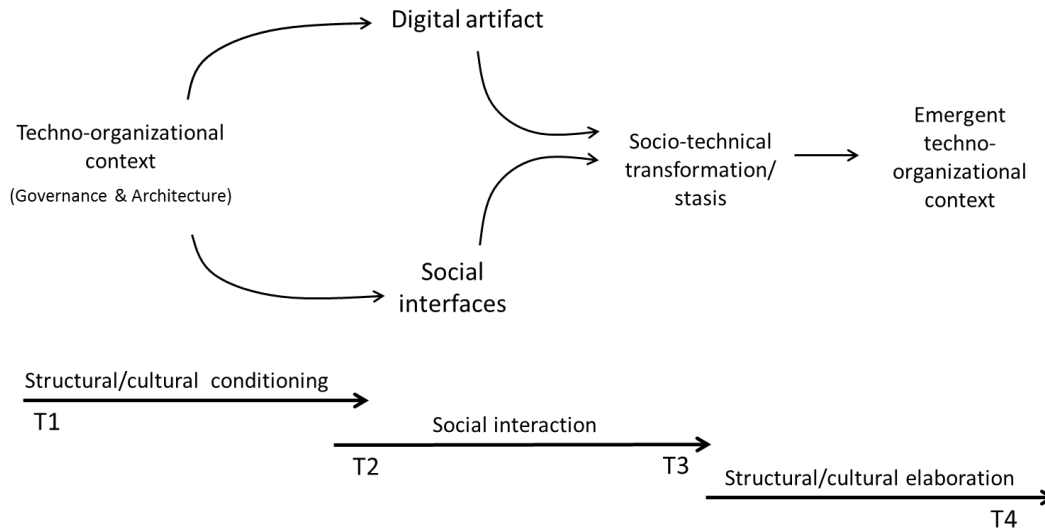


Figure 2: Conceptual model for the research

3.3.1. Structural/cultural conditioning (T1)

At the structural conditioning phase of the morphogenetic cycle, structures/cultures (institutions, roles, resources, values) emerge over time from the previous actions of human actors, but once in place form the conditions for exercising agency (Archer, 1995). The structural/cultural condition examined is the techno-organizational context. The techno-organizational context “consists of networks of human, social and technical objects, which in various combinations enable (or create the potential for) action” (Bygstad, Munkvold, & Volkoff, 2015, p. 5). Therefore, I look to examine if and how the pre-existing techno-organizational context conditions the configuration of the digital artefact and human action/interaction.

Various studies have identified that the properties of structures inscribed in technology can both constrain and enable agency (Mutch, 2010; Mutch, Delbridge, & Ventresca, 2006). However, the materiality of technology is not solely responsible for this constraint, the presence of previously established ideas, organizational arrangements, roles and practices also plays a key role (Mutch, 2010). This is particularly evident in the development and implementation phase of systems where previously established structures condition the process of their design and deployment.

Two key structural/cultural conditions of the techno-organizational context are examined: (i) governance modalities and (ii) architectural constellations.

Governance modalities: refers to the distribution of decision-making rights among enterprise stakeholders, and the procedures for making and monitoring decisions (Weill & Ross, 2004). As outlined at the outset of this thesis, development project governance and particularly those of IT-based projects has been a pertinent area of concern. Recent studies have found that governance structures are key factors influencing the processes and outcome of digitalization initiatives (Henfridsson & Bygstad, 2013;

Kierkegaard, 2015). Consequently, the governance arrangement is identified as a key structural condition for synthesis.

Architectural constellation: refers to the components that make up a system, their properties and the relationships between them. Architectural constellation is viewed as a pre-established structural condition relating to the assemblage of data, business process, and IT infrastructure. Such a view of architecture goes beyond its technical properties but also relates to a holistic systems view of an organization's information infrastructure. Properties of the architecture constellations can also be inscribed in technology and can have a conditioning effect on the digitalization process (Braa & Sahay, 2012; Henfridsson & Bygstad, 2013).

3.3.2. Social interaction (T2-T3)

Social interaction corresponds to the next phase of the morphogenetic cycle which refers to the actions and events taking place between T2 and T3. Here, the interplay between technology and social actors transpires under particular structural/cultural conditions. A key consideration in this phase is how the particular design and implementation of the digital artefact emerges.

Agents are enabled and constrained by pre-existing structural conditions under which they operate. The properties of structural conditions are mediate by social interactions which conditions how the process of technology development and implementation unfolds (Archer, 1995; Mutch, 2010). According to Archer (1995), it is at the social interaction phase that pre-existing structural systems evolve as a result of actions and interactions of people organized in numerous ways as agents. She states:

social or socio-cultural interaction is explained by the changing interrelationship between the structures of resource distributions and the structure of material and ideal vested interest groups. This is how interaction mediates the social context, ultimately effecting societal elaboration (or recursiveness). (Archer, 1995, p. 297)

In order to analyse these dynamic interactions and actions, I draw on the notion of social interfaces (Long, 1989). The social interface approach provides an analytical device which accounts for key dimensions of vested interest groups, their actions and interactions (Long, 1989, 1999). By drawing on interface analysis, the dynamic and emergent nature of key exchanges and actions that shape the digitalization process can be better examined. I discuss social interfaces in the following section.

Social Interfaces: an actor-oriented approach for analysing development practice

To facilitate conceptualization and analysis the social interaction phase of the morphogenetic cycle, Norman Long's concept of social interface from the development sociology field is adopted (Long, 1989, 2003). Long defines social interfaces as: "a critical point of interaction or linkage between different social systems, fields or levels of social order where structural discontinuities, based upon differences of normative value and social interest, are most likely to be found" (Long, 1989, pp. 1-2). Simply put, social interfaces refer to junctions of ongoing interaction to address a specific problem.

According to Long, “studies of social interfaces should aim to bring out the dynamic and emergent character of the interactions taking place and to show how the goals, perceptions, interests, and relationships of the various parties may be reshaped as a result of their interaction” (Long, 1989, pp. 1-2). Analytical focus on interactions has the potential to explain the role of emergence in digitalization since “emergence is embedded in interaction” and its properties are fundamentally relational (Archer, 2010, p. 245).

Long has applied the social interface approach primarily to interfaces between national or local levels in the field of development (Long, 1989, 1999). More recently, global health researchers have adopted the interface approach to study the current trends of global health governance from an institutionalist perspective focusing on the political process and dynamics of power among collaborating organizations (Bartsch, Hein, & Kohlmorgen, 2007; Buse, et al., 2009; Hein, et al., 2009).

The socio-political process of digitalization also involves social actions which are situated contextually and temporally, and always involve interactions and transactions (W. Orlikowski, 2000). Through these interactions, actors can impose their interests, exercise power and engage in conflicts, constructing and reconstructing the structures they are part of (Mutch, 2010). Therefore, the interaction of social actors is recognized as an important factor in shaping technology and its social context which merits attention to its synthesis (Bijker & Law, 1992; Mutch, 2010; W. Orlikowski, 2000).

Social interface analysis also allows for the analysis of socio-politics in inter-agency development projects. There has been extensive research on the socio-political aspects of digitalization (Jasperson, et al., 2002; Sahay, et al., 2009a; Sillince & Mouakket, 1997; Silva, 2007). However, few studies in this context explicitly theorize these socio-political dynamics among diverse multi-level interorganizational actors. These complex dynamics are often black-boxed with the emphasis being on organizational forms and governance modes such as top-down, bottom-up and hybrid approaches.

Key aspects of the social interface approach

An actor-oriented perspective. The interface approach posits “active agents” who problematize situations, processes information and strategize by dealing with others (Long, 1992, 1999). Social change and its trajectory is the result of interactions, negotiations and social and cognitive struggles that take place between specific agents (Long, 1989, 2003). Actors involved in interface situations can be individuals, groups or institutions and are inclusive of not only those present in face-to-face situations but also those who are absent but nevertheless impinge upon such situations (Long, 2003). Accordingly, interface analysis need not be limited to the study of the minutiae of day-to-day social interactions (Long, 1989). Rather it situates these interactions within broader institutional contexts and power structures (Long, 2003).

Consequently, the interface approach does not negate the influence of broader structural conditions (Long, 1992). It accounts for the role that structural conditions play in the social-life of development projects not only to influence the interactions and behaviours of actors but to also to be mediated and transformed by them. In line with Archer, Long’s “actor-oriented paradigm” thus aims to find a balance in understanding social change as a dynamic interplay and mutual determination of actor and structural

factors and interactions, but stresses the central role of human action (Long, 1992). As a result, social interface analysis also calls for the analysis of specific structural conditions that constrain and/or enable how the goals, strategies, interests and relationships of various project actors may be reshaped as they come into interaction (Hein, et al., 2009; Long, 2003).

Interface as sites of conflict, discordancy and negotiation. Among diverse project stakeholders, interfaces can facilitate common interest or generate conflicts (Long, 1989, 1999). The greater the heterogeneity of key stakeholder's attributes, the more conflictive the political processes at the interfaces are likely to be (Long, 1989). Conflict can emerge due to imbalanced power relations or contradictory interests among stakeholders which manifests during interface situations (Long, 1999; Long & Long, 1992). Therefore, interfaces can be sites of conflict, incompatibility and negotiation (Long, 1989, 2003).

Types of interfaces

What determines the number and type of interfaces enacted in a particular planned initiative depends on the particular problem domain, its planned intervention, and the wider politico-economic context which includes the cluster of actors (Long, 1989, 1992; Long & van der Ploeg, 1989). In the global health governance literature, three major types of interfaces are distinguished: discursive, resource-based, and organizational (Hein, et al., 2009). As I will discuss later, a fourth interface associated with digitalization that will be explored in this study is technical interfaces.

All interfaces are associated with different forms of power (Hein, et al., 2009). The distinction in the type of interfaces and powers highlights the different ways interactional dynamics can shape the institutional, financial, technical and social aspects of development projects in the global health context. The four interfaces are discussed below.

Discursive interfaces: are interactions where changes to norms, values and perceptions held by different actors take place (Long & van der Ploeg, 1989). A central means of discursive power is communication (Hein, et al., 2009). Through various modes of communication, discursive power can shape actors' values and interests based on the promotion of certain ideas and values which can influence decision-making and resource distribution (Long & van der Ploeg, 1989). Discursive power is the capacity to influence the perceptions and interests of others (Long & Long, 1992). A particular discourse can emerge from global or local contexts and often gains momentum through struggles over social meaning and resources capacity (Long, 1999; Long & Long, 1992).

The discursive interface lens allows the analysis of how dominant discourses are adopted, transformed or challenged (Long, 1999). While some discourse can become accepted as norm, others can be challenged by actors who deploy discourses that offer alternative perspectives (Long & Long, 1992). A major task of interface analysis, then, is to deconstruct this interplay and to understand how discursive interfaces emerge and frame the process of digitalization.

Organizational interfaces: refer to decision-making interactions and arrangements linking different actors involved in an initiative (Hein, et al., 2009). Influence at organizational interfaces depends on

decision-making power that exists between actors. The differences in power among actors is the result of the asymmetric ownership and control of resources and rules (Bartsch, et al., 2007). Decision-making power refers to the ability of an actor to alter their course of events by intervening in a series of decisions (Archer, 1995; Buse, et al., 2009). For instance, meetings, workshops and technical working groups are common organizational interfaces where ideas are proposed, plans are developed and decisions are made in many development initiatives. An actor’s power as a decision-maker depends on their level of involvement and legitimacy at these organizational interfaces. However, gaining legitimacy at organizational interfaces involves a socio-political process which the interface approach aims to elucidate (Long, 1999).

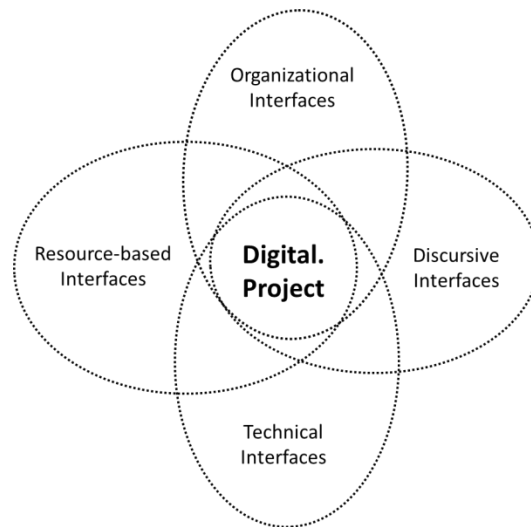


Figure 3: Digitalization projects as a confluence among four interfaces

Resource-based interfaces: are interfaces where resources deemed necessary for a planned initiative are identified, mobilized and distributed. These interactions and transactions take place at resource-based interfaces, which involve the resource-transfer relationship between NGOs, their donors and the recipient country (Bartsch, et al., 2007). Resources are also one medium through which power can be exercised (Archer, 1995). Power and its use in organizations are mediated by resources that actors mobilize within interactions as bargaining power (Archer, 1995). Therefore, resource-based interface situations are also where donors and NGOs can exercise decision-making power (Hein, et al., 2009).

Technical interfaces: are interfaces where the technical design and implementation of the system are carried out by technical stakeholders. The characteristics of technology and how it is implicated with social interfaces is an area that Long acknowledges but does not explicitly address. For instance, irrigation system development in rural communities is identified as “a process which combines technical and social properties” (Long, 1989, p. 86). Drawing on various irrigation system development projects in developing countries, the study identifies differences in outcome across countries. These differences were not only attributed to social positions and interrelationships, but also to the technical properties of the system and the mode of intervention. The study also identified that the physical configuration of the system was a direct reflection of interface situations. Additionally, the technical design of the system contained assumptions about the social organization, which influenced the project.

At technical interfaces, the focus of analysis shifts to examining the distribution of technical roles and tasks and how the collaborating actors interact and exchange information in project activities. How these interface dynamics transpire and its association with the technical properties of the system is also a focus of inquiry.

In summary, the social interface approach has the potential for facilitating an in-depth analysis of the technological and the interactional dynamics of digitalization initiatives. Distinguishing different interfaces also allows for the analysis of their relationship and dynamics. It enables the analysis of the changes in the relative importance of different forms of interaction in shaping the financial, institutional, and social aspects of ICT4D projects. Overall, I adopt the interface approach to deconstruct the socio-political process of planned ICT interventions so that I can better analyse it, understand it and see it for what it is.

Overall, this dynamic relationship of technology and human action with its context is the focus of analysis at the social interaction phase. The dynamic interaction between social interfaces and the digital artifact at this phase produces socio-technical transformation/stasis.

3.3.3. Structural/cultural elaboration (T4)

Structural elaboration at T4 is where the socio-technical interactions and actions from the previous phase actualizes particular digitalization outcomes to varying degrees. As mentioned, digitalization involves the transformation of techno-organizational structures formerly mediated by non-digital artifacts into ones mediated by digitized artifacts (Yoo, et al., 2010). Therefore, it extends beyond the technical process of digitization to address the organizing of new techno-organizational structures. Consequently, it is a socio-technical process the outcome of which, not only leads to the digitization of content and processes, but ensuing reconfiguration of roles, capacities, relationships, practices, and organizational arrangements (Tilson, et al., 2010).

New techno-organizational configurations emerge as a result of successful digitalization, that is, change where morphogenesis occurs. This is where socio-technical transformation produces a desired change in the pre-existing techno-organizational structures, namely, changes in the relational entities of the governance arrangement and the architectural constellation. Therefore, morphogenesis is the emergent techno-organizational structure, while morphostasis ensues when the actions and interactions fail to produce change, reproducing the pre-existing structures.

Chapter 4

Research Approach

4.1. Ontology and epistemology

This study is based on critical realist perspective. Critical realism emerged from the work of Roy Bhaskar in the philosophy of science (Bhaskar, 1998). His work influenced various disciplines and was extended to the social arena by authors such as Archer and Sayer (Archer, 1995; Sayer, 2000). More recently, critical realism has garnered an increasing interest by IS researchers.

The fundamental tenants of critical realism offer an alternative perspective to the two widely adopted philosophical paradigms: positivism and interpretivism. Critical realism asserts that:

- there is an external and objective reality independent of our knowing of it (objective ontology)
- our knowledge of the world is not objective but fallible (subjective epistemology)

These assertions diverge from the ontological and epistemological views espoused by both positivism and interpretivism. Interpretivism or constructivism fundamentally aims to understand the subjective meanings held by those under investigation. The notion of an objective or external reality is rejected. Therefore, both its ontological and epistemological assumption are based on subjectivity (Easton, 2010). On the other hand, positivists are primarily concerned with testing, confirmation and falsification of theories and hypotheses (Fleetwood, 2014). The focus of such research is to develop generalizable theories about an objective and scientific knowledge. The philosophical assumptions of positivisms are grounded in an objective epistemology and ontology.

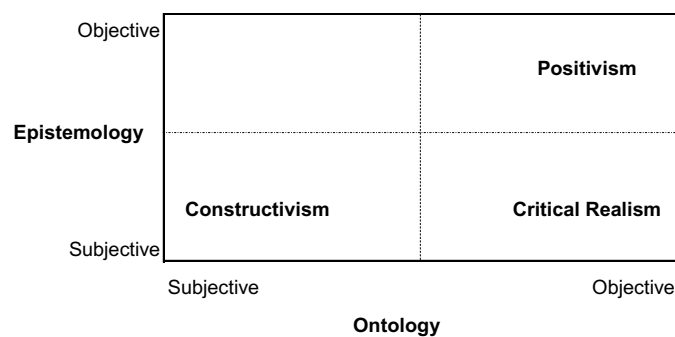


Figure 4: Ontological and epistemological variations between the research approaches

Contrary to both research paradigms, critical realism asserts that reality is characterized by stratified, emergent, and transformational entities, relations, and processes (Fleetwood, 2014). Firstly, reality is stratified; meaning there are different levels of reality (Bhaskar, 1978). Critical realism proposes three domains of reality. These include the *empirical* (observable events), the *actual* (events) and the *real* (what exists). The *empirical* consists of that which is directly observed or experienced and which can be

accessed by our senses. The *actual* exists beneath the empirical and consists of events and actions that may be actualized but not necessarily observed. Lastly, the *real* subsumes the domains of the empirical and actual and comprises of underlying structures and mechanisms that give rise to discernible events and empirical observations (Bhaskar, 1978). Mingers (2004) defines the real as “a complex interaction between dynamic, open, stratified systems” (p. 94). The real consist of structured entities, both social and physical, that behave in particular ways. These capacities or tendencies to behave are called generative mechanisms (Fleetwood, 2014).

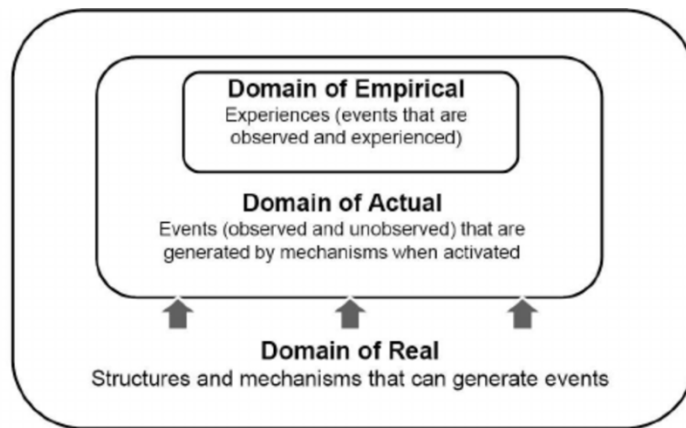


Figure 5: Three overlapping domains of reality in critical realist ontology (Mingers, 2004)

Generative or causal mechanisms exist in the domain of the real and when triggered, their effect becomes evident in the actual domain. Furthermore, when these events in the actual domain produce observable events they manifest in the empirical domain. Therefore, critical realist research works through retrodution to determine what the world must be like (in the domain of the real) to generate a particular phenomenon (Bhaskar, 1978).

Secondly, critical realism asserts that reality is emergent, in that “entities existing at one ‘level’ are rooted in, but irreducible to, entities existing at another ‘level’” (Fleetwood, 2014, p. 205). Emergent properties arise from the relations that develop among entities. For instance, the social is rooted in the biological, but is not reducible to it, just as memory emerges from the biological, but is not reducible to it. Similarly, the capacity for an organization to adopt a technology is rooted in, but irreducible to, the properties of the technology or the social tendencies of the agents that constitute the organization. However, it is in their association that these entities produce emergent properties.

Lastly, social reality is transformational. This concept is captured by Bhaskar’s Transformation Model of Social Action (TMSA) and Archer’s morphogenetic approach (Archer, 1995; Bhaskar, 1978). It asserts that agents do not simply create structures but rather transform and reproduce pre-existing structures. Thus, every action necessitates the pre-existence of structures, which agents exploit to trigger that action (Fleetwood, 2014).

This briefly outlined ontology of critical realism has a number of implications for the research design of this work. According to Fleetwood (2014) “one’s ontology influences one’s aetiology, epistemology, choice of research techniques, mode of inference, the objectives one seeks, and the concepts of

explanation, prediction, and theory one adopts” (p. 182). The methodology and mode of inference in critical realist research aims to elucidate and provide thick explanations of structures and mechanisms that influence human action. Thus, explanatory power and not predictive power is a key attribute of critical realism. This calls for a retroductive method of analysis. Retroduction involves ‘arguing backwards’ where one draws on a particular phenomenon or empirical observation and hypothesize a mechanism that might explain the observed outcomes (Fleetwood, 2014; Sayer, 2004). In line with this, the study uses a retroductive approach by examining empirical events of digitalization to identify causal mechanisms that explain particular outcomes in the case.

Aetiologically (i.e. the investigation or attribution of the cause for something) an important area of focus in this dissertation relates to uncovering causality by identifying and explaining generative mechanisms of digitalization. Causality within critical realism is considered as powers and tendencies and is distinguished from laws or having law-like regularities (Fleetwood, 2014).

4.1.1. Causal explanation of digitalization

Research in IS has typically pursued one of two predominant forms of causal explanation grounded in either positivism or interpretivism. Positivism’s notion of causality adopts a Humean view that propose ‘X causes Y’ relationships through event regularities and law-like relations often validated through repeated observations and statistical correlations (Fleetwood, 2014). Explanations focus on the succession of events or the correlation of event regularities. Therefore, causation remains at the level of observed events. This shortcoming is attributed to adopting a flat ontology. As Fleetwood (2014, p. 196) elaborates: “If one has an ontology of observed atomistic events, one’s concept of causality cannot be conceived of in terms of anything other than events and their regularity. The cause of event x must be some prior event y”. A fundamental weakness of this approach is that they can only tell us *what* may happen. However, it does not provide explanation about *how* and *why* X causes Y or *how* and *why* particular IS phenomena came about.

On the other hand, interpretivists are often hesitant to discuss causation since their perspective of causality is associated with event regularities and laws proposed by positivist (Fleetwood, 2014). Consequently, determining causality is considered a naïve endeavour. Explanations generally focus on the subjective views and interpretations of actors in their particular setting and how these are fostered and sustained. Therefore, unlike positivist research that seeks a uni-directional cause-effect relationship, interpretive research constructs explanations that are more dynamic. According to Orlikowski and Baroudi (1991, p. 9): “Interpretive researchers posit circular or reciprocally interacting models of causality, with the intention of understanding actors’ views of their social world and their role in it”.

Contrary to both perspectives, a critical realist view of causation is rooted in the concept of causal powers, tendencies or generative mechanisms (Bhaskar, 1978). Generative mechanisms do not exist at the level of empirical events but rather at the domain of the real. Accordingly, the examination of causation shifts from the pattern of a flux of events (i.e. the outcomes or results) to the conditions that make those events possible. These empirically observable events can be likened to symptoms, which a doctor draws on to make a diagnosis of an underlying disease.

4.1.2. Generative mechanisms

Generative mechanism can simply be described as causal powers or tendencies that explain an empirical outcome (Fleetwood, 2014; Sayer, 1992). Mechanisms are inherent to social or physical structures, facilitating or hindering what can happen within a given context (Sayer, 2000). In IS phenomenon, the entities of mechanisms can consist of individuals, groups, organizations and artifacts. Uncovering and understanding generative mechanisms that account for empirical observations is a key focus of social realist research (Fleetwood, 2014). This entails investigation of the processes by which outcomes are produced by the relational entities of structures, actions and contextual conditions (Sayer, 2000).

Generative mechanisms are contingent, complex and conjunctural (Bhaskar, 1978). They are contingent because they often occur in open systems of the social world where a range of mechanisms exists and converge. The relationship between mechanisms and their outcomes are not fixed and should not be viewed as deterministic (Fleetwood, 2014). Accordingly, in open systems the same mechanism can generate different outcomes, rendering mechanisms as context-dependent.

Mechanisms are also complex and conjunctural because there are a number of entities and relations that can produce a chaotic and disordered series of mechanisms, each generating their own tendencies, thereby counteracting and reinforcing each other (Bhaskar, 1978). Therefore, the outcome of a specific mechanism is dependent on other mechanisms (Sayer, 1992). Mingers (2004) points out that: “the interaction of these generative mechanisms, where one often counterbalances another, causes the presence or absence of actual events” (p. 94).

Consequently, a focus of critical realist research is to identify sets of generative mechanisms and how their interactions triggered particular events. Developing such a comprehensive causal explanation of complex social phenomenon cuts across levels of analyses to include the actions of individuals/groups and the social context in which they are embedded (Avgerou, 2013). A number of approaches have been proposed for identifying mechanisms at different levels (Mingers & Standing, 2017).

A widely adopted perspective is the macro-micro-macro approach for identifying three distinct causal episodes (Coleman, 1986). Drawing on Coleman’s work, Hedström and Swedberg’s (1998) propose three types of mechanisms. First are situational mechanisms (macro-micro) which relate to contextual conditions that influence the beliefs, desires and actions of people. Second are action-formation mechanisms (micro-micro) which explain how the combination of individual desires, beliefs and opportunities generate a specific action. Lastly, transformational mechanisms (micro-macro) explain how the actions and interactions of actors are transformed into a collective outcome at the macro level.

A critical realist approach that resembles Hedström and Swedberg’s macro-micro-macro categorization of mechanisms is Archer’s morphogenetic approach. For Archer, generative mechanisms are emergent properties where “the relations between its components are internal and necessary ones rather than seemingly regular concatenations of heterogeneous features” (Archer, 1995, p. 173). Archer proposes three types of generative mechanisms consistent with the three types of emergent property in the morphogenetic cycle – structural, cultural, and people’s emergent properties (SEPs, CEPs, and PEPs). Based on the critical realist stratification of reality (i.e. real, actual and empirical domains), Archer argues

that “the morphogenetic approach makes no leap from the real to the actual, but rather dwells on the ground between them by analyzing the generative mechanisms potentially emanating from structures (and cultures) as emergent properties and their reception by people, with their own emergent powers of self and social reflection” (Archer, 1995, p. 175).

Overall, I build on the ontological premise of critical realism and the theoretical concepts of the morphogenetic approach to develop a mechanism-based explanation of a large-scale digitalization initiative in Ethiopia.

4.2. Methodology

The research approach of this PhD has been a reflective and adaptive process. My initial motivation for doing this PhD was based on my experiences in the HIS domain in Ethiopia and more generally my interest development informatics that began with my master’s research. My initial plan at the start of my PhD was to carry out a multiple case study based on cases in Ethiopia and Norway. Part of the motivation for this was to examine contrasting cases with aims of deepening understanding and explanation. With this in mind, I started with the study of a large scale eHealth implementation in a Norwegian regional health authority while also working on my first paper on the Ethiopia case. The Norwegian study, which is not included in this dissertation, was published as a conference paper. However, challenges with language and access to participants made it increasingly difficult to build further on the Norwegian study. Given my initial interest in the development context in addition to the more in depth knowledge and experience that I had in Ethiopia, it became more feasible to shift my focus to the Ethiopia case.

The Ethiopia case offered a number of advantages a predominant of which was the first-hand knowledge and experience I had with the project. Despite this, it proved to be problematic to explicitly draw on and analyse these experiences and observations as this was not consistent with canonical and legitimized ways of doing research. Conversely, my personal involvement in the project offered detailed accounts of events, hands-on experience with project activities, numerous interactions and insights that would otherwise be difficult to obtain through interviews or other methods. This dilemma has led to my consideration of the autoethnographic case study approach.

4.2.1. Autoethnography

Autoethnography is a form of qualitative research that seeks to explore and systematically analyse one’s personal experience with a particular phenomenon or issue (Ellis, Adams, & Bochner, 2011). It provides a way for researchers to bring their lived experience into dialogue with theory (Raudenbush, 1994). This approach is not limited to the researcher’s self (i.e. emotions and feelings), but can also involve narratives about how institutions are affected by broader social structures (Anderson, 2006). This approach challenges traditional ways of doing research which can be sterile, divorcing the researcher from their lived experience. Additionally, beyond the contribution to new knowledge, the autoethnographic approach treats research as a political and socially-conscious process (Ellis et al., 2011).

There are different forms of autoethnography. For this work, I draw on a form of autoethnography called analytical autoethnography (Anderson, 2006). Key features of analytical autoethnography include: the researcher's full membership in the research setting; dialogue with informants; and commitment to theoretical analysis and understanding of broader social phenomenon. Analytical autoethnography draws on empirical evidence from self-experience to develop and refine theoretical perspectives of social processes. In this way, it varies from evocative autoethnography which purely focuses on researchers' subjective experiences (Anderson, 2006).

In my study, the autoethnographic approach has especially been beneficial for identify generative mechanisms. Retroducing mechanisms can be a challenging undertaking. Simply following pre-set guidelines may not suffice. It is an inherently creativity and intuitive process (Bygstad, et al., 2015). Bhaskar (1975, p. 47) describes our knowledge of mechanism as:

A rare blending of intellectual, practio-technical and perceptual skills. They are not artificial constructs. But neither are they Platonic forms. For they can become manifest to men in experience.

In line with Bhaskar, my personal lived experience with the events of the case offer an advantage when it comes to uncovering generative mechanisms. This allows the study of the real world as it unfolds and offers a vantage point from where rich insights can be garnered not only to describe events but also to understand why they occur. Easton (2010, p. 120) reiterates:

Most social science research methods create data that are reported rather than directly observed. Descriptions of the events that occur during the implementation of an MIS are rarely experienced at first hand or recorded in a way that is close to the event.

Despite its benefits, there are many criticisms of the autoethnographic approach. Primarily, the use of self as a primary source of data raises concerns about the researcher's bias and the credibility of the study. However, autoethnography contends with the widely adopted assumption that research can be done from a purely objective, neutral and impersonal position (Denzin & Lincoln, 2000). Such an assumption is presumed to often be unachievable.

That said, I have taken a number of steps to ensure the credibility of the study. First, at a general level, I have attempted to provide sufficient detail about the data collection and the process of analysis to allow the reader to judge the research findings. With regards to the analysis process, I have endeavoured to ensure analytical rigour and to follow a process that is explicitly systematic.

Secondly, I have used two kinds of triangulation to ensure credibility, namely, methods triangulation and theory/perspective triangulation (Patton, 1999). The first type of triangulation involved cross-checking observational data with different data sources including: interviews, document reviews, and a survey. The interviews and surveys comprised of participants from different points of view, thereby, triangulating views of project staff, government staff, end users, donor and bilateral organization staff. On the other hand, document reviews particularly those related directly to the project (i.e. meeting

minutes, reports, statements of work, field trip reports, and issue logs) were also used to corroborate the other data sources (refer to Appendix 1 for a full list of documents).

For the second type of triangulation, multiple perspectives or theories were used to interpret the same data. All four papers included in this dissertation use different theoretical approaches to analyse the same case. For example, in paper 3, actor-network theory and Callon's four moments of translation is used as a theoretical approach while in paper 2, social interfaces is used to highlight the substantive issues in the case.

As an emergent form of qualitative research, autoethnography is also criticized for not being methodologically rigorous and for its lack of satisfactory theoretical contributions. It is also dismissed for drawing heavily on personal experience thereby being susceptible to producing biased data that is not grounded in sufficient analysis and theorizing (Anderson, 2006; Ellis, et al., 2011). Contrary to these criticisms, autoethnography can be rigorous, analytically sound and theoretically grounded while also being inclusive of personal and broader social phenomenon (Anderson, 2006). Additionally, it presents a powerful approach for unravelling the many nuances involved in studying a complex phenomenon in its context.

4.2.2. Case study

Together with autoethnography, the study adopted a case study approach. Case studies have been identified by critical realist researchers as a useful approach for exploring the dynamics between structure, events, actions, and context in order to uncover causal mechanism (Mingers, 2004). Yin (2009, p. 18) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context". Case studies are most suited for answering "how" or "why" questions (Easton, 2010).

The case study research approach was selected because of its usefulness in setting boundaries around a phenomenon of investigation that is broad and complex and which involves uncovering sets of underlying factors and relationships (Yin, 2009). The particular case or unit of analysis in this study was the digitalization initiative in Ethiopia.

The case study approach was also selected because it allows consideration of important contextual conditions that may be relevant to the key phenomenon and, as a result, are useful for explaining processes, actions, and interactions (Easton, 2010). A multi-level contextual stance was adopted consistent with the view that the process of digitalization in developing countries cannot be simply studied and understood by focusing on the local administration alone or the technological features in isolation. Rather, it needs to consider together various local and international events that impinge on the digitalization process (Avgerou, 2008; Ciborra, 2005).

4.3. Methods

4.3.1. Data collection

The data collection for this study consisted of: participant observation, semi-structured interviews, document reviews and an end-user survey. Unlike ethnographies, researchers doing autoethnography do not solely collect data through participant observation and field notes nor do they go through these experiences for the purpose of research or publication, rather these experiences can be assembled using reflections and hindsight (Freeman, 2004; Denzine, 1989; Bruner, 1993). Accordingly, the first part of the case data was compiled retrospectively through journaling about key events that took place during my involvement in the eHMIS/PHEM project in Ethiopia (Ellis et al., 2011).

Participant observation

A key data source for this research was longitudinal participant observations. These observations were based on the period of my involvement in the eHMIS/PHEM project from March 2012 to March 2013. Participant observations included involvement in the day to day activities as a member of the NGO team. As I will outline in further detail, my responsibilities in this position involved a variety of activities related to the management and implementation of the eHMIS/PHEM.

In studying the multifaceted process of IT implementation in such a political institutional context, participant observation has offered a useful data source, where the investigator was part of the setting and the process being studied (Sofaer, 1999). Participant observation has also allowed the study of the case as it has unfolded (Lincoln & Guba, 1985). This has offered a rich insider perspective, enriching my understanding and the possibility to follow the case from different perspectives among interorganizational partners at the various contextual levels, namely; NGO, health facilities, districts, regions, and national FMOH. This has offered a far greater learning opportunity (about the inner workings of an NGO, the challenges of the digitalization process, and the role and rationalities of the various interorganizational stakeholders) than could have been obtained by purely using structured methods such as interviews or surveys.

Given that this research study draws on my personal experience, the main documentation method employed was retrospective journaling. This was a useful approach that has helped me to both document and analyse my experience in order to derive insights from key events. According to Ellis, et al. (2011) retrospective journaling involves the researcher's retroactive and selective documentation of past experiences. Accordingly, the journaling process began with narratives of selected key events from my experience. Descriptive accounts included narratives of the main actors and organizations involved, their roles, the overall development and outcome of these events, and how they were managed. These events included, but were not limited to, implementation initiatives in particular regions where challenges and moments of crisis occurred. The journaling was also an iterative process where the writing itself was helpful in better illustrating events more vividly and bringing to light pertinent issues in the case.

My Role in the Project

My involvement with the eHMIS/PHEM project began in March of 2012. Prior to this, I had spent almost two years with another NGO where I had worked in monitoring and evaluation in HIV care and treatment. Building on this experience, I was eager to be part of a large-scale IT project in the health context. Immediately upon being hired, the NGO director had assigned me with a research role in order to compile lessons learned from the various IT-based initiatives the NGO was undertaking. The NGO had a suite of systems in various phases of development and implementation included; an electronic medical record system, human resource information system (HRIS), eHMIS/PHEM, geographic information systems, and a mHealth solution for community health.

However, my research role would soon take a back seat as the scale-up of the eHMIS/PHEM became a primary focus for the NGO. The Tigray region had been planned to be the first regional implementation after Addis Ababa. With weeks on the job and still familiarizing myself with the project and my colleagues, I was to travel to Mekelle, Tigray with 15 other NGO staff. We were to provide trainings and implement the eHMIS/PHEM at 60 sites in the Tigray region. Additionally, prior to the trip, I was instructed by the management to carry out a baseline survey of end-users during the training. As I look back on my experiences in the NGO, this would be the only research-related activity I would undertake as the continued scale-up of the eHMIS/PHEM demanded the full effort of the NGO's staff.

While in Mekelle, I was thrown in the deep end right away. As the team was conducting trainings, I was assigned the task of planning the logistics of the implementation together with regional HMIS managers. This would be more complicated than initially anticipated. Without maps of roads and no precise idea of distances from one site to another, we had to talk to participants from the districts and do some guesswork to determine the estimated distances, best sequence of sites to visit and the most ideal towns where the team could layover. For me, this would also be my first field trip to rural sites with this project. I was paired with an NGO staff and with two regional staff with whom we would implement the system at nine health institutions (trip outlined in Figure 5).

Order of visit	Day	Woreda/Hospital	Distance	From	Base	Initial Travel day(s)
1a	Day 1	Ayder Hospital	0km	Mekelle	Mekelle	0
1b	Day 1	Mekelle Hospital	0km	Mekelle		
2a	Day 2	Mekelle City	0km	Mekelle		
2b	Day 2	HEWO Hospital	10km	Mekelle		
3a	Day 3	Enderta	10km	Mekelle		
3b	Day 3	Quiha Hospital	10km	Mekelle		
4	Day 4	Hintalo Wejerat	30km	Mekelle		
5	Day 5	Degua Tenben	45km	Mekelle		
6	Day 6	Seharti Samre	45km	Mekelle		

Figure 6: Tigray system upgrade trip plan

Although there would be many more field trips like this to come, most of my time in the eHMIS/PHEM project was spent in the NGO's offices located in Addis Ababa. Majority of my work there involved attending regular meetings with the NGO's management as part of the preparation and planning phase

for implementations. This involved gathering information on the implementation sites including: facility names and hierarchy list, and the availability of electricity, network coverage, and designated data clerks. This information was necessary for a number of reasons including: populating the eHMIS/PHEM with the right facility names and reporting hierarchies, for identifying sites with electricity for implementation, and determining which facility staff to invite for trainings.

There were also various post-implementation tasks I was delegated with. I was responsible for the follow-up of region-based NGO staff whose bi-weekly reports I would compile and report to my managers. These reports included information about tasks carried out in the region’s health institutions related to logged issues, troubleshooting, technical assistance and other support activities. These reports were useful for informing the system’s progress in various regions.

As outlined above, one of the key venues of participant observation was field visits, where I spent numerous hours on the road and at remote cities with NGO and regional staff. These were valuable opportunities to talk openly about office politics, the project’s status and challenges. These interactions offered insight on the viewpoints of local staff about the NGO, the project and the eHMIS/PHEM system. It also allowed me to experience the various practical challenges first-hand. Although difficult to innumerate, over the course of my involvement in the project I have taken part in over a dozen field trips with an estimate total of three months in the field with visits to over 90 health institutions across three regions. An overview of my involvement in key field trips is provided in Table 2.

Table 2. Key Field Visits (Implementations, support & trainings)			
Place/Sites	Time/Duration	Activities/Role	Actors Involved
Tigray Region (9 sites in Mekelle area)	March 2012 (2 weeks)	Week 1: training HMIS officers (training assistance) Week 2: eHMIS implementation (planning & on-site support)	<ul style="list-style-type: none"> • Regional HMIS staff • District & hospital data clerks • NGO staff
Amhara Region (6 sites in Bahir Dar & Adet cities)	September 2012 (2 week)	Annual review meeting site preparation	<ul style="list-style-type: none"> • Health centre heads & data clerks • Community health workers
Amhara Region (19 sites in 4 zones)	December 2012 (2.5 weeks)	eHMIS troubleshooting & upgrade	<ul style="list-style-type: none"> • District, health centre & hospital data clerks • One regional HMIS/IT officer
Amhara Region (Bahir Dar)	June 2012 (1 week)	eHMIS & PHEM training (trainer)	<ul style="list-style-type: none"> • Zone & regional disease surveillance officers • EHNRI staff • NGO staff
Tigray Region (10 sites)	August 2012 (2 weeks)	Malaria hot spot eHMIS/PHEM implementation (planning & on-site support)	<ul style="list-style-type: none"> • Regional HMIS managers • Regional HMIS officer • District & hospital data clerks • NGO staff
Amhara Region (Bahir Dar)	January 2013 (2 weeks)	Two rounds of eHMIS training (trainer)	<ul style="list-style-type: none"> • Zone, district, & health centre data clerks • NGO staff

In additionally to field trips, I was also involved in various meetings with both government and NGO staff as a coordinator of the implementation activities. Meeting with local government primarily took place with regional HMIS managers and teams. These meetings involved pre-implementation planning and logistics (i.e. scheduling, sites assessments, transport, staff, etc.). Meetings with FMOH officials were less frequent and were focused on large scale deployment planning, presentations and discussing project status updates. An overview of my involvement in various meetings is provided in Table 3.

Table 3. Key meetings attended			
Place	Date	Topics	Actors Involved
Mekelle, Tigray (RHB)	March 20, 2012	eHMIS regional deployment update meeting	<ul style="list-style-type: none"> • Tigray Region HMIS managers • NGO staff
Bahir Dar, Amhara (RHB)	April 18, 2012	eHMIS regional deployment strategy	<ul style="list-style-type: none"> • Amhara Region HMIS managers • NGO staff
Addis Ababa (EHNRI)	July 10, 2012	PHEM software requirement solicitation meeting	<ul style="list-style-type: none"> • EHNRI manager • NGO staff
Addis Ababa (FMOH)	July 24, 2012	FMOH eHMIS/PHEM malaria hotspot implementation planning meeting	<ul style="list-style-type: none"> • FMOH & EHNRI managers • NGO managers
Mekelle, Tigray (RHB)	Week of August 19, 2012 (multiple meetings)	Negotiations and conflict resolution between RHB and NGO manager	<ul style="list-style-type: none"> • RHB HMIS managers • RHB head • NGO staff

Overall, my involvement in this project has provided me with a multifaceted perspective including collaboration and interactions (formally and informally) with a range of stakeholders in the Ethiopian Federal Ministry of Health (FMOH), regional health bureaus, districts and health facilities. Below I share two vignettes from two field trips that shed more light on my experiences and the practical issues of IT implementation in this context.

Vignette 1: The Amhara Expedition

It was January 2013 and an unusually large number of system malfunctions were reported by the Amhara Health Bureau regional staff. Prior to this, an initial scale up of the eHMIS/PHEM had been carried out at 163 health institutions in the Amhara region. However, within weeks after implementation, various software issues at 95 health institutions were identified. A fellow NGO staff and I were asked to go to Bahir Dar (headquarters of the Amhara Regional Health Bureau). From there, we were to split into two teams, each of us partnering with a regional HMIS staff to troubleshoot the issues.

After the day drive to Bahir Dar, we met with the region's HMIS management and devised a plan of action. Since we only had one car, the region had to also designate a car for the trip. The effort proved demanding for the region since they had to not only find a car for a period of a week, but they also had to cover costs for fuel and per diems for the chauffeur and the region's technical staff. Despite early challenges, a car was finally assigned and the finances were finalized.

The morning of our departure, the region's car and an IT officer of the region met me outside my hotel. We would spend the following week together traveling to a planned 40 sites located in 4 zones covering over 1,000km in often difficult terrain. We were able to plan our trip so that we could spend a few nights in Bahir Dar while making day trips to closer health facilities. As we ventured out to farther areas, we had to spend nights in Debreabor, Gondar and Simada.



Figure 7: Managing difficult terrain in Amhara region for eHMIS/PHEM troubleshooting

On one of the trips to a small town called Simada in South Gondar Zone, the terrain would prove to be too much for the car. The region's car was a Toyota Land Cruiser which had seen better days. The dashboard shook whenever a certain speed was exceeded and dust entered through the floor forcing us to cover our mouth and nose with 'netela' (traditional scarfs). However, as we were approaching Simada, it would be both front tires that would succumb to the conditions. With only one spare, we had to contact the district and wait for their assistance. The ordeal took over four hours and with nightfall we decided to spend the night in the small town.



Figure 8: Stranded with two flat tires on the road to Simada district

In addition to these circumstances, on a few occasions we were lost and had difficulty finding the sites, while in other instances individuals who had keys to the offices where the computers were located were not on site. By the end of the trip we were able to manage visiting about 30 sites. Of the 95 health institutions who reported issues, majority (56 of the 95) were related to a reoccurring “database not found” error, requiring a reinstall of the system. Installer files were only given to the regional bureau and not to peripheral health institutions, therefore these issues had to be addressed on site. Additionally, 25 problems related to location/hierarchy setting (including adding facilities under district’s jurisdiction, which staff did not have user rights to do), 12 password and log-in related issues, 8 miscellaneous issues related to formatting, RAM module problem, power supply/board failure, and two SQL database merging errors.

Overall, dealing with technical issues on the ground, spending long hours on the road, managing difficult terrain and unforeseen circumstances allowed access to a raw experience on the realities of implementing and maintaining IT systems in this context. It was also an opportunity to openly discuss the project with both NGO and regional colleagues allowing for a candid exchange. For instance, given the difficulties of this trip, a major concern that came up by the region’s HMIS staff was how such a process could be sustained. Furthermore, the interaction with numerous local staff from zonal, district and health centre heads and data clerks during such trips were very informative as most saw a visit by an NGO and regional staff as an opportunity to voice their challenges, suggestions and their overall opinion about the system and the way it is being implemented.

Vignette 2: Dealing with Disagreements in Tigray

In August of 2012, an important incident in Mekelle, Tigray would prove to be an important turning point for my involvement in the eHMIS/PHEM project. In the months prior to the trip to Mekelle, I had been busy working with colleagues preparing for a rapid malaria hot-spot implementation initiative across the country.

Earlier, in July of 2012, just prior to the malaria season in Ethiopia, a rapid implementation of the eHMIS/PHEM system was planned for selected health institutions. The purpose of the implementation was to equip selected health facilities with the electronic PHEM system enabling them to collect and disseminate timely malaria information to key stakeholders, hence facilitating rapid response to malaria outbreak. The implementation was planned in malaria hotspot districts and health centers identified by FMOH/EHNRI in five regional states of Ethiopia, namely; Tigray, Amhara, Oromia, SNNPR and Benishangul-Gumuz. An ambitious big-bang implementation effort over a two-month period was planned targeting the implementation of the system in 346 health institutions dispersed across the five regions (Figure 8) and requiring the training of approximately 1,067 end-users

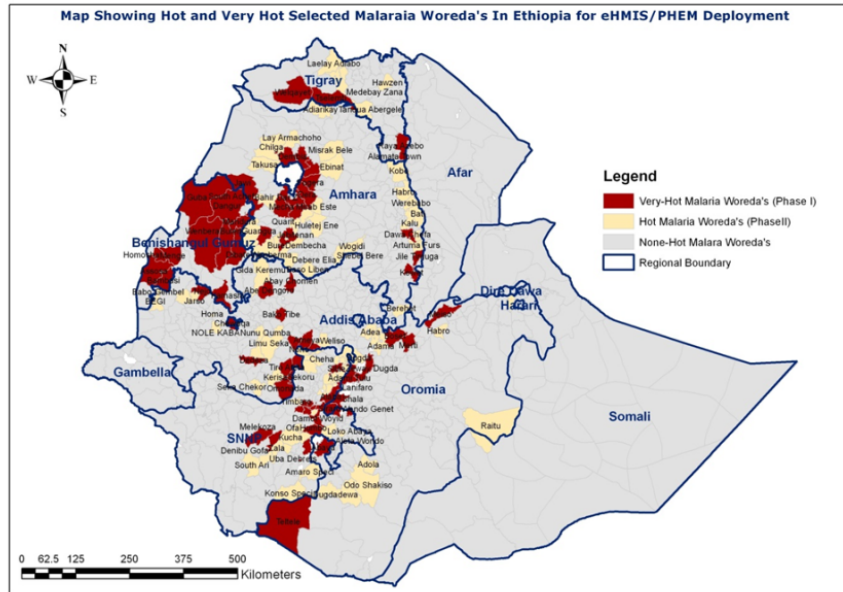


Figure 9: Map of malaria hotspot eHMIS/PHEM implementation

Prior to the Tigray trip, two other colleagues and I were called into the director’s office. We were given careful instruction about a sensitive situation that had emerged with management of the Tigray regional health bureau. The region’s HMIS managers had grievances about a set of change requests that had been ignored by the NGO. Not knowing the full extent of the situation, we were instructed to meet with the managers and inform them of the upgraded eHMIS/PHEM system before installing it on all the region’s HMIS computers. The NGO management assumed this would be sufficient to address the region’s concerns so that the malaria hotspot implementation could proceed. Accordingly, part of the team were to proceed with providing training on the PHEM component before travelling to implement the system at the malaria hotspot implementation at 4 districts, 5 hospitals and 26 health centres.

With this plan in mind, we boarded a flight to Mekelle for what was to be a busy couple of weeks. Having arrived at the region’s office, we met with the region’s HMIS managers. One of NGO’s staff presented the updated version of the system to the region, outlining the key changes. The updated version was then to be installed on all HMIS computers at the region’s office. However, the region insisted that the upgraded version of the eHMIS be installed at the 46 districts and 14 hospitals where the previous version had been implemented.

During this meeting, the team also learned that the region was not aware of the planned malaria hot-spot PHEM implementation. In addition to being uninformed and uninvolved in the decisions to implement in selected malaria sites, the region’s management had an overall frustration with the way the eHMIS systems had been ignored after its initial implementation in March of 2012. This issue was further exacerbated by the way a recent meeting between the regional managers and the NGO’s top management had played out. In light of these issues, the region voiced their frustration and declined to go forward with the malaria hot-spot implementation.

The situation would take an even worse twist as this decision by the region was communicated to the NGO's management, who took the matter directly to the FMOH. The issue had escalated and ensued in what would be a highly charged set of negotiations lasting a number of days. For me and the rest of the NGO team on site, it was a difficult set of circumstances as we were being used as proxy to communicate with the region. At no point did the NGO management step in to communicate directly with the regional staff.

The NGO's strategy to leverage on their connection with key FMOH staff to push the malaria implementation and to forgo the software updates in the region would eventually backfire. This backdoor effort by the NGO created a very charged set of interactions between us and the region's management. The issue would eventually reach the head of the regional health bureau who called a meeting between the region's HMIS managers and the NGO team. For me, the region was justified for taking the stand it took. I voiced these sentiments when asked by the region's director. Despite this, no friends would be won through this ordeal and my standing with the NGOs management would also change after this trip.

Finally, the region ultimately gave the NGO an ultimatum; implement the eHMIS upgrade or cease all work with the region. As the midnight deadline for an answer was approaching, my colleagues and I sat in the lobby of Axum hotel awaiting a response from the NGO management. The answer would eventually come at the last hour. The NGO's management decided to comply with the region and halt the malaria hotspot implementation in the region. Following this, two NGO staff and I were to spend the next week upgrading the systems at the 60 health institutions in the region.

Interviews

The second data collection method was semi-structured interviews conducted between January and March 2016 in Ethiopia. A total of 13 informants were interviewed: one from a major donor organization, six NGO staff, four from local government organizations and two from a multilateral organization. Getting participants proved to be more challenging than I had initially anticipated. Particularly, a number of FMOH and EHNRI staff did not respond to requests for an interview. I also visited one regional health bureau to meet with the HMIS head in order to set up interviews with staff. However, a request for interview of the staff was denied. The individual voiced his concern with researchers entering, studying and recklessly writing about local contexts for their professional gain. Some NGO staff who were recruited for interviews were also reluctant to participate, as this was viewed as potentially compromising their position in the NGO.

Despite these challenges, participants were selected based on a combination of convenience and purposive sampling strategy. Participants were selected based on their involvement and familiarity with the case, their knowledge of the HIS and eHealth domain in Ethiopia, their working experience with government and NGOs, and their overall experience and capacity to provide rich information and deep insight about the issues surrounding IT-based development projects (Patton, 2002). Accordingly, NGO staff, government staff and donor representatives were recruited for participation. Interview notes were used to capture the data from the interviews as some participants declined to be recorded. Recorded

interviews were transcribed. Interview notes and transcripts were broadly thermalized in order to inform case narrative and analysis.

Document review

The third data source included document reviews. Summary notes were made on pertinent areas of the selected documents. Additionally, these documents served to validate interpretations made throughout the data analysis process. Two sets of documents were reviewed.

First, project documents were used, which included: meeting/workshop minutes, project status update reports, issue logs, and statements of work. Project status updates reports provided detailed documentation of the system's implementation status and activities carried out in the regions. These were documented by NGO staff who were seconded to regional offices or who simply had the responsibility of supporting particular regions. These reports included information on the eHMIS/PHEM support, troubleshooting and implementation activities, trainings conducted, assessments completed, challenges and planned activities. On the other hand, issue logs provided information on various reported software/hardware issues and bugs. This included the issue description, what institution the issue was logged by, and the issues status and resolution.

The second set of documents reviewed were high level strategic and assessment reports. These include national implementation strategy documents and pertinent assessment reports of the HIS initiative in Ethiopia. A complete list of documents used and their specific input to the study is provided in Appendix 1.

Survey

Lastly, a pre-implementation survey of end-users was also conducted in the Tigray region. Prior to the eHMIS/PHEM deployment at 46 districts and 14 hospitals in the Tigray region of Ethiopia, training was provided to 69 users from WorHOs, hospitals and Tigray RHB. Of these, 59 participated in the survey, consisting of 38 data encoders or HMIS focal staff, 10 district planning staff, 1 Nurse, 2 IT staff, and 8 HMIS and ICT staff from the RHB. There was no sampling procedure as all identified users were invited to complete the survey. However, ten users from four WorHOs did not complete the survey. The survey form is included in Appendix 2.

4.3.2. Data Analysis

Although this thesis is based on four papers, it draws heavily on Paper 1 for its framing and conceptualization, which is based on a critical realist perspective. Accordingly, the data analysis of the thesis also draws heavily on the approaches adopted in Paper 1. The data analysis was generally grounded in a critical realist analysis approach (Easton, 2010; Sayer, 2000). More specifically, the steps and principles for critical realist data analysis proposed by Bygstad and Munkvold (2011) was used to guide the analysis (see Table 4).

The first stage of the analysis involved preparation of the data for analysis. Accounts of the case were extracted from various sources by writing notes from my field experience, summarizing interviews, and

developing short summaries of documents that informed the case (Sayer, 2000). Based on these texts, this stage was essential for producing an initial narrative of the case and allowed the condensing of the data into brief summaries organized around key events. No explicitly defined coding schema was used at this stage as the main objective was to develop an exploratory and descriptive account of the key events in the case.

The second stage of analysis involved repackaging and re-description of the data. Drawing on Miles and Huberman (1994), this involved identifying themes and trends in the data in order to move from a descriptive to a conceptual level. Initially, a conceptual approach had to be identified that could provide an organizing schema and a relevant framing for the case. Given the conceptual focus on how particular structure-agency interplays influence the transformational change in the digitalization process, the morphogenetic cycle (Archer, 1995) was identified as a useful theoretical underpinning. Accordingly, the unfolding of events in the digitalization phenomenon was categorized according to the three temporal phases of the morphogenetic cycle (see Section 6.1).

Additionally, as part of the process of identifying patterns and proposing explanation, the study focus was to identify key generative mechanisms. Building on Archer (1995), the three types of mechanisms which correspond to structural, cultural and people emergent properties (i.e. SEPs, CEPS & PEPs) provided a general guidance of where to begin. Drawing on the conceptual framework, I set out to identify the generative mechanisms that provide explanation of immediate outcomes at each phases of the morphogenetic cycle.

The identification of individual mechanisms was carried out through an iterative process where different series of analysis were pursued for each type of mechanism. For the structure/culture (contextual) mechanisms, the two key structural conditions (i.e. governance arrangements and architectural constellation) set the boundary for the types of mechanisms I wanted to focus on.

At the first phase of the morphogenic cycle (i.e. structural conditioning), two reoccurring themes emerged from the data: (i) the imbalanced arrangements of power, resources and activities between the NGO and government throughout the digitalization project, and (ii) an unwavering commitment to digitalization despite a complex set of enduring challenges. Drawing on these overarching themes, I set out to examine what it was about the structural/cultural conditions and the nature of state-NGO collaboration that produced and sustained these two themes. In other words, what was it about the configuration of relational entities of these structures that caused the observed phenomenon in the data?

To distinguish these relational entities, a process of retroduction was employed. First, low-level outcomes which correspond to the two themes were identified. These immediate outcomes were then consolidated into a high-level outcome. Following this, sets of internal and necessary relations among entities (i.e. material, ideal, artefactual & social) whose presence were necessary to trigger the observed low-level outcomes were then deliberated on drawing on the data. Put simply, I set out to understand what kind of arrangements between project personnel, teams, organizations, resources and artifacts (i.e. manual and digital) had to be present in order to bring about the low-level outcomes.

Lastly, stimulating and releasing conditions were identified by examining their influence on the identified relational entities. According to Bygstad, et al. (2015, p. 7) “stimulating conditions are typically organizational arrangements that make it easier to act. Releasing conditions are often specific decisions”. For the context mechanisms (i.e. SEPs & CEPs), stimulating and releasing conditions were properties directly related to the HIS governance arrangement and architectural constellation in Ethiopia.

The steps pursued in uncovering action mechanisms (i.e. PEPs) were similar to the contextual mechanisms outlined above, but with two distinctions. First, the analysis of action mechanisms was informed by the social interface analysis (Paper 2). This in-depth analysis of interactional dynamics in the project provided clarity on the social and technical dynamics in the project. Secondly, there was a difference in how stimulating and releasing condition were identified for action mechanisms (i.e. PEPs). Here, stimulating and releasing conditions that were influenced by the outcomes of other mechanisms were accounted for in the analysis. This was done in order to identify potential links among mechanism and to develop an analytical narrative of the digitalization process.

Table 4. Data Analysis Process	
Stage	Activity/Outcome
1. Description of events and issues	<ul style="list-style-type: none"> • Chronological account of HMIS digitalization • Description of key events in the digitalization process developed and categorized into three distinct phases based on Archer (1995) (Section 6.1)
2. Identification of key entities	<ul style="list-style-type: none"> • Key entities (i.e. actors, organization, artifacts) identified informed by the theoretical focus and drawing on observation and interview data.
3. Theoretical re-description (abduction)	<ul style="list-style-type: none"> • How structure-agency interplays unfolded to influence the digitalization process identified as a key theoretical focus • Morphogenetic approach used as the main theoretical underpinning to describe the case (Archer, 1995)
4. Retroduction: Identification of generative mechanisms	
a. Identification of immediate outcomes	<ul style="list-style-type: none"> • High and low-level outcomes of digitalization identified for each phases of the morphogenetic cycle
b. Analysis of interplay among key entities	<ul style="list-style-type: none"> • Dynamics among human and material/artefactual entities examined based on critical realist perspectives (Fleetwood, 2014; Mutch, 2010).
c. Identification of stimulating and releasing conditions	<ul style="list-style-type: none"> • Sets of structural and cultural conditions identified and assessed for their stimulating and releasing effects on relational entities (i.e. material, ideal, artefactual and social).
5. Analysis of selected mechanisms	<ul style="list-style-type: none"> • Candidate mechanisms and their relational entities identified for each phases of the morphogenetic cycle (Archer, 1995) • Developed explanation of the causal process based on the interaction and dependency among interrelated entities and ensuing immediate outcomes
6. Assessment of explanatory power	<ul style="list-style-type: none"> • Empirical corroboration conducted to select the mechanism with the strongest explanatory power for the observed digitalization events and outcomes

Overall, mechanisms that correspond to one of the three emergent properties – structural, cultural and people’s (SEPs, CEPs and PEPs) were identified. Each mechanism is explained by its stimulating and releasing conditions (C), its internal relational entities (E), and its low-level and high-level outcomes (O) (see Figure 10). As mentioned, associations among mechanisms were accounted for by examining the extent to which the outcome of an actualized mechanism was an input to another mechanism.

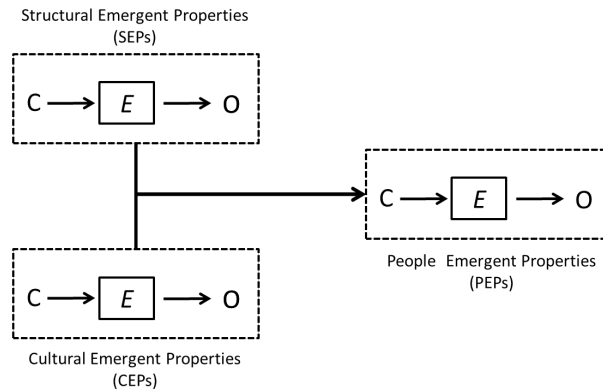


Figure 10: Conjuncture of mechanisms

Together, this step-wise process provided an explanatory narrative that uncovered sets of interrelated mechanisms. Additionally, the pre-framing of the mechanisms according to the tri-part stages of the morphogenetic cycles helped group the analysis into distinct manageable episodes.

4.4. Ethical Considerations and Limitations

With the use of the autoethnographic approach, there are a number of ethical issues and limitation that are worth touching on. The implication of participants in research is an issue that confronts every researcher. However, relational ethics is especially amplified for autoethnographers (Ellis, et al., 2011). Because such research involves the use of personal experience, autoethnographers can implicate not only themselves but also close colleagues or friends. In my research, maintaining the anonymity of former colleagues who are participants in my research has made relational ethics complicated since these are not just informants that are purely recruited for data.

In light of this, the privacy of participants in my research has been protected by avoiding details that identify certain participants. However, this has not always been possible. Although I have attempted to mask the identity and position of a particular group or individual by not identifying their name, gender or specific title, they might be implicated by the mention of a particular set of events, location, organization or department. On the other hand, these protective measures can also influence the integrity of the research and how the work is understood (Ellis et al., 2011). Despite this balancing act, I have been careful and mindful of these ethical issues as they have been crucial concerns throughout my research. Any information that may compromise the well-being of any individual has not been included in this study.

Secondly, the issue of informed consent is one that is challenging in both autoethnographic and ethnographic studies. The research has received ethical clearance with the Norwegian Social Science Data Services (Ref. 45492) and interviews were carried out with consenting participants. However, consent from the NGO was not solicited in light of the fact that any information that does not depict the organization in a positive light would be barred from being shared. Given these issues, consent formalities with regulatory regimes in Ethiopia would undermine the contribution of this research to the creation of more emancipatory and effective development ends in the research context. The critical

perspectives promoted by Walsham, et al. (2007) which calls for ICT4D research to shed more light on the political dimension of development projects are likely to also confront these dilemmas.

Case Description

5.1. Country background

The digitalization case took place in Ethiopia; the second-most populous country in Africa with a population of 99.4 million (World-Bank, 2016). Over the past decade, the country has experienced one of the fastest growing economies in the world and aims to become a lower-middle income country by 2025. Economic growth has averaged 10.8% over the past decade compared to the regional average of 5.4% (World Bank, 2016).

In light of these developments, the implementation of the government's Growth and Transformation Plan (GTP) has seen extensive investments in physical infrastructure. The country's GTP, which is in its second phase (2015/16 – 2019/20), aims to continue development of physical infrastructure and transform the country into a manufacturing center in the region (World Bank, 2016). This development boom is most visible in the capital Addis Ababa where the frantic development of roads, highways and numerous high rise buildings is a small indication of the push for infrastructural development. ICT uptake is also growing with a budding private IT sector and increased adoption of e-government.

However, there remain numerous development challenges in relation to continued poverty, job creation in a crowded labor market and good governance. The continued influx of large-scale donor support aims to address these challenges in order to ensure sustained positive economic growth. Ethiopia is also working towards achieving the Sustainable Development Goals (World-Bank, 2016). In previous years, great strides have been made by the country towards achieving the Millennium Development Goals (MDGs) by cutting in half child mortality, quadrupling primary school enrollments, doubling the number of people with access to clean water to name a few (FMOH, 2010; World Bank, 2016).

5.2. The case

This paper examines a case of a digitalization initiative called the eHMIS/PHEM (Electronic Health Management Information Systems/Public Health Emergency Management). The eHMIS/PHEM is the first nation-wide ICT implementation of its kind in the Ethiopian health sector. The system was developed by a donor-funded international organization; hereafter referred to simply as NGO. The eHMIS/PHEM is a core system in the Ethiopian Federal Ministry of Health's (FMOH) effort to digitalize various health services in the country.

5.2.1. The eHMIS/PHEM System

The eHMIS/PHEM system was designed as a standalone system that operates on local machines that work offline. It supports two primary functions: HMIS and disease surveillance. The eHMIS component is the electronic equivalent of the indicators and paper reporting format of the HMIS that enables health

institutions to electronically aggregate, analyze and submit data to higher level institutions. The eHMIS consists of a set of morbidity, mortality and service delivery indicators that are compiled into reports at health facilities. The HMIS component is overseen by Policy, Plan and Finance Directorate at the FMOH and the HMIS units at RHBs.

PHEM, on the other hand, is the national routine disease surveillance system which aims to ensure nationally coordinated, comprehensive surveillance and response to the outbreak of contagious disease. It is overseen by the Ethiopian Health and Nutrition Research Institute (EHNRI); the arm of the FMOH responsible for managing disease surveillance among other tasks. PHEM addresses disease surveillance of immediately notifiable infectious disease (e.g. Ebola, cholera, yellow fever) while the HMIS deals with routine health data. PHEM includes 20 (13 daily and 7 weekly) reportable diseases. Essential activities within PHEM include disease detection, reporting, analysis, response, monitoring and preparedness. The system incorporates both the eHMIS and PHEM domain areas into separate systems packaged into a single software.

System design and development (2009-2011)

The eHMIS/PHEM project was initiated in 2009 after an initial assessment of other systems in the region by the NGO. Following the assessment, the NGO decided to develop a system in-house in order to meet the unique demands of Ethiopia. A technical team consisting of mostly local developers were hired by the NGO to carry out the development. The team also consisted of public health professionals, technical staff (e.g. network engineers) and an implementation team. The design strategy and development of the eHMIS/PHEM primarily consisted of requirements-driven software development and a prototyping/pilot phase. By 2011, an initial prototype was completed and a pilot of the system was carried out in three zones in the Oromia region (13 districts, 15 health centers, 2 hospitals).

In the eHMIS/PHEM design process, broader structural conditions have influenced the system's features. First, at the level of data structure, certain structural properties of the Ethiopian HMIS architectural constellation find materiality in the technology. The most evident is the core HMIS data sets and indicators which make up the core content of the eHMIS/PHEM. Secondly, organizational governance configurations (Figure 3) were also inscribed into the data structure of the technology. User roles and access rights were designated in the system to delineate who can view, edit and submit data based on their facility level in the hierarchy.

Thirdly, structural conditions at the time of development have also influenced the system's design. The eHMIS/PHEM is a stand-alone application, installed on individual workstations. The stand-alone design decision was influenced by the infrastructural challenges existing during the time of development (2009) when network coverage across numerous rural health facilities in Ethiopia was limited. To remedy this challenge, the NGO opted for a non-web based application that would allow offline data entry and collation. Reports are submitted and received electronically each month through the system's internal e-mail feature by means of any available communication infrastructures including Code Division Multiple Access 2000 (CDMA2000), dialup, and broadband. Data can also be exported via removable media such as USB flash disk and CD where Internet connectivity is not available.

In designing a standalone application, the inclusion of a technological feature to accommodate a structural condition of a particular period has been made durable in the material properties of the technology. Examined more closely later, this has posed various challenges and has also limited the exploitation of specific properties of the technology.

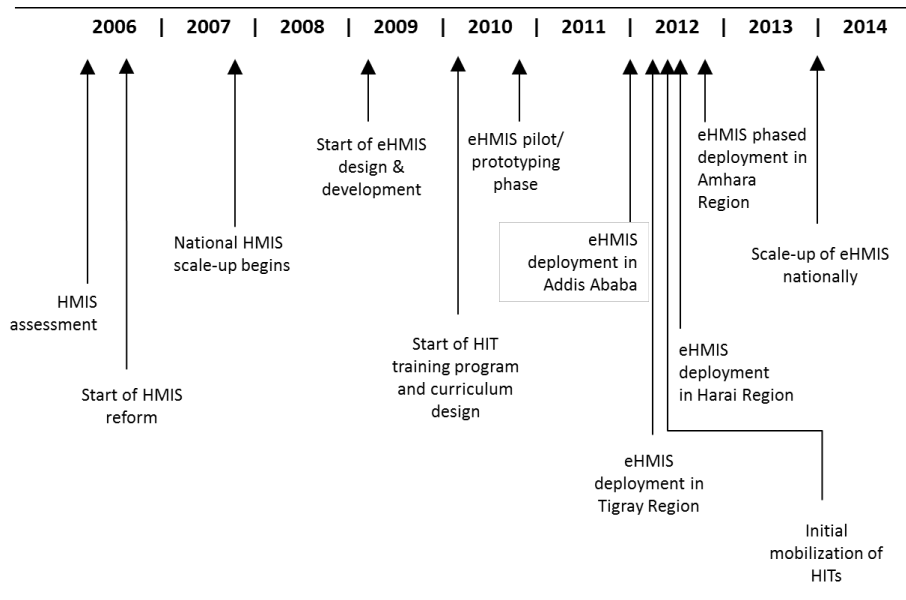


Figure 11: Timeline of the Ethiopian HMIS/PHEM digitalization

Development and implementation (2012-2015)

In 2012 an initial scale-up of eHMIS/PHEM began and by 2013 implementations had been carried out in four regions: Addis Ababa (51 sites), Tigray (60 sites), Harari (20 sites) and Amhara (163 sites). By 2015, following rapid implementation efforts, the system was reported to be implemented at 2,700 health institutions across the country.

Despite the seemingly successful scaling of the system, there were a number of challenges in the project. The scaling of the system has been sporadic with some regions making significant progress (e.g. 100% implementation at districts and hospitals in Tigray, Harrari, Addis Ababa) while other regions lag behind. Given the infrastructural context, the digitalization effort has also been confronted by deep structural challenges such as the infrastructure (i.e. poor Internet and electricity coverage) and local financial commitment and constraints to cover ongoing costs.

Some of the enduring challenges are also attributed to the system’s design. The eHMIS/PHEM’s underlying architecture was not easily malleable to facilitate changes or expansions to its core functional components. The system’s architecture was also not robust enough to accommodate emerging data sets, reporting requirements, and new demands from district based planning (i.e. Woreda based planning) or other programs. Additionally, the non-web based design has hindered prompt and regular upgrades. The manual upgrade process was time consuming, costly and prone to bureaucratic delays.

Additionally, poor versioning procedures were also evident due to the mandate from NGO managers to assign the same version number to the latest version of the eHMIS/PHEM, with the aim of endorsing a completed system and discouraging further demand for upgrades. This resulted in poor version management and disorganization with regards to keeping track of which versions were implemented at the various health institutions.

The system development process was informally managed without a designated project manager or a clear development or project management methodology. As a result, despite a lengthy prototyping period, little change had been incorporated to improve the system. The lack of local input and inadequate pilot testing later created a number of setbacks for the project. Following initial scale-up, numerous bugs and functional issues emerged that had to be addressed. Only then did the NGO hire testers to follow-up on logged issues. This delayed the project's national scale-up due to the demands of frequent modifications and version upgrades.

These fundamental management gaps also produced a number of issues with regards to amalgamation of the eHMIS and PHEM. First, at higher level health institutions (i.e. region and national) where the HMIS and PHEM are distinct departments, it created business process issues with the two departments working under varied business logic and objectives. Secondly, PHEM deals with extremely sensitive data that has major public health implications related to disease outbreak. The openness of this data to a broad set of HMIS staff raised concerns among PHEM staff. Perhaps importantly, the merger of the eHMIS and PHEM has marginalized the PHEM system. For the Ethiopian Health and Nutrition Research Institute (EHNRI), the organization that overlooks PHEM activities, its requirements were overshadowed by the predominant HMIS. This was apparent in the pilot phase and subsequent implementations in Addis Ababa, Tigray, Harari and Amhara where the PHEM system was implemented alongside the eHMIS but not operationalized.

Additionally, the PHEM system partially fulfilled the core functional requirements of disease surveillance activities and EHNRI. For instance, basic reporting formats were not added including: daily epidemic report for districts and regions, line list for reporting from health facility to district, zone, region or national levels or in the event of outbreaks. The geographic information system (GIS) feature of the PHEM which is crucial for geographically pinpointing specific outbreak cases was also not functional due to missing GIS data (shapefiles), which allow plotting of designated patient addresses in the case-based data entry feature of the PHEM system. In addition, although PHEM allowed submission of individual case-based data, it provided no tallying or line-listing functionality for the recipient organization which makes its use problematic. Lastly, disease surveillance as a business process is heavily dependent on data analytics which necessitates adequate data visualization or dashboard functionalities which were not included in the PHEM system. Overall, the broad set of public health emergencies that range from recurrent epidemics, emergent infections, nutritional emergencies, chemical spills, and bioterrorism use a multifaceted set of recording, reporting and analysis tools that demands a separate software.

Organizational transformation

From the organizational perspective, the lack of transformation in relation to improvements in local IT capacity and capabilities for data management, quality assessment and data use are not evident yet. These challenges were especially evident during the scale-up of the eHMIS/PHEM where implementers discovered facilities without focal HMIS staff and knowledge gaps among users on the HMIS making it difficult for them to adequately use the system.

For instance, in the Tigray region, of the 46 districts, only 35% had designated full-time data clerks or HMIS staff during implementation in 2012. Among health centers, 90% (n=201) of the 223 health centers in the region did not have designated data custodians. The HMIS activities were mostly carried out on part-time basis by nurses and health officers. Additionally, many who assumed these responsibilities had not received training. As a result, various challenges ensued during data collation. For example, the validation rules embedded in the eHMIS/PHEM for indicators such as 'Antiretroviral Therapy (ART) cumulative ever started', an indicator whose value should never decrease on successive reports, caused frustration among data clerks who complained of the system not accepting the values they entered.

To mitigate these challenges, a workforce called Health Information Technicians (HIT) has been deployed across the country. The FMOH's strategic plan is to train approximately 9,000 HITs to support the HMIS across Ethiopia. A few batches of HITs have already graduated and have been placed in various health facilities. However, there continues to be high demand at peripheral health institutions. Additionally, the capacity of HITs (with 2 years training after grade 10 completion) to support their local institutions technically continues to be a concern.

However, from an IT perspective, the NGO has done little to develop the organizational capacity of the FMOH and regions to enable their self-sufficiency. Both the FMOH and regions lack qualified IT staff to support this digitalization initiative, which is to span over 4100 institutions. The underestimation and unwillingness to address fundamental institutional capacities has compromised the effectiveness of the project creating excessive reliance on the NGO.

An overview of the distribution of the key activities in the eHMIS/PHEM project is relayed in Table 5. The responsibilities shared between the NGO and local government is specified in a RACI matrix that relates each organization to the activities and deliverables with letter codes: R- Responsible: role is responsible for actually doing or completing the item, A- Accountable: role is accountable for ensuring that the item is completed. C- Consulted: role whose subject matter expertise is required in order to complete the item, and I- Informed; role that needs to be kept informed of the status of item completion. The results show the control of the NGO as a key actor responsible, consulted and accountable for most project activities.

Table 5. Distribution and responsibility of key project activities in eHMIS/PHEM

	Roles/Activities	NGO	FMOH/RHBs	Description
Technical Project Activities	Software development	R,A,C	I,C	All software development of the eHMIS/PHEM carried out by NGO developers.
	Software testing	R,A,C	I	Initially, software testers and standard testing procedures were not in place but later addressed by NGO. No involvement by FMOH.
	Software updates & version control	R,A,C	I	Exclusively carried out by NGO.
	Maintenance & support	R,A,C	I,C	NGO responsible to facilitate troubleshooting as all technical issues are direct to them. Some ongoing regional involvement in Tigray by HMIS/IT staff.
	Central server backup & maintenance	R,A,C	I	Server located at FMOH and maintained by NGO staff.
	Implementation	R,A,C	I	Regional HMIS/IT staff involved in some implementations in Amhara and Tigray. No FMOH IT staff involved in project initiation, development and implementation phases.
Management Related Project Activities	Documentation & knowledge management	R	I	Project management deliverables not documented
	Implementation planning & logistics management	R,A	I,C	Software implementation and planning led by NGO. RHB management involved in implementation planning.
	Health Information Technician (HIT) mobilization	C	R,A	HIT education, evaluation and placement carried out by RHBS and 15 Health Science Colleges under Technical and the National Vocational Education and Training program.
	Project management	R,A	I	Carried out informally by NGO. No designated IT project managers at FMOH.
	Risk/issue management	R,A,C	I,C	Various issues dealing with software handled by NGO while organizational capacity and infrastructure related issues often reported and handled by FMOH.
	Evaluating & monitoring performance	R,A	I	Lack of institutionalized business case practice for monitoring project progress and impact. Informally carried out by NGO.
	Training	R,A,C	I	Most software trainings planned and instructed by NGO staff. RHB staff provided support in some cases.

A 2013 assessment of the eHMIS/PHEM also states that there is “strong dependence” on the NGO “at all levels for a range of functions, including software, software support, infrastructure, training and others. This reduces capabilities of the health systems to become self-reliant and sustainable” (FMOH, 2013, p. 101). Given these setbacks, the digitalization initiative has done little in the way of addressing institutional gaps and in reconfiguring the techno-organizational structure of local organizations.

5.2.2. Interorganizational collaboration in digitalization

The collective decision-making in the digitalization process were mediated by a long-term and contested series of interactions and collaborations between NGO and government staff. The eHMIS/PHEM project involved a number of government and non-governmental stakeholders. These actors and their roles in the project are relayed below.

Non-government Stakeholders: The international stakeholders primarily consisted of the implementing partner (i.e. NGO), donor country office and international donor. The international donor was based in the U. S. and primarily oversaw grant projects. On the other hand, the donor country office was primarily responsible for administering the implementation of donor-funded programs in country. Both these actors' role in the project was primarily from a resource perspective. They had little technical involvement in project management and decision-making.

The eHMIS/PHEM project was primarily led by the NGO. The NGO oversaw all project activities from development to implementation and took the sole responsibility from a management, technical and resource perspective. The NGO had been in Ethiopia working in the HIS space for over 10 years. Over this period, it had become deeply embedded in HIS development efforts of the Ethiopian health sector becoming the main development partner of the FMOH. This is also attributed to the NGO's earlier involvement in the standardization of minimum data sets and reporting formats of the paper-based HMIS in early 2007.

The NGO's strong relational ties, particularly between its top managers and key FMOH officials, have been instrumental in driving its IT initiatives in Ethiopia. These strong ties at ministry level and its backing were also necessary for maneuvering local bureaucracy and for garnering continued funding from its donor. These ties between the NGO and government institutions were also strengthened by a number of influential staff the NGO had recruited from the FMOH and RHBs. These staff played an influential role during eHMIS/PHEM implementation planning and negotiation with regions. Over the years, the NGO has leveraged on its technical, resource and relational capacity to expand its mandate, renew its resource-base and gain legitimacy with the FMOH and its regional constituents.

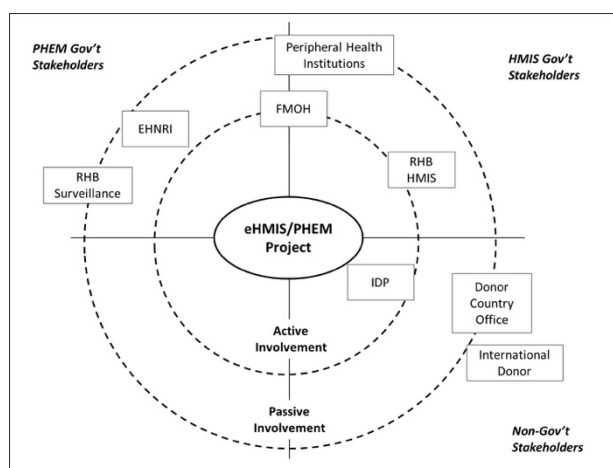


Figure 12: Various actors and their level of involvement in the eHMIS/PEHM project

Government Stakeholders: A number of government stakeholders were also involved in the eHMIS/PHEM project. These included the FMOH, RHBs, and peripheral health institutions including: zonal health departments (ZHDs), districts, hospitals and health centers. Majority of these actors consisted of peripheral health institutions that make up the main end-users but who had limited active input and involvement in the project.

Throughout the eHMIS/PHEM project, the level of collaboration between the NGO and the FMOH in project activities was negligible. The eHMIS/PHEM project was controlled by the NGO with limited information sharing and minimal participation by government stakeholders. Information exchange between the NGO and FMOH primarily took place among the NGO and FMOH top management through sporadic reports or meetings. Activities such as software development, software upgrades, maintenance/support, project management, implementation, trainings and overall project monitoring were exclusively carried out by the NGO. As a result, a strong dependence on the NGO was evident among government health institutions. A report drafted by the FMOH HMIS staff states:

Troubleshooting and maintenance support is highly dependent on experts from the collaborating partner. There are no capable personnel at RHB or sub-city level to provide troubleshooting and maintenance support... (FMOH eHMIS Supportive Supervision Report, June 2012)

All technical issues from the periphery were directly reported to the NGO with no clear line of communication articulated. The government's participation in the project mainly involved their input and collaboration during rapid scale-up planning and deployment initiatives. As a result of these arrangements, there was minimal transparency and accountability of project tasks and planned resource allocation throughout the project. As one informant reiterates:

Our primary accountability is to our donor...Information and reports provided to donor are also given to government, but I'm not sure they are looking at it.

The NGO's ad hoc involvement with different levels of the organizational hierarchy, circumventing established organizational structures, also made the eHMIS/PHEM project governance improvisational. On the other hand, governance around IT initiatives was generally weak in the Ethiopian health sector, as one informant stated:

Governance is practically zero. Governance is basically based on our judgment.

Another informant articulated the challenges of state bureaucracy and inefficiency saying:

The smallest thing takes forever... decision-making is not a strong suite of the government. Not even good decision-making but decision-making.

Additionally, cooperation in the interorganizational alliance had also become susceptible to spontaneous activities which increased the level of ambiguity in decision making and resource distribution and the possibility for conflict. To demonstrate this, I draw on a set of events in the project that took place during a malaria hotspot eHMIS/PHEM implementation.

Research Findings

Four individual papers contribute to the findings of this dissertation:

1. *Digitalization mechanisms of health management information systems in developing countries.*
2. *Navigating socio-politics and governance of ICT4D projects: A social interface analysis.*
3. *Countering the 'dam effect': the case for architecture and governance in developing country health information systems.*
4. *Governance lessons from an interorganizational health information system implementation in Ethiopia.*

In the following section, I present the findings which have been categorized according to the three phases of the morphogenetic cycle: structural condition, socio-technical interaction and structural elaboration.

6.1. Morphogenetic cycle of digitalization

6.1.1. Structural conditioning of digitalization (T1)

Accord to Archer (1995), structural conditioning corresponds to the first phase of the morphogenetic cycle. These refer to specific structures existing prior to digitalization. In accounting for these contextual conditions, the four research papers highlight different aspects of two key structural conditions: (i) governance modalities and (ii) architectural constellation.

Governance modalities

The eHMIS/PHEM digitalization process took place under two intertwined modes of governance: hierarchy and horizontal governance. The first is where various government health institutions are governed by the institutionalized arrangements of the Ethiopian health system. This is characterized by hierarchical arrangements among the government's health institutions. The hierarchical governance of the health system is a federated one, which allows health institutions (e.g. districts, zones, regions) autonomy to make administrative decisions over their designated local jurisdiction while also being overseen by higher health institutions. Interactions among health institutions are largely managed by formal structure, standardized practice and planning. Thus, the established HMIS standards (in terms of data indicator, tools, reporting procedures, district/Woreda-based planning) act as main governance and management tools in this hierarchy.

The HMIS digitalization process, although subsumed under the aforementioned governance structures, was predominantly controlled by the NGO, which operated outside the health system’s governance structure. This was because the project was contracted to the NGO by the US government and locally administered by the Center for Disease Control (CDC) country office in Ethiopia. As a result, the NGOs operational structure and funding schema was largely based on a project-based approach.

As a result of the project-based approach, the NGO’s collaboration was characterized by horizontal collaboration of the NGO with various levels of government health institutions (i.e. FMOH, regions, zones, districts). As a result, there were no formalized governance procedures in terms of distribution of decision rights, division of labor, and established approach for collaboration between the government and NGO.

At the federal level, since the FMOH did not have a formalized IT unit, IT initiatives such as the eHMIS/PHEM were loosely overseen by the Policy and Planning Directorate (PPD). The directorate leans heavily towards public health and monitoring activities. However, the lack of IT staff and IT leadership meant the FMOH’s PPD staff had limited information about the project and the status of the eHMIS/PHEM at peripheral health institutions. Additionally, their involvement in the decision-making of day to day activities was minimal. On the other hand, the regional HMIS staff were often informed and in some cases involved in the decision-making process, which often took place during pre-implementation meetings.

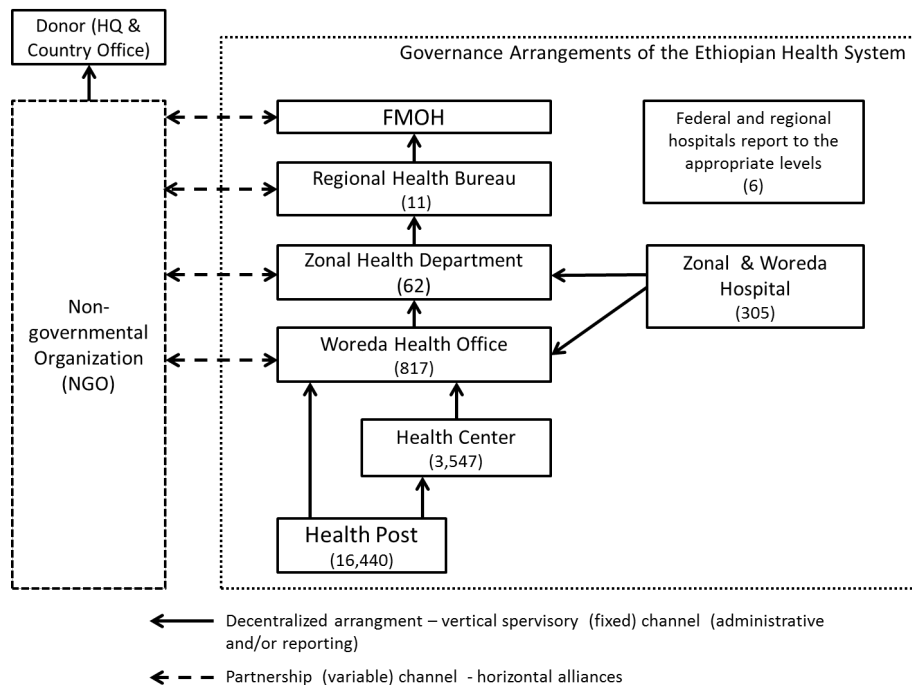


Figure 13: Governance arrangements around HIS digitalization

Overall, the governance arrangements of digitalization in Ethiopia were influenced by the development strategies of bilateral donors who fund private contractors to implement donor projects (Roodman, 2009). The ideas and values propagated by project-based approaches have not only led to the

proliferation of development projects but they have become adopted as a necessary modality of international development (Heeks & Stanforth, 2014). In light of these trends, the role of state institutions has been reduced as there seems to be no clear strategy around the governance of development projects in health.

Architectural constellation

The overall architecture of the HIS in Ethiopia was characterized by complexity and diversity of vertical programs and systems (e.g. HIV/AIDS, Malaria, etc.). However, in recent years, much effort has been devoted to the harmonization of data sets across programs, routinization of reporting procedures, and availing of resources and efforts to digitalize the paper-based HIS tools and processes. As a result, over the past decade, the architecture of the HIS has undergone major reforms in Ethiopia.

Consequently, a key structural condition for digitalization has been the preexisting architectural constellation namely, the manual (paper-based) HIS. The study found that a key attribute of the architecture was its high-volume and high-variety of data. The HMIS data covers a variety of data including: resource (e.g. HR, logistics, lab & blood bank indicators), health system (e.g. service coverage indicators), family health (e.g. reproductive health indicators), and disease prevention and control (e.g. HIV-AIDS, malaria indicators). The scale of HMIS data is also magnified by the estimated 21,389 health institutions that constitute the public health system in Ethiopia. Collectively these institutions produce about 249,292 reports annually (see Appendix 3). This has produced difficulties with collecting, tabulating, storing, analyzing and visualizing these information assets.

The challenges include the timely submission of reports, methods through which reports are submitted and the means through which higher level organization can provide peripheral facilities with timely feedback to address missing or incomplete reports. Approximately 83% (n=48) of users surveyed agreed that they had difficulty sending reports. The main method used to submit manual reports was by sending it with other people or delivering it themselves (71.2%, n=42). Other means included; electronic submission via e-mail (11.9%, n=7) and by post office (3.4%, n=2).

When asked about what districts do with compiled reports, approximately 40.4% (n=21) stated that they simply complete and send their reports and do not analyze or use their reports locally. One factor that affected information use was the countless paper reports often filed in disorganized and inaccessible ways at the districts and hospitals. This was evident during deployment of the system across the districts, as the most recent 6-month retrospective data that had to be entered at the time of deployment were inaccurately filled, incomplete and altogether missing at many districts.

Overall, these setbacks together with the scale of data and the reform of the architectural constellation, primarily through standardization and integration, raises a number of gaps that can create a demand for digitalization but which cannot be entirely addressed by it.

6.1.2. Socio-technical interaction in digitalization (T2-T3)

Socio-technical interaction is the second phase of the morphogenetic approach that deals with the actions and interactions of stakeholders involved in the digitalization of the eHMIS/PHEM. Two

interrelated activities in the socio-technical configuration include: (i) configuration of the digital artifact and (ii) confluence of social interface.

Configuration of the digital artifact

In the design and development phase of the eHMIS/PHEM, both local and broader structural conditions have influenced the system's configuration. At the level of data structure, certain structural properties of the Ethiopian HMIS and disease surveillance architectural constellation find materiality in the technology. The most evident is the core data sets and indicators which make up the core content of the eHMIS/PHEM. Additionally, organizational arrangements were inscribed into the data structure of the technology. Thus, user roles and access rights were designated in the system to delineate who can view, edit and submit data based on their facility level in the hierarchy. Lastly, structural conditions at the time of development have influenced the system's architecture. Paper 3 examines two critical software architecture decisions in the eHMIS/PHEM: merger of the eHMIS and PHEM and the standalone application architecture.

The merger of the eHMIS and PHEM systems was motivated by both logistic and economic reasons. Primarily, having a single software would minimize management, support and maintenance demands. Despite these advantages, this decision has not been without problems. Among these include the sharing of computers at peripheral sites and the openness and accessibility of sensitive disease surveillance data to HMIS staff. The merger has also marginalized the PHEM system. For the Ethiopian Health and Nutrition Research Institute (EHNRI), the organization that overlooks PHEM activities, its requirements have been overshadowed by the predominant HMIS. The relegation of the PHEM system is primarily due to the prominence of the HMIS as a key source or routine health data in the health system. The push also came from the global health community where the standardization of reports and minimum data indicators in the HMIS was seen as important steps towards health reform and the data demands from the Millennium Development Goals.

Ultimately, the merger of the two systems and the subsequent relegation of the PHEM system highlight the imbalanced distribution of decision and input rights between the FMOH, EHNRI and the NGO, where the PHEM system did not receive the same due diligence as the more publicized eHMIS. Furthermore, the decision to merge these disparate systems was not monitored to inform decision-makers of its benefits and setbacks, especially in the pilot phase of the project.

The second and perhaps more critical software architecture decision is the stand-alone design of the eHMIS/PHEM. The stand-alone design decision was influenced by the infrastructural challenges existing during the time of development (2009-10) when network coverage across numerous rural health facilities in Ethiopia was limited. To remedy this challenge, the NGO opted for a non-web based application that would allow offline data entry and collation. Reports would be submitted and received electronically each month through the system's internal e-mail feature by means of any available communication infrastructures including Code Division Multiple Access 2000 (CDMA2000), dialup, and broadband. Data could also be exported via removable media such as USB flash disk and CD where Internet connectivity was not available. In developing a standalone application, the design decision to accommodate a structural condition of a particular period has been made durable in the material

properties of the technology. This decision has posed a great challenge in the digitalization effort as highlighted by the demanding and costly process of system implementation, upgrade and troubleshooting.

Further to the standalone feature, Paper 1 highlights three key properties of the eHMIS/PHEM including: programmability, addressability, and communicability. With regards to *programmability*, the system's overall architecture was not easily malleable to facilitate changes or expansions to its core functional components. In term of *addressability*, the eHMIS/PHEM had a way of uniquely identifying each institution. However, it was inadequate in the degree to which each eHMIS/PHEM installation could be uniquely identified in a computing architecture to allow enrollment and communicability with other digitalized artifacts. Lastly, *communicability* of the eHMIS/PHEM was found to be limited to the system, not extensible to allow submission and receipt of data with parallel systems. In light of these gaps, the eHMIS/PHEM is bound to be confronted with changing use cases and the demands for adaptability as data sets, indicators, procedures, types of health facilities, and organizational arrangements change and new requirements emerge in the ever evolving health sector.

Confluence of social interfaces

Paper 2 examines the development project practice through the analysis of social interfaces. The paper endeavour to generate deeper insights into what transpired during the eHMIS/PHEM project with particular sensitivity to the way politics was enacted in the digitalization process. In line with this, the confluence of four social interfaces (i.e. organizational, resource-based, discursive and technical interfaces) were analysed.

At the organizational interfaces of the project, a common venue for project decision-making was meetings. Some meetings were formally organized involving key FMOH personnel and NGO staff, while in other instances the NGO met only with regional staff. These meetings primarily dealt with decisions around implementation planning and logistics. However, such meetings were not the only interfaces for decision-making since decision were also informally reached behind closed doors, often through personal dialogue between NGO managers and key government staff at both the FMNOH and regional levels.

In both case, an actor's legitimacy as a decision-maker depended on their level of involvement at both the formal and informal interfaces. This is where the NGO has especially legitimized itself as a principal actor in all organizational interfaces. The NGO's legitimacy at these decision-making interfaces was achieved by three means: (i) monopolizing the technology; (ii) mobilizing brokers; and (iii) establishing relational ties. Subsequently, the IT organizational interfaces among government stakeholders were found to be weak, with the NGO playing a primary role not only as a mediator but also a key decision-maker.

The NGOS capacity to take part at decision-making interface was also made possible by the resource-based power it mobilizes at resource-based interfaces. The NGO's effective mobilization of resources largely depended on its political and economic resource potential which it has gained as a representative of macro-structures (donors) and backed by discursive means (HIS strengthening mandate). The long-

term funding of the NGO has validated its position as key resource mobilizer in Ethiopia's HIS domain. This has been a medium through which the NGO has also been able to exercised control in project activities.

Additionally, both decision-making and resource-based interfaces can be swayed by norms and beliefs discursively constructed at discursive interfaces (Buse, et al., 2009). How discursive interfaces play out depends on the discursive power espoused by influential entities (e.g. UN, WHO) and the perceived expertise others associate with them (Hein, et al., 2009). At the country level, strategy documents that mimic agendas set by global actors have played a role in influencing funding of particular initiatives. For example, the push for national HIS coordination and harmonization, as proposed by WHO's Health Metrics Network, has been adopted into Ethiopia's HIS strategic plan. In addition, the UN's resolution (WHA60.27) for the "strengthening of health information systems" (WHO, 2007) has reinforced these values. Although these strategic documents have not fully materialized in Ethiopia, these development mandates framed at discursive interfaces have justified HIS donor investments and NGO-led IT initiatives in country.

At the project level, the NGO has also participated in discursive interfaces in order to ensure local legitimacy and to carve out space for its ongoing participation. In the eHMIS/PHEM project, the NGO has used discursive means with government stakeholders and the public. It has done this at various local and international venues by promoting the eHealth mandate and by marketing itself as a capable development partner to carry forward this change. With the public, it has regularly demonstrated its suite of eHealth solutions at the annually held Ethiopian ICT Exhibition where public organizations and local and foreign private sectors participate. Among international development actors, it has used discursive means by showcasing its solution at international conferences and more importantly at health sector's annual review meetings.

Lastly, the lack of active involvement by government institutions in the eHMIS/PHEM project is perhaps more evident at the technical interfaces. An overview of the actual distribution of the key technical activities in the eHMIS/PHEM project was relayed in Table 4 (Section 5.2.1). The results show the predominate role of the NGO as a key actor responsible, consulted and accountable for most technical activities.

The lack of partnership and collaboration between the NGO and local stakeholders has not only produced a lack of ownership but has also resulted in an unsatisfactory system. For instance, after early scale-up in Tigray numerous bugs and functional and content change requests emerged from local users. Subsequently, extensive efforts and costs were incurred by the NGO in upgrading the software and deploying its technical team to perform upgrades and troubleshooting on-site. Perhaps an important post-implementation technical interface was trainings where end-users had their first encounter with the eHMIS/PHEM. During these trainings, both end-users' appreciation for the system as well as their concerns regarding local capacity and infrastructure were voiced.

Overall, the dynamics at all four interfaces shows the intricacy of the socio-political context in such projects. By concurrently considering the four social interfaces, the nature of power exercised in the digitalization project can be understood as relational power or "associative power" (Heeks & Stanforth,

2014, p. 18). Conventional perspectives view power as a static capacity owned by particular actors. On the contrary, interfaces were junctions where different forms of power, namely; discursive, decision-making, resource-based and technical power were exercised. In the eHMIS/PHEM case, stakeholders possessing different forms of power jostled at various interface situations to shape the institutional, financial, technical and social aspects of the project. The simultaneous enactment of these forms of power highlights the realities of development project practice as a contested socio-political process. In light of this, development project practice in Ethiopia was as much about ensuring one's legitimacy at these interfaces as it was about achieving development outcomes.

6.1.3. Structural elaboration of digitalization (T4)

Structural elaboration corresponds to the last phase of the morphogenetic cycle where the social interactions and technical configurations from the previous phase produce morphostasis (i.e. reproduction of the existing system) or morphogenesis (i.e. transformation of the system). Transformation (morphogenesis) has been slow to emerge in the Ethiopia HIS context. In fact, the nearly decade long digitalization initiative by the NGO has seen the country lag behind neighbouring countries. The extent to which new techno-organizational configurations have emerged in both the HIS architecture and the governance modalities in Ethiopia is not evident, both from the technology and organizational perspectives.

After initial implementation, the digitalization process continued to be subsumed under the preexisting governance structure, which was based on a project-based arrangement primarily controlled by the NGO. Consequently, government institutions continued to rely on the NGOs project-oriented operational structure and funding schema to support the systems ongoing operation. A 2013 national assessment of the eHMIS states:

The original decision of the Ministry was to aim for an eHMIS technical systems development that would take place as a collaborative activity between the partners and the Ministry technical team within the premises of the FMOH. However, that did not happen, with consequences for the development of capacity of the Ministry team, (for example, related to the understanding of the software, the code, and processes of technical support) (FMOH, 2013, p. 139).

From the technology perspective, the scale-up of the eHMIS/PHEM has covered a reported 2,700 health institutions across the country (FMOH, 2015). However, it is not known how many of the 2,700 implementations are still functional. Additionally, the scaling of the system has been sporadic with some regions making significant progress while other regions lag behind. These challenges are partly attributed to infrastructure challenges such as poor Internet and electricity coverage.

Despite this, the mere design and scale-up of a technology in an undeveloped and unsustainable institutional context is insufficient and cannot in itself be considered digitalization. As it stands, the FMOH, regional and district level institutions have little to no ICT capacity for full uptake and ownership of the eHMIS/PHEM. The underestimation and unwillingness to address fundamental institutional capacities has compromised the effectiveness of the project creating excessive reliance on the NGO.

In the eHMIS/PHEM project, there has been a taken-for-granted notion of digitalization that ignores the complex organizational transformation process. These rationalities are rooted in underestimation of the effort required to transfer ICT skills and knowledge to foster new organizational norms and practices in developing countries. These are long-term and incremental development efforts. However, the rapid scale-up of the eHMIS/PHEM without an enabling environment to supplement it has added pressure for accelerated transformation of local health institutions which has been unrealistic.

The reasons for the lack of effort on fundamental institutional issues are multifaceted. The sheer scale of such an endeavor is daunting and perhaps too large a burden to place on one NGO. Additionally, the financial, technical and political effort necessary to carry out radical organizational transformation of government institutions requires a long term and enduring commitment. Perhaps most importantly, the NGO's shortcomings in this endeavor reflect underlying anxieties that many NGOs face. The digitalization process which involves IT innovation and organizational change requires both the institutionalization of IT and deinstitutionalization of traditional organizational structures and practices. Such efforts would entail challenging an elite-driven politics which would compromise the NGO's continued participation in this space. As a result, the NGO relies deeply on existing social and institutional forces for its support and ongoing existence. By not disrupting the existing structures, the NGO's indispensability is ensured ironically reflecting the disparity between development projects and their impact.

It is not the first time that the inherent contradictory rationalities of development stakeholders are identified as a fundamental reason for why developmental aims have been difficult to attain. As Schemel (2013, p. 224) highlights: "once created and filled with human agents, institutions tend to persist if only to suit their personnel's ambitions: bureaucrats create their own work and set their own norms in order to stay forever." Self-preservation, adaptation and 'survival at all cost' seem to be predominant drivers for many NGOs.

6.2. Generative Mechanisms

Building further on the findings from the case, this section presents an analytical account of the digitalization process by revealing underlying causal mechanisms framed within the morphogenetic approach. Four mechanisms of digitalization were identified: (i) projectification (ii) informatization, (iii) embedded inscription, and (iv) scaling.

6.2.1. Projectification

The first mechanism explains the cultural emergent properties (CEPs) of international development shaping the ideas, values and behaviors of actors involved in digitalization. A key cultural condition in the eHMIS/PHEM case was the international development strategies that promote project-based approaches to development. According to these strategies, bilateral donor funds were channeled through privately contracted organizations who became implementing partners to donors (Mosse, 2005; Roodman, 2009). In 2016, 29% of funds awarded by the US were through private contractors (US\$4.7 billion) while the UK and Australia allocated 13% and 24% of their total aid spending respectively to contractors (Commons, 2017).

These trends have not only produced a rise of international NGOs, but they have also led to the proliferation of projects (Roodman, 2009). This has created a number of issues in Ethiopia, namely, administrative burden, parallel projects and the challenges of advancing health sector's need to work towards integrating interventions "as a key element of services, not as a project" (FMOH, 2013, p. 77).

In the case of the eHMIS/PHEM, the project operated outside the health systems governance structure with no direct oversight by local ministries. The project arrangements also skewed the type of accountability and collaboration that ensued between NGOs and local institutions. As one NGO informant stated: "our primary accountability is to our donor". Additionally, the large grants given to support NGO operations have produced unsustainable conditions. One informant who is an NGO manager stated: "If funds were channeled through the government, they would not fund our activities, our annual operations cost is 7 million USD".

Based on these insights, both stimulating and releasing conditions that triggered a set of culturally-mediated behaviors were identified in the eHMIS/PHEM case. First, I identified the dominant development discourse around project-based development as a stimulating condition that endorsed the project-based approach for HIS digitalization in Ethiopia. In line with this, the eHMIS/PHEM project was seen as a series of technical and capacity transfers mediated by NGO experts. The project was also expected to sidestep the ineffective institutions of local ministries in order to accelerate decision-making processes and problem-solving.

Secondly, a key releasing condition that reinforced this emerging phenomenon was donor funds in the form of project grants. The NGO leading the eHMIS/PHEM project has been the recipient of multi-million dollar grants annually from its US government donor. Its continued funding has not only provided the NGO with the resource capacity to fund project activities, including the assembly of a highly remunerated technical team, but it has also garnered the NGO and its project legitimacy among local stakeholders.

This discursive and cultural phenomenon has framed the overall coordination and partnership that has ensued between local government stakeholders and the NGO. From the outset, a distinction existed between the beneficiaries and the experts that would deliver the technology. The experts not only possessed the technical competence but the financial backing, elevating them as owners of the project and the key change agents (what Archer refers to as corporate agents) in what was touted as a collaborative development initiative.

These stimulating and releasing conditions have bolstered the control of the project by NGO including: ownership of project funds, technical resources and overall project activities (see Table 5 for distribution of project tasks). Consequently, the project arrangement and its instruments have produced political subtleties that have created and sustained power asymmetries in the digitalization initiative which we will consider further in our later discussion.

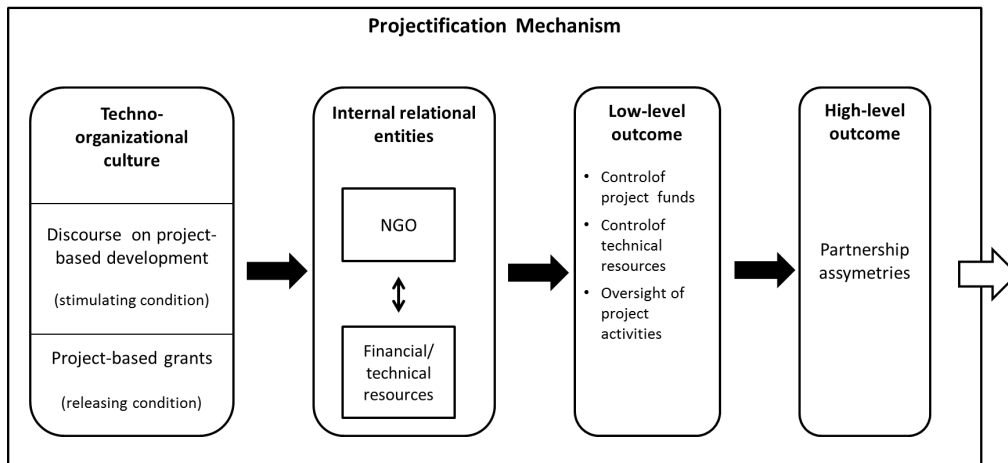


Figure 14: The projectification mechanism

Together, I refer to this as the *projectification mechanism*; a process by which partnership asymmetries are produced as projects become primary instruments for organizing work and transferring resources in digitalization.

6.2.2. Informatization

Within the Ethiopian health system, a key structural emergent property (SEP) for HMIS digitalization has been the preexisting data and its architectural constellation in the manual (paper-based) HMIS. An important attribute of the manual HMIS was the high-volume and high-variety of data it supported. The HMIS comprised a variety of data including: resources (e.g. HR, logistics, lab & blood bank indicators), health system (e.g. service coverage indicators), family health (e.g. reproductive health indicators), disease prevention and control (e.g. HIV-AIDS, malaria indicators).

The volume of HMIS data was also magnified by the estimated 21,390 health institutions that constitute the public health system in Ethiopia. Collectively these institutions produce about 249,292 reports annually (see Appendix 3). This has produced difficulties with collecting, tabulating, storing, analyzing and visualizing these large data assets. The volume and variety of data has been identified as a stimulating condition towards digitalization. Additionally, the local government’s reform initiative of the manual HMIS was recognized as a crucial releasing condition for the digitalization strategy. Both these stimulating and releasing conditions have elicited various features of the HMIS we will discuss below.

At a basic level, the manual HMIS provides health facilities with the capacity for collecting (Feature (Feat. 1 in Table 6) patient level data at points of service delivery using registers (e.g. antenatal care register). These registers contain the defined data sets that are to be recorded at each health facility (e.g. pregnant woman tested for HIV). The recorded data sets enable the aggregation and calculation (Feat. 2) of indicators (e.g. proportion of pregnant women tested for HIV). Finally, the manual HMIS enables health facilities the reporting (Feat. 3) of indicators using the standardized reporting forms. Together, I refer to these set of features of the HMIS as basic features.

However, these basic features can only be realized in combination with data standardizing features which allow standardized recording (Feat. 4-5) and reporting (Feat. 6) of data sets/indicators across all health institutions. Overall, the basic and data standardizing features have been simultaneously employed by public health institutions in varying degrees across Ethiopia. However, factors such as the organizational context, availability of HMIS tools and user capabilities have affected the broad utilization of these features across some health institutions.

Table 6. Manual HMIS Features	
Basic Features:	
1.	Collecting and tallying patient level data and minimum data sets
2.	Calculating defined indicators
3.	Reporting data through a single channel
Data Standardizing Features:	
4.	Standardizing minimum data sets and recording formats
5.	Standardizing indicators
6.	Standardizing reporting formats

It should be noted that not all features of the manual HMIS can be actualized at the same time with some features being realized earlier than others. In the HMIS case, three groups of advanced HMIS features were identified (Table 7). These include: *analyzing*, *process standardizing* and *controlling* features. These features contribute to achieving multiple goals including: efficient and accurate data synthesizing capability (Feat 1), enhanced data analysis and use (Feat 2-3), standardized processes for data collation at all levels (Feat 4), standardized storing and reporting procedures (Feat 5-6), and improved data security and quality (Feat 7-9).

Table 7. Manual HMIS Advanced Features	
Analyzing Features:	
1.	Compiling data from multiple health institutions
2.	Synthesizing high-volume and high-variety health data
3.	Visualizing and monitoring longitudinal health data
Process Standardizing Features:	
4.	Standardizing data aggregation and indicator calculation procedures
5.	Standardizing data storage and management procedures
6.	Standardizing data reporting procedures
Controlling Features:	
7.	Controlling which individuals/institutions can access and perform each transaction
8.	Guiding and validating data entry and reporting
9.	Controlling timeliness and completeness of reports

The aforementioned advanced features in Table 6 and 7 offer local health institutions the potential to achieve three broad outcomes:

- (1) Integration: single source for each data item, one report and one reporting channel in order to organize and simplify data (Table 6: Feat 1, 2, 3)
- (2) Standardization: standardized data-sets, indicators and forms (Table 6: Feat 4, 5, 6) and standardized procedures for data collation, storage and reporting (Table 7: Feat 4, 5, 6) in order to harmonize available data

- (3) Optimization: optimize available data through data analytics, visualization, and management (Table 7: Feat 1-3 and Feat 7-9) in order to create value from data

A strong temporal and functional dependency was identified between the three groups of outcomes and their features. The realization of data optimization required that the preceding features of integration and data standardization be first realized.

However, unlike the standardization and integration features, the immediate outcomes of the optimization features were not realized in the manual HMIS. Optimization refers to the extent to which data generates value through its extraction and transformation. This highlights the enduring problem of too much data and not enough information at local health institutions. Why the optimization outcomes have not been realized in Ethiopia is attributed primarily to missing institutional and technical features in the manual HMIS.

This need for optimization in order to generate value from data assets has influenced the push for the Ethiopian HMIS digitalization strategy. The strategic direction towards digitalization was initially drafted by the HMIS reform team in 2008 which, outlines key strategic actions needed for HMIS reform (FMOH, 2008). Among the five thematic areas identified was to “appropriate technology”. The strategies include the aim to “establish customized HMIS software system at Woreda, sub-city, zone, regional, and federal levels; procure and install required hardware; train staff in basic computer literacy and in HMIS electronic system” (FMOH, 2008, p. 44). An early benchmark for this strategy was to have “80% of all RHBs, ZHDs, and WorHOs with required infrastructure installed eHMIS” (FMOH, 2008). These focus areas are also currently evident in Ethiopia as reflected by a new initiative called the Data Use Partnership and the FMOH’s Information Revolution Roadmap which sets out to prioritize the use of data as part of the digitalization and scale-up of HIS (FMOH, 2016).

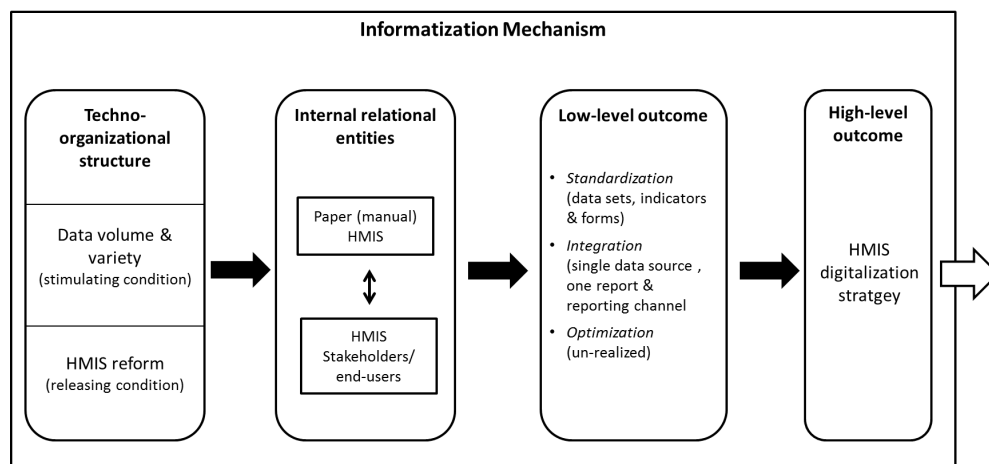


Figure 15: The informatization mechanism

Together, I refer to this as the *informatization* mechanism; the process by which high-volume and high-variety data produce a demand for its optimization through digitalization. The outcome of this mechanism is the HMIS digitalization strategy which aims to produce enhanced insight, decision making, and process automation.

6.2.3. Embedded Inscription

Beyond structural and cultural emergent properties, the interactions and relations of people (PEPs) themselves have emergent powers (Archer, 1995). This is also where agents mediate the conditional influence of preexisting structural and cultural properties, but also transform or reproduce them through their actions and interactions.

Two conditioning effects of the structural/cultural context were identified in the eHMIS/PHEM case. First, the outcomes of the previously actualized mechanisms (i.e. asymmetric partnership and digitalization strategy) were stimulating conditions for the ensuing digitalization activities. For instance, through the structured distribution of resources in the *projectification* mechanism, the organizations have been pre-grouped as change agents of digitalization (i.e. NGO) and recipients (i.e. government institutions). This has influenced the extent to which government institutions participated in and took ownership of digitalization activities.

Second, the strategic embeddedness of corporate agents at the social interfaces was a key releasing condition which influenced how other stakeholders collaborated and engaged with each other and with the digital artifact. Through the analysis of social interfaces (Paper 2), the NGO's embeddedness in all four social interfaces (i.e. organizational, resource-based, discursive and technical) has been elucidated. Embeddedness refers to the degree to which change agents are deeply entrenched in the social and technical fiber of the institutional context and whose opportunities for action are consequently enhanced.

The NGO has achieved embeddedness at key interfaces by; establishing relational ties with key government actors, enlisting brokers from national and regional health institutions, and by monopolizing the eHMIS/PHEM. For the NGO, this has been a long-term political process involving complex struggles and negotiations over status, reputation and resources, and requiring development of strategic alliances with key FMOH and regional managers. These alliances served as critical governance modalities in the project, predisposed the digitalization to predominantly informal processes.

Additionally, these interactional dynamics at the interfaces between the NGO and state institutions influenced how they collaborated in the inscription (design and development) of the eHMIS/PHEM. Consequently, the embeddedness achieved by the NGO was not apart from the technology artifact. The NGO's monopoly of the technology has made its role indispensable in the strategic pursuit towards digitalization. This dominant social and technical position has also enabled it to govern how other stakeholders participated in digitalization activities.

What is inscribed and how technology inscription occurs is determined by particular agents or what Archer (1995, p. 179) refers to as corporate agents. Primary agents, on the other hand, differ from corporate agents because in a given situation they lack the power to influence structural and cultural modelling and neither demonstrate the interest to organize for strategic pursuits (Archer, 1995). Consequently, the interaction of the corporate agent (i.e. NGO) with primary agents (i.e. government institutions) during inscription was largely controlled by the NGO.

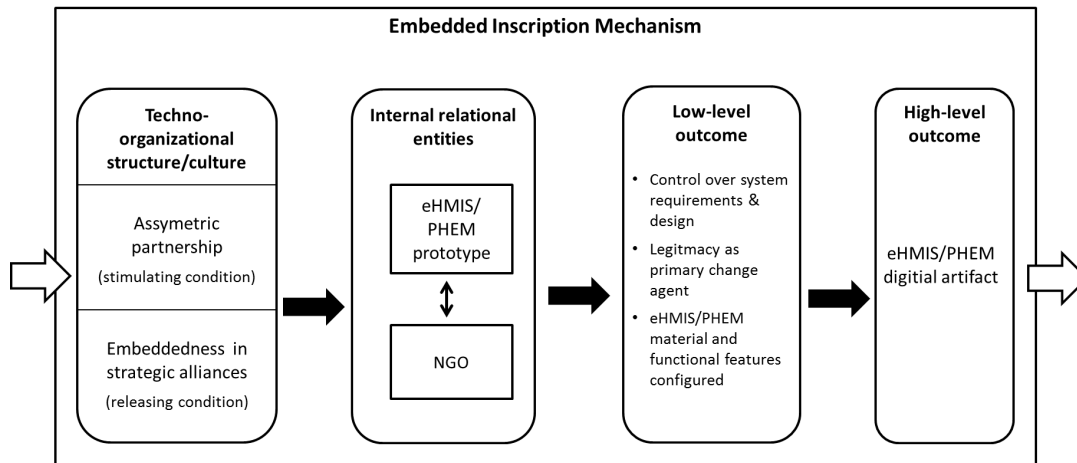


Figure 16: The embedded inscription mechanism

Together, I refer to this as the *embedded inscription mechanism*; the process by which strategically embedded actors pursue opportunistic modes of interaction to influence digitalization decisions. Along with the NGO's institutional legitimacy and control of the design of the eHMIS/PHEM system, the main outcome of this mechanism was the development of an initial version of the eHMIS/PHEM.

6.2.4. Scaling

The final mechanism is *scaling*. It explains how the outcome of the *embedded inscription* mechanism is transformed into a collective outcome – national HIS digitalization. The success of the HMIS digitalization ultimately depended on its capacity to scale. The NGO's rapid implementation efforts, although seemingly effective initially, uncovered two key underlying issues that hampered the sustainable scale-up of the eHMIS/PHEM.

The first was the configurability of the eHMIS/PHEM. Configurability or technical malleability determines the extent to which the properties of digital artifacts can be reshaped to accommodate emerging needs. As previously discussed, these properties include: programmability, addressability, and communicability. In the eHMIS/PHEM, these were partially realized through considerable workarounds.

With regards to programmability, the system's overall architecture was not easily malleable to facilitate changes or expansions to its core functional components. In term of addressability, the eHMIS/PHEM had a way of uniquely identifying each institution. However, it was inadequate in the degree to which each eHMIS/PHEM installation could be uniquely identified in a computing architecture to allow communicability with other digitalized artifacts. Fully actualizing these configurability features (Feat 1-3 Table 6) has proven difficult give the current software architecture of the eHMIS/PHEM. Even in the early periods after deployment, the system had faced demands for adaptability as data sets, indicators, procedures, number of health facilities, and organizational arrangements changed and new requirements emerged in the ever evolving health sector. The NGO coped with these demands through a makeshift and improvisational manner leveraging on extensive financial and technical resources.

Table 8. Configurability and Diffusion Features

<p>Configurability features:</p> <ol style="list-style-type: none"> 1. Programmability of the technology allowing changes to its form and functions 2. Communicability of the technology allowing sending and receiving data with emerging IT artifacts 3. Addressability of the technology enabling identification and linkage with new IT artifacts into the information infrastructure
<p>Diffusion of institutional features:</p> <ol style="list-style-type: none"> 1. Deploying the technology through more user adoption and institutional buy-in 2. Scaling local skills and institutional capabilities

Secondly, only realizing configurability of the eHMIS/PHEM was not sufficient in the project. Diffusion was necessary for successful digitalization. Diffusion refers to the spread of both the technology in terms of more user adoption and the propagation of institutional capabilities (Sahay & Walsham, 2006). Thus far, a fundamental challenge in the scale-up of the eHMIS/PHEM across Ethiopia has been the scaling of skills and local learning among health institutions both in data management and the use and ongoing management of the system’s operation. This lack of institutional capacity at the FMOH and regional bureaus has been a recognized concern for sustainable digitalization.

Thus far, trainings, on-site technical assistance and sensitization workshops have been activities carried out by the NGO to build local capacity. Additionally, the health information technician (HIT) curriculum has been instituted in various technical and vocational education and training sites in Ethiopia. This program has mobilized a cadre of trained HMIS staff and aims to fill an essential human resource gap. This is perhaps the most institutionally rooted initiative the NGO has introduced. Even though challenges remain around the quality of the curriculum, turnover, and poor career structures, the program has been deemed a key input for digitalization success.

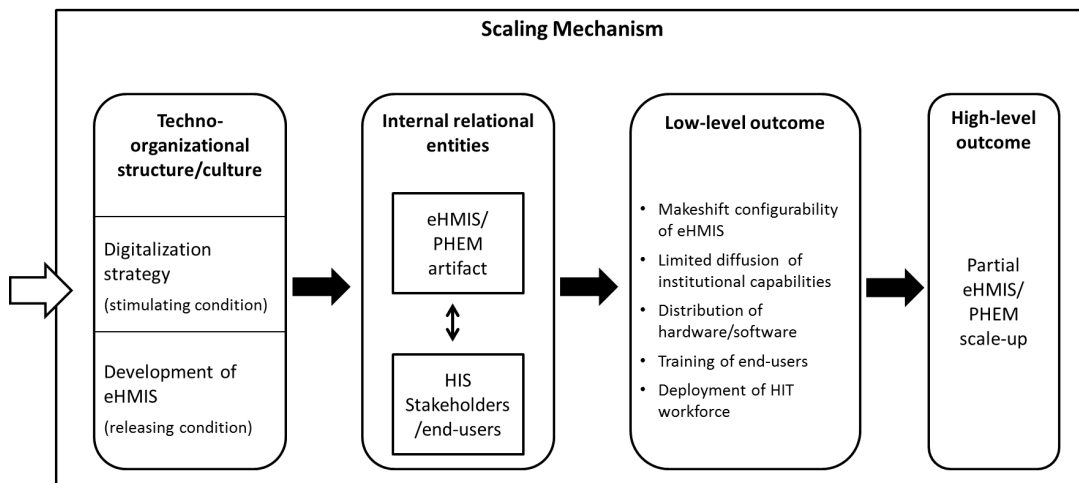


Figure 17: The scaling mechanism

Overall, I refer to the *scaling* mechanisms as the process by which digitalization spreads in terms of the propagation of institutional capabilities while allowing the adaptability of its properties.

Table 9: HIS Digitalization Mechanisms

Mechanism	Definition
Projectification	A process by which partnership asymmetries are produced as projects become primary instruments for organizing work and transferring resources in digitalization.
Informatization	A process by which the need to gain value from data produces a demand for its optimization through digitalization.
Embedded Inscription	A process by which strategically embedded actors pursue opportunistic modes of interaction to influence digitalization decisions.
Scaling	A process by which digitalization gains institutional traction spawned by capabilities and the malleability of the digital artifact

Implications and Contributions

7.1. Contributions to ICT4D and DM research

The findings and analytical approaches used in this dissertation offer insights that are relevant to both ICT for development (ICT4D) and development management (DM) researchers. These contributions relate to the theoretical challenges outlined at the outset of the dissertation. They include:

- Conceptualizing and analyzing socio-politics in development projects and its bearing on ICT4D project governance
- Theorizing contextual contingency - understanding the relationship between the broader context and digitalization events and phenomena
- Navigating the macro-micro analytical domains to develop an understanding of how particular digitalization trajectories emerge

7.1.1. Analysis of socio-politics in ICT4D projects and interface governance

For researchers examining digitalization among interorganizational actors, this dissertation contributes to the stream of ICT4D research which gives emphasis to socio-political analysis. How politics is enacted in development projects has been deemed fundamental to understanding project practice and its developmental potential (Heeks & Stanforth, 2014; McCourt & Gulrajani, 2010). As demonstrated in more depth in Paper 2, these political dynamics were identified as important facets of the digitalization process in Ethiopia. Here, the interface approach was useful for examining how various forms power was constituted in the project among NGO and state constituents. This has also concretely revealed the nature of institutional interrelations, opening up the black-box of NGO-state partnership. The interface analysis has also brought insight into the critical junctions where planned digitalization projects are often shaped.

Fundamentally, the issues of socio-politics in digitalization projects relate to the ways in which people interact in response to the various issues presented by the particular technology and social context. Such a conclusion might appear simple and self-evident. However, coherent theoretical basis that guide the systematic analysis of these socio-political dynamics is often missing. I argue that social interface analysis can make the interlocking of institutional actors, their associative power and the ensuing socio-political process in IS phenomena analyzable and interpretable.

An important aspect of the analysis of socio-politics in development projects is to situate interface situations within broader institutional contexts and power structures (Long, 1999, 2003). In this way, the influence of the various social systems that actors are embedded in can be accounted for, both within

and beyond the context situation of the individual or the organization. This dissertation has undertaken this line of analysis by positioning the social interface approach within the morphogenetic approach. This has provided theoretical depth to understanding the social interaction phase of the morphogenetic approach. Moreover, it has offered of a theoretical middle ground by linking the intervening macro dimensions with the interactions and action of agents.

Overall, the application of the interface approach in this dissertation demonstrates its analytical benefits for ICT4D researchers examining socio-politics in IS phenomena. First, it provides empirical guidance for categorizing and synthesizing the nitty-gritty of social and political subtleties in which ICT4D projects are situated. Secondly, it integrates different dimensions of power and provides an analytical device that can help researchers untangle the concurrent enactment of different forms of power. Although the social interface approach has been advocated as a useful approach for examining development practice and socio-politics by researchers in development management (Mosse & Lewis, 2006) and global health governance (Buse, et al., 2009), it has received little to no uptake in ICT4D literature. ICT4D studies, especially those of the 'socially embedded action' discourse (Avgerou, 2010) that explore the social and political process of IS implementation can benefit from the social interface approach.

Interface governance

One of the challenges outlined at the beginning of this dissertation was the knowledge gap in our understanding of how politics is enacted in digitalization projects and its implication for governance interventions. The first part of this challenge was discussed in the above section. For the latter, I propose the notion of *interface governance*. Building on the idea of 'governance as interactions' (Kooiman, 2003), *interface governance* is a perspective that can sensitize our understanding of the nuances of governance in digitalization projects in this context. Such a perspective is intended to account for the realities of social-life in development projects. Development projects have been shown to be shaped by how interactions are managed among a variety of stakeholders including NGO and local government constituents (Madon, 2005).

According to the *interface governance* perspective, governance can be conceptualized as a set of interactional dynamics between actors and entities involved in different interface situations. In this dissertation, I have analyzed the confluence of four such interfaces (i.e. organizational, resource-based, discursive, technical) with each having governance implications (further discussed in the Section 7.2.3). Such a perspective of governance avoids the analytical limitations of broad categorization of governance into centralized/decentralized or hierarchical/networked. Instead, the interface perspective on governance engages with the interactions and interdependencies of multiple actors. This allows for the development of more detailed insight into the governance of multi-agency development interventions.

The *interface governance* perspective has implications for ICT4D. Since interactions have a central place in governance, *interface governance* can sensitize ICT4D researchers in their investigation of how and under what interface circumstances digitalization projects could be better governed. Overall, the application of the interface analysis to governance is a promising theoretical contribution.

7.1.2. Tracing contextual contingency through generative mechanisms

Understanding digitalization in developing countries demands analysis that extends beyond the local socio-political milieu to consider the broader context. Coherent theoretical basis for examining the interrelationship between digitalization and its broader context has been identified as a longstanding area of focus in the extant ICT4D research (Avgerou, 2008, 2017; Walsham, et al., 2007). However, accounting for the dynamics between digitalization phenomenon and broader social, political, and cultural conditions has been a difficult analytical and empirical task. Two particular challenges are raised in this regard: (i) the choice of where one starts in analyzing the key conditions of a particular context and (ii) how these conditions affect the ideas and actions of people involved in digitalization phenomena.

In addressing these challenges, appropriate theory is needed for grounding contextual explanations by framing the key conditions that enable or constrain digitalization (Avgerou, 2017). Archer's morphogenetic approach pays particular attention to these dimensions of context. The theory reframes context in terms of social structures which have structural emergent properties (SEPs) and cultural systems which have cultural emergent properties (CEPs). These presuppose different types of generative mechanism that explain contextual conditioning.

Therefore, identifying these mechanisms and their emergent properties is the type of theorizing that can help researchers understand how particular context enables or constrains. A key theoretical proposition that Archer puts forth is that there are internal and necessary relations within and between social structures/cultural systems. These relations exist among key components that are internal to the particular structure and cultural system and which are necessary for them to have emergent properties or causal powers. The contextual mechanisms identified in this study have put forth the internal and necessary relations of both a CEP (i.e. projectification) and SEP (i.e. informatization) in the eHMIS/PHEM project (See figures 6-9).

Both the *projectification* and *informatization* mechanisms illustrate the cultural and structural emergent properties, respectively, and their conditioning effects on agents involved in the project. The *projectification* mechanism demonstrates how the contextual conditions of dominant discourse around project-based development backed by international development funding schemes shapes development practice by generating specific liabilities. The outcome of this mechanism was the asymmetric partnerships that ensued between the NGO and local government institutions.

On the other hand, the *informatization* mechanism explains how the structural emergent properties of the Ethiopian health system's data architecture conditioned agents with strategic directional guidance. More specifically, it draws on the components of the institutional context (i.e. data reform initiatives) and material resources (i.e. data and manual data management tools) to trace standardization, integration and optimization features, their level of utilization, and their immediate outcomes. Both mechanisms speak to the aforementioned theoretical challenge by identifying what it is about the specific properties of the context that produces enabling and constraining effects on agency. Accordingly, identifying and analyzing the cogs and wheels of mechanisms can help ICT4D researchers build better explanatory theories around contextual contingency.

However, identifying the internal and necessary relational entities to uncover generative mechanisms can be a complex and analytically messy process. For instance, given that a number of internal and necessary relations can exist in a particular mechanism, some are likely to be stronger, weaker or more apparent than others. According to Bhaskar (1975, p. 47), untangling these entities and their relations calls for “blending of intellectual, practio-technical and perceptual skills”. This also speaks to the challenge of distinguishing between various candidate mechanisms in open systems. Given the lack of clear criteria outlined by critical realism, Sayer (2000) suggests that the mechanisms (i.e. their sub-components and relations) that offer the strongest explanatory power based on the empirical evidence and causal depth should be selected.

7.1.3. Navigate the macro-micro analytical domains by conjuncturing mechanisms

As outlined in the above two sections, development presupposes an ongoing process of transformation at multiple levels. This demands the grounding of research in theories that elucidate the macro-micro transformative process. In this dissertation, I have drawn on Archer’s morphogenetic approach as the main theoretical underpinning for framing these macro-micro dynamics. The morphogenetic approach has also been used for linking generative mechanism that relate to the structural, cultural or people emergent properties existing at different levels. The complexity of development means that there are numerous mechanisms that exist in a particular IS phenomena. Although not possible to uncover all, by identifying sets of mechanisms, their contingency and immediate outcomes, researchers can build a more defensible explanation of both the developmental process and impact of digitalization projects.

Given the nature of open systems, the outcome of a specific mechanism depends on the actualization of other mechanism (Sayer, 1992). In examining the interaction among sets of mechanisms, Henfridsson and Bygstad (2013) offer a unique perspective. Using the context–mechanism–outcome approach of Pawson and Tilley (1997), they examine the configuration of three mechanisms and the outcomes they generate in the evolution of information infrastructures.

In this dissertation, I put forth a different perspective for concatenating mechanisms that account for the systemic and social (i.e. macro-micro) dimensions. First, I draw on the typology of mechanisms proposed by Archer’s morphogenetic approach (i.e. SEPs, CEPs & PEPs) to identify the types of mechanisms that fit at the macro-micro levels. Hedström and Swedberg (1998) also propose a typology of mechanisms to account for the interaction of mechanisms at different levels. They link three types of sequential mechanisms including: situational mechanisms (macro-micro); action-formation mechanisms (micro-micro); and transformational mechanism (micro-macro). The tri-part change process of Hedström and Swedberg (1998) is also in line with the three temporal phases of the morphogenetic approach, although they do not account for the analytical distinction between cultural systems and social structures or hold to critical realism’s ontological premise of mechanisms. Nevertheless, accounting for different types of mechanisms that correspond to macro and micro-level processes has proven to be a beneficial way of concatenating mechanisms in order to navigate the macro-micro domains.

However, purely identifying different categories of mechanism that correspond to the different levels may not, in itself, be sufficient for explaining how specific mechanisms enforce or counterbalance each

other. Consequently, one could be left with three or more mechanisms whose reinforcing or counterbalancing effects on other mechanisms is not clear. Moreover, such categorization may cause researchers to focus on the parts of the process at the expense of the dynamic unfolding whole leaving us with a disjointed analytical narrative.

The approach employed in this study can help address some of these challenges. Given that the outcome of a specific mechanism depends on the actualization of other mechanism(s), further explanatory theorizing requires analysis of how the outcomes of earlier enacted mechanisms produced conditioning effects on succeeding mechanisms. For example, the outcome of the projectification mechanism was the asymmetric partnerships that ensued between the NGO and local government institutions. Asymmetric partnership was in turn a stimulating condition in the embedded inscription mechanism as it influenced how stakeholders interacted and how system development and implementation activities were carried out. Similarly, the outcome of the informatization mechanism (i.e. digitalization strategy) was a stimulating condition for the scaling mechanism. The concatenation of mechanisms is outline in Figure 10.

This is perhaps the most challenging aspect of concatenating mechanism since the outcomes and conditioning effects of the identified mechanisms may not be coherently linked to each other. In my analysis, this has been an iterative process where I have had to go back and forth between the conceptual framework, data, and sets of entities, collectively considering the various candidate mechanisms in order to build on those that offer explanatory power. Additionally, through various iterations, candidate explanations were tested with research colleagues.

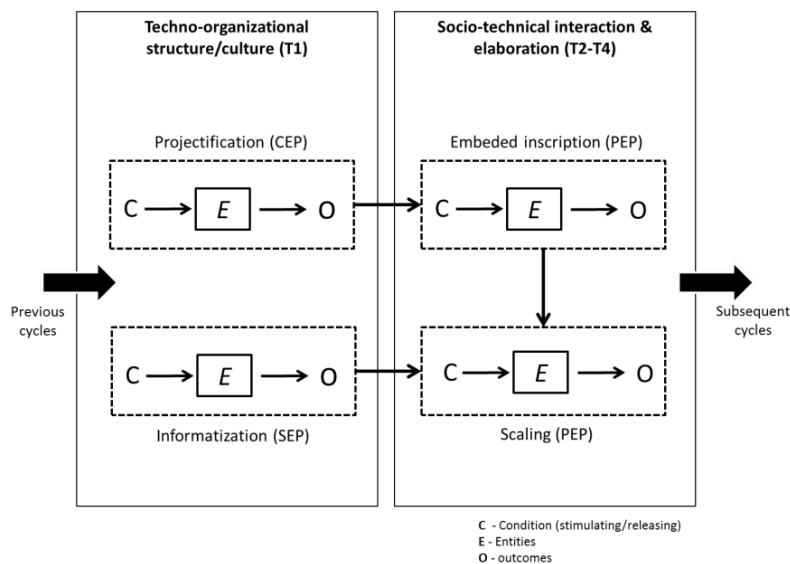


Figure 18. Concatenation of mechanisms in HIS digitalization

Overall, by concatenating mechanisms in this way this dissertation demonstrates an approach for navigating the macro-micro analytical domains and provides a more nuanced explanation of the multi-level digitalization phenomenon. Additionally, the use of temporal separability and analytical dualism, which Archer proposes, is a valuable approach for IS researchers examining how structure, culture and

agency interact and mutually emerge in IS phenomena. I argue that this line of analysis can help ICT4D researchers build more defensible cases for exploring the role of IS phenomena in development.

7.2. Practical implications to HIS development projects

For local managers and development practitioners involved in HIS projects, the study offers insights that can inform policy and guidelines in the effort toward digitalization. To position the practical contributions, I first outline the key problems that were identified from the study. Second, I propose ways that local ministries and development agencies can tackle these challenges in order to foster favorable digitalization outcomes. Four fundamental gaps were identified from the analysis:

- *Projectified development*: projects as primary modalities for digitalization have created partnership asymmetries between NGO and local institutions.
- *Poorly governed inter-agency collaboration*: lack of formalized arrangements between State-NGO collaboration has led to informal politics and individual relations becoming primary modes of decision-making resulting in poor accountability environments.
- *Gap filling at the neglect of institutional development*: total dependency on external partners as NGO assumes a gap-filling role thereby replacing rather than building local institutional capacity.

7.2.1. Cultural transformation around ‘projectified’ development

The ideas and values promoted by project-based development approaches have not only led to the proliferation of development projects but they have become primary means for development intervention (Heeks & Stanforth, 2014). Edwards (1989, p. 119) iterates that there is a “dangerous obsession with ‘projects’ that characterizes the work of most development agencies”. The project-oriented view of development in the Ethiopia case has seen the project as an accelerated sequence of technical transfers carried out by NGO experts.

This approach essentially skews the fundamental ideals of development which involves a long-term process of experimentation and innovation through which local stakeholders learn and thereby build their competencies and confidence alongside their NGO counterparts. Short-term project-based approaches that focus on rapid implementation and hand-over of IT systems to local institutions avoid local engagement, empowerment and participation. This limits the extent to which knowledge is effectively extracted and internalized by local institutions. It is improbable that capacity building ends can be achieved by sidestepping the very means by which they are cultivated. As illustrated in the Ethiopia case, the project-based approach has created disproportionate partnership that have failed to engage with institutional development.

However, there are potential tensions that require consideration here, especially around managing the demands of short-term needs with more long-term concerns (Manda, 2015). Researchers have proposed the need to establish institutional processes that facilitate the coordination of project-based interventions with government agencies in order to minimize dependency of short-term technical support arrangements (Kimaro & Nhampossa, 2005; Manda, 2015). These approaches relate to an

'alternative project-based intervention' as opposed to *'alternatives to project-based intervention'*. I will discuss the governance implications of the former in a later section.

An *'alternatives to project-based intervention'* challenges the very notion of project-based development, which under the guise of being 'short-term' evades engagement with deep institutional issues which lie at the heart of sustainable development. That projects are short-term is itself a notion that needs careful reflection. When is an endeavor no longer a project? A key characteristic of projects is that they are temporary and produce a unique output, be it, a product, service, or a result. This implies, on the one hand, that a project must have a defined beginning and end date. However, the eHMIS/PHEM, much like many other development projects of its kind, has endured for a decade drawing on renewed grants and diversified portfolio of initiatives. On the other hand, the NGO has taken responsibility for operational activities while still maintaining the 'project' status and arrangement. This has been evident in the NGO's ongoing role in maintaining and sustaining the eHMIS/PHEM system.

A move away from the project mindset requires a cultural shift (in ideas, beliefs, and values) towards *'alternatives to project-based intervention'*. Changing widely espoused ideas and beliefs around project-based digitalization demands an increased awareness of its potential downsides. Studies have found that the proliferation of development projects has had very little impact on national plans and government reforms to improve their overall effectiveness (Mosse, 2005). Projects were also found to facilitate "neo-colonial (unequal or paternalistic)" approach to development (Mosse, 2005, p. 193).

Another problem noted by Mosse (2005) was the poor track record of project-based initiatives to scale. The burden placed on NGOs with small teams and short-term grants to scale-up and support national systems like the eHMIS/PHEM is perhaps unrealistic. As it stands, it is local governments who have the durability and institutional reach to scale digitalization efforts.

Creating cultural change around project-based development is likely to encounter various conflicting forces. Among such forces are those identified in the *projectification mechanism*, namely; dominant discourse on project-oriented development and project-based funding arrangements. Addressing these areas requires a long term multi-level engagement due to the vested interest of many actors. A case from DFID in India is one example of such shifts (Mosse, 2005). In the early 1990s, DFID primarily relied on an approach that funded projects that operated outside state institutions. However, because of the minimal impact of projects, DFID has increasingly moved away from funding isolated and small-scale projects through private contractors towards supporting government agencies and sector-wide programs. DFID's current strategic focus includes active engagement with government institutions and higher-level partnerships based on shared objectives and responsibilities as reflected by their low spending on private contractor projects relative to other donors (Commons, 2017). However, such strategic shifts cannot be purely driven top-down; they need to be negotiated locally and be reinforced by techno-organizational arrangements that facilitate productive collaboration.

7.2.2. Transitioning from gap-filling to institutional development

The gap-filling role that NGOs play has become common, especially where local governments cannot shoulder those responsibilities. This is particularly the case in fragile and conflict-affected states.

However, this can be problematic when NGOs whose primary role is to provide technical assistance become cornerstones of government operations thereby undermining the role of local institutions. Two implications for HIS are proposed in this regard.

From scaling IT solutions to scaling digitalization capabilities

The development of individual competencies and institutional IT capabilities has been grossly underemphasized in the eHMIS/PHEM project. This is also evident in similar digitalization efforts in this context, which often reduce capacity development to sporadic trainings or technology distribution.

First, an area of primary concern towards building institutional capabilities is to ensure adequate processes of transparency and accountability exist between NGOs and government institutions. The lack of NGO engagement with the more challenging aspects of institutional capacity development stems from the limited accountability that NGOs face regarding their performance. Generally, the due diligence of donors in appraising contracted NGOs tends to focus on the bidding phase and not on the implementation or delivery phase. Donors and local ministries simply lack adequate number of skilled staff to monitor the performance of several NGO projects they have funded or are supported by (Commons, 2017; FMOH, 2016). As a result, NGOs tend to cherry-pick easier interventions, avoiding more demanding tasks.

This challenge is also attributed to the poor definition or absence of development targets or milestones against which ICT4D project success is measured. Targets, where defined, often shift emphasis away from what is really important towards what can be readily measured. In Ethiopia, figures of systems implemented, staff trained and equipment distributed have been regularly reported as measures of eHMIS/PHEM scale-up. However, this depicts an inaccurate picture of development success.

Secondly, improving the digitalization capabilities of local institutions calls for an improved approach of learning and knowledge transfer. As it stands, most ministries tend to prioritize short-term objectives at the cost of more long-term institutional gains. IN line with the aforementioned point, local ministries are also not clear about where and how NGOs can build their capacity. A preliminary step is for local ministries to specify priority areas for knowledge transfer and to formalize the process of collaboration and sharing with their NGO counterparts. Local ministries should ensure that the resource and technical input of NGOs are carefully managed and that outputs of project targets are aligned with their strategic priorities. The related governance implication of how local institutions can facilitate this process is further discussed further in section 7.2.3.

Cultivating data capabilities concurrently with digitalization

Digitalization of HIS is so intertwined with data that its value to the development context of health is inextricably linked to the optimization of data and its capacity to facilitate evidence-based decision-making. Drawing on the *informatization* mechanism, data optimization along with standardization and integration have been identified as the core set of benefits that digitalization should offer health institutions. Current trends in international development also emphasize this demand for harnessing data for decision-making, accountability and service improvement (UN-IEAG, 2014). These aims are reflected in the UN's Sustainable Development Goals and in particular its "data revolution" initiative

which aims to create new funding streams for strengthening data capabilities (UN-IEAG, 2014). These focus areas are also currently evident in Ethiopia as reflected by a new USAID funded initiative called the Data Use Partnership and the FMOH's Information Revolution Roadmap which sets out to prioritize the use of data as part of the digitalization and scale-up of HIS (FMOH, 2016).

Despite this promising trends, digitalization efforts in the health sector have emphasized technology at the cost of information and automation at the cost of insight. Digitalization needs to stress its role in data optimization to garner tangible development impacts and to gain validity as a worthwhile development endeavor for local ministries. The *informatization* mechanism highlights the importance of having a clear strategy of how to maximize value from data by leveraging on digitalization opportunities. This entails a renewed engagement with data literacy, organizational data capabilities, and the institutional and funding environments for the production, dissemination and use of data. Local ministries can leverage on the "information revolution" momentum by linking them with their digitalization efforts through two means: first, by adopting digitalization strategies that incorporate data optimization among its core set of implementation, technical assistance and institution building activities, and second, by establishing local governance processes that oversees the implementation and monitoring of data optimization activities across health institutions.

7.2.3. Governance of State-NGO collaboration

The lack of clearly articulated arrangements around state-NGO collaboration has been an underlying challenge in digitalization projects in the health sector. These challenges are augmented by the primary role that informal politics plays in decision-making producing poor accountability environments. As a result of these dilemmas, governance has emerged as important development agenda among local ministries (FMOH, 2016)

Given that digitalization projects are replete with socio-politics, a balanced treatment of governance in digitalization requires consideration of the various social interfaces identified in this study. These interfaces shift governance interventions to account for the 'game-like' interactions taking place among state-NGO actors. In this regard, both government agencies and donors need to commit to processes of institutionalizing these interfaces. In the following sections, I provide practical insights in this regard. The four interfaces (i.e. decision-making, resource-based, discursive and technical) are considered together with the three IT governance capabilities proposed by Peterson (2004), namely: structural, process and relational governance. Ultimately, through these governance interventions, partnership asymmetry and accountability in digitalization projects can be better enhanced to maximize aid effectiveness.

Structural governance reform

Structural governance reform approaches aim to establish control systems (e.g. financial schemes, coordination processes) at the interfaces between NGOs and local government. There is global consensus articulated by the OECD, World Bank and the United Nations that governance around development efforts should be driven and owned by recipient governments (OECD-Paris, 2005; WHO-ITU, 2012; World Bank, 1993). In the ICT4D context, these shifts to state-driven governance of IT

initiatives are not yet evident nor are state actors seemingly willing or ready to take on this responsibility in the presence of well-funded and more technically apt NGOs.

The need for local government to establish formal positions and teams that are actively involved in overseeing NGO-led ICT4D projects is apparent from the case relayed. As demonstrated in the Ethiopia case, the NGO's capacity to influence the project's trajectory has been possible due to the lack of formal IT governance structures and accountability frameworks throughout the project.

This gap also highlights an area of priority in the development of IT capabilities within ministries. There is a necessity to prioritize the development of IT governance and management capabilities first. Given the scarcity of technical capacity, many ministries of health are ill equipped to carry forward entire ICT4D projects. However, building IT governance and management capabilities through formal roles (e.g. IT project managers) and groups (e.g. eHIS committees) is a realistic short-term objective that can position national and regional health authorities with the capacity and responsibility to oversee and monitor NGO-led initiatives.

The restructuring of resource-based interfaces are also pertinent to the sustainable transition of projects to government agencies. One downside to current financial arrangements has been the poor awareness of local institutions regarding the resources needed to adequately support the operation of such systems. For instance, in the eHMIS/PHEM case, the ministry's financial dependence on the NGO resulted in the lack of funds being allocation for covering ongoing cost such as internet fill-ups at peripheral health institutions.

Perhaps more importantly, the current arrangement of donor funds being channeled through NGOs to implement large ICT projects has diminished their impact on the capacity of local organizations due to poor financial accountability, inequitable distribution of resources and overall mismanagement. The resource-based interface between NGO and ministries has often been that of a funder and recipient. Additionally, although NGOs' financial accountability is predominantly to their donor, their financial expenditure and profits are not rigorously monitored against targets to determine their value for money (Commons, 2017).

More rigorous systems of accountability and transparency need to be established between NGOs and donors through local ministries in order to reap greater benefits of donor funds. Of course, such arrangements may potentially open up ICT4D projects to greater bureaucracy hindering their progress and ultimate impact. But the fact remains that governments are better positioned to monitor the delivery and value of NGO interventions.

At technical interfaces, NGO focus should also be directed towards transitioning technical assistance to regional government agencies. This calls for formal IT roles and teams among state-NGO constituents collaborating in development and implementation activities. Although many NGOs partner with local implementing partners and develop transition plans as demanded by their donors, these transition plans (i.e. from NGO to government organizations) are rarely followed through due to poorly defined strategies and regulatory frameworks.

Lastly, an important aspect of the strategic success of projects is bringing clarity to the strategic input of particular ICT4D projects to local ministries. Local ministries need to create, modify and authoritatively interpret their HIS strategies to fit their local priorities and capabilities. For instance, the Ethiopian FMOH has developed national eHealth and HIS strategies. However, these strategies fail to be operationalized and to delineate where and how particular projects are contributing to achieving these strategic objectives.

Process governance reform

Structural governance reforms alone are not sufficient for effective ICT4D project governance. Local institutions need to address their process-based IT governance capabilities. This refers to governance procedures where IT decision-making and monitoring activities follow specified rules and standard procedures. Such procedures aim to operationalize IT governance arrangements by encouraging desirable decisions that are consistent with the local government's strategies and values. As relayed in the Ethiopia case, unclear processes for IT decision-making not only compromise the effectiveness of digitalization projects but they can also make the monitoring of decisions against performance very difficult.

At discursive interfaces of digitalization projects, a key challenge exists around the implementation and oversight of strategic objectives. National strategies of developing country MoHs have largely been ignored with no relevance to NGO projects and donor funding. How these strategies can be operationalized to guide ICT projects is a concern the process-based IT governance reform engages with.

This gap also highlights the lack of standard processes for periodic IT strategy development and reviews by local stakeholders. Discursive interfaces are critical for the development and implementation of strategies that outline how and where donor/NGO funds and initiatives fit into government plans for national HIS development. However, these strategies first require strong commitment from governments themselves and need to be robust enough to instill donor confidence and participation. The need to build and sustain process IT governance capabilities locally by linking these efforts with global level initiatives and funds needs to also be adequately articulated and fostered through discursive means in order to raise awareness and buy-in.

At the IT organizational interfaces, a key activity is the monitoring and evaluation of IT decision implementation in projects (Peterson, 2004). Given the socio-political dynamics of digitalization projects, embedding standard procedures for inter-organizational IT decision-making/-monitoring can be challenging. However, these process reforms can be facilitated by adopting management frameworks such as the Balanced Scorecard tools. The Balanced Scorecard has already been adopted in the Ethiopian health sector for planning, monitoring and managing health sector development activities since 2009. However, it has not been used for assessing IT performance. These existing capabilities within ministries can be leveraged to facilitate process-based IT governance capabilities. The planning, monitoring and evaluation of projects can also serve as an entry point for more meaningful participation of local ministries' in NGO-led ICT4D projects.

These governance interventions also have a bearing on technical interfaces between states and NGOs. Formally articulated processes for state-NGO participation and collaboration throughout IT project activities can be made stronger by addressing ministries' processual IT governance capabilities. In the eHMIS/PHEM initiative, the technical interfaces among interorganizational stakeholders were characterized as loosely defined cooperation between the NGO and various government agencies. These unstructured processes have led to development practices that emphasize system development/implementation over local capacity development and the disproportional distribution of resources.

Table 10. Summary of IT governance reform at key interfaces

	Structural reform	Process reform	Relational reform
IT organizational interfaces	<ul style="list-style-type: none"> Formally designated roles and allocation of decision rights among stakeholders 	<ul style="list-style-type: none"> Formal venues and procedures for interorganizational IT decision-making Institutionalized IT monitoring of ICT4D project decisions 	<ul style="list-style-type: none"> Fostering norms around state-NGO partnership in decision-making, negotiation and conflict resolution
Resourced-based interfaces	<ul style="list-style-type: none"> Official unit/group (e.g. IT project office, committee) that oversees the allocation and use of project resources 	<ul style="list-style-type: none"> Standard processes for investment prioritization/allocation and monitoring 	<ul style="list-style-type: none"> Promoting transparency and accountability around resources distribution and use
Discursive interfaces	<ul style="list-style-type: none"> Designated local officials and technical working groups that manage strategic direction 	<ul style="list-style-type: none"> Protocols for periodic strategy development and reviews 	<ul style="list-style-type: none"> Cultivating visibility and shared commitment to strategic aims
Technical interfaces	<ul style="list-style-type: none"> Formal IT roles and teams among state-NGO constituents collaborating in development and implementation 	<ul style="list-style-type: none"> Institutionalized collaborative arrangements among state-NGO teams 	<ul style="list-style-type: none"> Nurturing voluntary knowledge sharing and collaboration between state and NGO technical teams

Relational governance reform

In addition to both structural and processual IT governance reforms, decision-making power at the interfaces in the eHMIS/PHEM case entailed more than the absence of formal governance arrangements and processes that demarcate social positions and regulate decision-making. As shown in the case, stakeholder's legitimacy at the interfaces depended on their relational embeddedness with government stakeholders, which are fostered through personal ties and norms of mutual gain and reciprocity. Improvisation, negotiation, politicking and strategic relations among interorganizational actors are all

facets of the ICT4D project process in this context (Sahay, et al., 2009; Walsham, et al., 2007). Here is where applying purely normative and instrumental IT governance approaches can be negated in a context that is informally driven.

The poorly governed partnership relationships between NGO and government constituents in Ethiopia are also attributed to the aforementioned informal or unstructured interface arrangements. Social embeddedness can be simultaneously enabling and constraining to successful digitalization. On the one hand, it can help deal with challenges of uncertainty, facilitating information exchange, decision-making and coordination among collaborating partners (Uzzi, 1997). Conversely, social embeddedness can have negative effects on digitalization when it functions as the sole mode of control for governing how stakeholders collaborate in development projects. As evidenced in this case, individual relations among organizational leaders were dominant means of partnership through which power was exercised in decision-making. The informality of governance in such digitalization projects comes with potential downsides for local governments leading to unclear decision-making, misuse of power and informal wheeling and dealing.

Governing people's behavior and how they are enacted through relation ties is where IT governance impacts can be won or lost (Long, 1999). This is the fundamental dilemma of planning and implementing change, namely, the transformation of agent's behavior. That one cannot explicitly control the intentions and behaviors of project stakeholders is evident. However, collectively agreed upon IT governance structures and processes can function to regulate stakeholders of ICT4D projects, not by only by overt control, but by a form of relational capabilities where a dynamic form of collectives or clan control that relies on shared norms and informal relationships enrolls and conforms behaviors. Such approaches can function in manifold ways to foster conformity and some degree of order (Mosse & Lewis, 2006).

Generally, this highlights the non-prescriptive or non-predictive aspects of relational governance. These relational IT governance capability deals with the 'softer' issues of governing state-NGO relationships, including fostering mutual dependency, trust, cooperation, open communication, and voluntary sharing of information. IT outsourcing studies have identified that the combination of relational governance and structural control (contractual governance) are associated with higher levels of outsourcing success (Lacity, Khan, & Willcocks, 2009).

Relational capabilities such as mutual partnership is necessary for effective governance of project activities. Although difficult to achieve in practice, these shared relations and exchanges among NGOs, donors and government stakeholders need to be accounted for in governance reforms if genuine partnership is to be nurtured. Understandably, this goes against the competitive and profit-driven climate of privately contracted NGOs. Therefore, effectively realizing these ideals will itself demand a political process of ongoing contestations and negotiations.

Chapter 8

This dissertation has presented a critical realist study of the digitalization process of a HIS in Ethiopia. Digitalization in the development context is a complex and multifaceted process. This study has attempted to engage with these complexities by developing causal explanations by uncovering generative mechanisms that were key drivers in the trajectory of the digitalization initiative in Ethiopia.

In this regard, the dissertation demonstrates the analytical and explanatory capacity of Archer's morphogenetic approach for studying the complex process of digitalization. Critical realism has also presented a useful perspective with its philosophical base to highlight the stratified, emergent and transformative nature of digitalization.

Practically, the dissertation grapples with a prevalent problem that has emerged with the prominence of NGO-led development projects. Fundamentally, the lack of state ownership and poor partnership in such projects has led to overreliance on NGOs and has seen the stasis of state institutions. These gaps have persisted, in-part, because of the lack of clear governance arrangements in development projects. As highlighted in this work, informal socio-politics and NGO self-regulation have become default means of governance. However, these have proven to be ineffective. The absence of project accountability and oversight by local government has led to mismanagement and negligible developmental impact.

The work highlights that unprecedented investments in digitalization initiatives have been imbalanced with alternate and perhaps necessary forms of interventions that constitute institutional development. The lack of institutionalization of digitalization processes in local institutions has been an ongoing development concern that remains unaddressed. The outsourcing of development has insulated local government agencies, both technically and financially, producing a myopic perspective that paints a false sense of development. The work challenges this persistent problem by proposing governance reforms for development project practice which can eventually promote a shift away from the prominence of project-based approaches to digitalization.

Fundamentally, I argue for state ownership and state-led development as necessary means by which institutional transformation and sustainable development can take place. As put forward in my thesis, facilitating these shifts will require the cultivation of governance capabilities in development projects. However, such governance reforms will need to contend with the socio-political nature of development at multiple levels. ICT4D projects are permeated by political discontinuities and power asymmetries making this change process complex. The analysis of these socio-political dynamics has been one area this study contributes to. In this regard, social interface analysis can generate better understanding of development practice and also inform how governance interventions in this context can be crafted.

Adequately guiding the activities of development projects will require greater engagement at the social interfaces, since this is where digitalization projects can be transformed among diverse actors who exercise different levels of discursive, decision-making, technical and resource-based power. In closing, this dissertation has aimed to bring a renewed awareness to development project practice and its governance in order to create sustainable digitalization in the health sector.

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Appendix 1: List of documents and areas informed in analysis

Document type	Document title	Key area informed
Assessment reports	Ethiopia Health Sector Development Program (HSDP IV) 2010/11 – 2014/15 Mid-Term Review (August, 2013)	Nation assessment of the eHMIS/PHEM scale-up efforts, software architecture challenges, NGO dependency and overall IT infrastructure status.
	Assessment of the Ethiopian National Health Information System (2007)	Inform the IT monitoring practice in HIS and the governance arrangements that coordinate HIS activities.
	FMOH eHMIS Supportive Supervision Report (June 11-14, 2012)	Collaboration and roles of NGO and government institutions in project activities.
	eHMIS/PHEM site capacity assessments (Tigray & Amhara Regions)	Peripheral level overview of human resources and infrastructural capacity.
National HIS strategy documents	Ethiopia FMOH National health information system strategic plan (2012-2019)	Outline national HIS governance roles and responsibilities, regulations, and a national HIS strategic road map.
Project reports	Addis Ababa & Tigray eHMIS/PHEM Issue-log document (up to June, 2012)	Log of software/hardware issues and bugs including: issue description, issue logged by, assigned person, status and resolution. Role of NGO and government in issue resolution process.
	eHMIS status update report (June 15, 2012)	Overviews of eHMIS implementation status updates (training, assessment, next steps & challenges) in Addis Ababa, Tigray, Amhara, Harari, regions and East Shewa zones.
	Tigray training and implementation update report (May 31 & August 10, 2012)	Tigray region eHMIS/PHEM issues, support activities, key challenges and projected activities.
Meeting minutes	Tigray RHB eHMIS deployment update meeting (March 20, 2012)	Collaboration between NGO staff and Tigray RHB on trainings conducted, deployment activities and sharing lessons learned and challenges.
	Amhara RHB eHMIS deployment planning meeting minutes (April 18, 2012)	Joint decision-making process for eHMIS deployment scope and strategy in Amhara region.
	FMOH eHMIS/PHEM malaria hotspot implementation planning	Decision-making process in determining an implementation strategy of the eHMIS/PHEM in malaria outbreak prone area health facilities.

	meeting (July 24, 2012)	
Statement of work (SOW) and trip reports	eHMIS/PHEM weekly support and implementation report (June 2, 18, 25, 2012 & July 6, 13, 20, 29, 2012)	eHMIS/PHEM support, troubleshooting and implementation activities, challenges and follow-up activities for Addis Ababa, Tigray, and Harari regions.

Appendix 2: eHMIS Survey

Introduction

This survey is part of the eHMIS deployment to improve management information systems in the health sector. The objective of this survey is to carry out a baseline assessment to further develop interventions for improving information system and use of information. Please express your opinion honestly. Your responses will remain confidential and will not be shared with anyone. We appreciate your assistance and cooperation in completing this survey.

Name of Woreda/Hospital: _____

Age: _____	Gender	Work position: _____	Years of employment: _____	Education:
	<input type="checkbox"/> Male			<input type="checkbox"/> Grade 10
	<input type="checkbox"/> Female			<input type="checkbox"/> Secondary School
				<input type="checkbox"/> Diploma
				<input type="checkbox"/> Degree

A. About your computer experience

Please state the number of years of computer experience _____

How would you rate your computer skills?	Lowest	Average	Highest	
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Have you ever taken a computer course?	<input type="checkbox"/> Yes	<input type="checkbox"/> No		
Do you use a computer in the workplace?	<input type="checkbox"/> Yes	<input type="checkbox"/> No		
How frequently do you use a computer?	<input type="checkbox"/> Daily	<input type="checkbox"/> Weekly	<input type="checkbox"/> Monthly	<input type="checkbox"/> Very rarely

B. About the current health information management systems at your Woreda/Hospital

Training

Did you receive any training in HMIS related activities in last 2 years? Yes No

The training was sufficient for me to carry out my work effectively.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Strongly disagree	Somewhat disagree	Disagree	Agree	Somewhat agree	Strongly agree

Data completeness & accuracy

How would you rate the completeness and consistency of data from health facilities? <20% complete 20-50% complete 50-80% complete 80-90% complete 100% complete

How would you rate the accuracy of data from health facilities? <20% accurate 20-50% accurate 50-80% accurate 80-90% accurate 100% accurate

Does your Woreda/Hospital compile its own monthly, quarterly, and annual reports disaggregated by facility? Yes No

Information Use

	Strongly disagree	Somewhat disagree	Disagree	Agree	Somewhat agree	Strongly agree
There is demand from regional health bureau for complete, timely, accurate, validated HMIS data.	1	2	3	4	5	6
Graphs are widely used to display information at your Woreda/Hospital.	1	2	3	4	5	6
Health information used in planning and in the resource allocation process (e.g. annual targets, long-term strategic plans).	1	2	3	4	5	6
I consider the information in the current system to be easily available.	1	2	3	4	5	6
I often get the information I need in time.	1	2	3	4	5	6
The current system often provides up-to-date information.	1	2	3	4	5	6
I feel there is a gap between the information we have and the information we need.	1	2	3	4	5	6
What do you do with reports when you have completed them?	<input type="checkbox"/> Analyze locally	<input type="checkbox"/> Complete and send				

Data collection/Analysis

How much time (hours/days) do you spend in collecting data and writing reports? _____

Are there any problems with data storage? _____

Do you analyze data at your level using the following? Graphs Tables Indicators

How much time (hours/days) do you spend in analyzing data? _____

Information Flow

	Strongly disagree	Somewhat disagree	Disagree	Agree	Somewhat agree	Strongly agree
Reports are submitted to regional health bureau on time.	1	2	3	4	5	6
The regional health bureau demands for reports.	1	2	3	4	5	6
I have problems sending reports to the regional health bureau.	1	2	3	4	5	6
How are you sending your reports to the regional health bureau?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
	Carrying it yourself	Sending it with other people	By post			

Perceived usefulness

Do you think computer software can improve data processing at the Woreda/Hospital? Yes No Indifferent

Why? _____

Appendix 3: HMIS architecture for data monitoring, aggregation and reporting

Health Institution	Data source(s) for monitoring	Frequency of data aggregation/ reporting	Amount of data (total reports generated annually)	Frequency of performance monitoring
Health post (HP) (16,640)	Own data	Monthly/ Quarterly	199,680	Monthly/ Quarterly
Health center (3,547)	Own data + HP report	Monthly/ Quarterly	242,244	Monthly by department / Quarterly by HI
Hospital (311)	Own data	Monthly/ Quarterly	3,732	Monthly by department / Quarterly by HI
Woreda Health Office (WorHO) (817)	Own administrative data + HF report	Quarterly	245,512 (excluding hospital reports)	Quarterly
Zonal Health Department (ZHD) (62)	WorHO report + Hospital report	Quarterly	249,244	Quarterly
Regional Health Bureau (RHB) (11)	Own administrative data + WorHO/ ZHD report	Quarterly	249,288	Quarterly
FMOH	Own administrative data + RHB report	Quarterly	249,292	Quarterly

HF – Health Facility (i.e. health post, health center, hospital) **HI** – Health Institution (all institutions including HF)

Digitalization mechanisms of health management information systems in developing countries

Abstract

The developmental potential of IT in developing countries continues to be confronted by enduring problems that hamper both the sustainability of digitalization initiatives and the realization of their expected benefits. Using a critical realist perspective, this paper examines the underlying causal chain of health management information system (HMIS) digitalization in a developing country. The study develops a mechanism-based explanation of the digitalization process drawing on Archer's morphogenetic approach (1995). Four generative mechanisms of HMIS digitalization were identified: projectification, informatization, embedded inscription and scaling. Theoretically, the paper demonstrates the joint value of Archer's structurational theory and the dynamics of interrelated causal mechanisms of digitalization. Practically, the mechanisms have implications for management practice in helping diagnose and address key developmental gaps of digitalization in this context.

1 Introduction

This paper engages with the process of digitalization in the health sector of developing countries. Information communication technology (ICT), particularly health information systems (HIS) implementation, has increased significantly across numerous developing countries. These digitalization efforts aim to address the various challenges that local governments face in managing their health systems. Digitalization in this context is expected to reduce cumbersome documentation and paperwork and increase the efficiency and quality of data collation and analysis routines to support decision-making.

The term 'digitalization' is used throughout this paper to refer to the development and implementation of ICT systems and concomitant organizational change (Yoo, Lyytinen, Boland, & Berente, 2010). Therefore, digitalization extends beyond the mere conversion of manual data into a digital format (i.e. digitization) (Tilson, Lyytinen, & Sørensen, 2010; Yoo, et al., 2010). Rather it involves the transformation of socio-technical structures formerly mediated by non-digital artefacts into ones mediated by digitized artefacts (Yoo, et al., 2010). As a result, digitalization is a socio-technical process the outcome of which leads to the digitization of content and ensuing reconfiguration of roles, relationships, practices and organizational structures (Tilson, et al., 2010). Yoo, et al. (2010) reiterate that this "process of digitalization is dynamic, chaotic, multipath and expansive" (p. 7).

Digitalization in the developing country context especially presents a unique problem characterized by diversity, complexity and significance. Diversity and complexity are due to the heterogeneous and intertwined set of interorganizational actors and the existing structures of domination and legitimation (Walsham, Robey, & Sahay, 2007). Significance is due to the spirit of development that underscores much IS research in this context and which is a fundamental aim of digitalization (Avgerou, 2008; Walsham, et al., 2007). The development focus particularly requires engagement with deep structural conditions of infrastructure and social order (Avgerou, 2008; Silva, 2007). This impinges on the way digitalization transpires and the nature of the process of 'development' towards which such digitalization is intended to contribute (Avgerou, 2008).

Consequently, the developing country context highlights dimensions of digitalization that have received little attention in mainstream IS research (Avgerou, 2008). These issues are especially visible in the health sector where global politics and the broader socio-economic context condition the process of socio-technical change (Sahay, Monteiro, & Aanestad, 2009; Silva & Hirschheim, 2007).

For over 20 years, various developing countries have attempted to digitalize their health management information systems (HMIS) with limited sustainable success (Sahay, Sæbø, Mekonnen, & Gizaw, 2010; Sahay & Walsham, 2006; Silva & Hirschheim, 2007). Many digitalization efforts often fail to meet their objectives (Heeks, 2002). Failures are often attributed to the challenge of complexity (Braa, Hanseth, Heywood, Mohammed, & Shaw, 2007) and the interrelationship between context and action that underlies the digitalization process (Heeks, 2002). This complexity is characterized by infrastructural gaps and heterogeneity and interrelatedness of actors and agendas of political, public and third sector institutions and global players (Njihia & Merali, 2013). These circumstances have produced counterproductive and unintended consequences, which raise questions about the underlying mechanisms that drive the process of digitalization and its outcomes in this context.

These questions call for a research focus and relevant theoretical grounding for understanding the underlying dynamics of digitalization.. Uncovering the socio-technical process of digitalization so as to identify the generative mechanisms that trigger transformations in social and material structures requires a conceptual framework that can be used to explain this change over time.

A generative mechanism is an emergent and causal power that arises from the interplay between structural properties and properties of agency through which observable events are produced (Archer, 2015). This study draws on the digitalization literature and Archer's (1995) morphogenetic approach to develop a conceptual scaffold to identify generative mechanism of HMIS digitalization. The research questions guiding the research are:

- (i) What are the generative mechanisms that influence the trajectory of health management information system digitalization in developing countries?
- (ii) How can they inform the technical and social dynamics of the implementation and management of digitalization in this context?

This study engages with this under-emphasized area in ICT4D (ICT for development) research dealing with developing mechanism-based explanations in order to understand the process of digitalization and how and why particular digitalization outcomes are produced. Theoretically, the study contributes to understanding the mutually and emergently transformed interactions between social and technical elements in the process of digitalization. Practically, the study is of relevance to the management of digitalization projects in the developing country health sector.

The paper proceeds by providing a brief review of digitalization in the developing country context. In section three, the theoretical frame and conceptual framework are presented followed by the research approach in section four. In section five, the case of the Ethiopia eHMIS, a national digitalization initiative is presented. Analysis , and discussions are offered in section six and seven respectively, followed by implications and concluding remarks.

2 Background

2.1 Perspectives of digitalization in developing countries

Unique and theoretically relevant insights for understanding the process of digitalization have been garnered from IS research in developing countries (Avgerou, 2008). In her review of ICT4D research, Avgerou (2008) identifies three predominant discourse. The first discourse focuses on the digitalization process drawing on a process-based explanation of technology and knowledge transfer. Researchers within this "transfer and diffusion" discourse often adopt system development approaches and best practices, although adapted to the context-specific demands of the developing countries.

Under this discourse, a number of studies in the health sector make the case for the adoption of various approaches in digitalization initiatives such as management practices of IT governance, enterprise architecture (Gebre-Mariam & Fruijt, 2017); strategic alignment (Odit, Rwashana, & Kituyi, 2014) and eHealth strategies for standardizing and integration of HIS (Braa & Sahay, 2012; Sæbø, Kossi, Titlestad,

Tohouri, & Braa, 2011). Other studies emphasize the transfer of technologies such as data warehouses (Braa & Sahay, 2012), health information exchange (Crichton, Moodley, A. Pillay, Seebregts, & Gakuba, 2013) and the emulation of the organizations of advanced countries (Mudaly, Moodley, Pillay, & Seebregts, 2013).

The second research stream relates the digitalization process as change occurring through socially embedded action, primarily studied from the perspectives of social construction and situated action (Bijker & Law, 1992; Ciborra & Associates, 2000). Further work espousing this tradition has examined how prevailing interests influence the shaping of technology through a process of “inscription” (Latour, 1992). Within this research perspective, studies in the health sector have examined how social interests, interpretations, conflicts and the process of negotiation aimed at attaining legitimacy and consensus influence digitalization (Sahay, et al., 2009; Silva & Hirschheim, 2007). Extensive research in this area has come out of the Health Information System Program (HISP) which has been involved in implementation of various HIS (Braa, Hanseth, et al., 2007; Braa, Monteiro, & Sahay, 2004; Sahay & Walsham, 2006). These studies carry out context-specific analysis dealing with a broad set of areas in the digitalization process including institutional, sociological and technical issues drawing on socio-theoretical approaches.

Lastly, digitalization in developing countries has been studied as a transformative process that is linked to its broader social context, namely, the global political and economic conditions that impinge on developing countries (Ciborra, 2005). Studies of large-scale digitalization initiatives in the developing country health sector have found that they are shaped by electoral processes, governance structures, telecom policies, funding, donor policies and other macro level issues (Sahay & Walsham, 2006; Silva & Hirschheim, 2007).

2.2 Theoretical challenges of digitalization studies in ICT4D

Three theoretical challenges are identified across the broadly categorized streams of ICT4D research (Avgerou, 2010). The first challenge deals with theorizing contextual contingency. Understanding the interrelationship between the broader context and digitalization has been a key focus of the extant ICT4D research, particularly in the socially embedded discourse. However, exactly where one starts in their analysis of the broader context (i.e. social, political, cultural and economic conditions) is often a matter of judgment in a particular context. Additionally, the relationship between context and agency is of key focus in such analysis. Avgerou (2010, pp. 11,12) argues that: “theory is needed to identify what is relevant context for each case of ICT innovation, and how it matters... More systematic theorizing efforts are needed to understand how the socioeconomic context enables or constrains”. The primary contextual issue that emerge in ICTD studies involve the role of the cultural and structural systems in which digitalization takes place (Avgerou, 2001; Njihia & Merali, 2013). In particular, there is a challenge of explicating culture and structure and its relationship with agency in ICT4D research.

The second theoretical challenge in ICT4D deals with developing theoretical foundations for linking ICT innovation with ICT-based development outcomes (Avgerou, 2010; Heeks, 2006). The role of ICT on institutional effectiveness, improvement of public services and its overall implication on those that are marginalized is of key emphasis. In this regards, development researchers have emphasized the need for deeper understanding of development practice as it relates to performance and outcomes (Heeks &

Stanforth, 2014; Lewis, et al., 2003; Mosse & Lewis, 2006). However, making these difficult links requires a theoretical approach that explicates development processes and the entanglement of not only actors and institutions but the material properties of technology. Lastly, Avgerou (2010) calls for research that brings together the two theoretical challenges aforementioned: context-based theorizing of digitalization and theories on ICT-enabled development. This demands theoretical grounding that enables researchers to navigate the macro-micro analytical domains.

Drawing on these theoretical challenges, we set the dynamics between structure, culture and agency and its systemic outcomes as a key focus of our analysis. While there is an increasing awareness of the relationship between structure and agency in IS research, studies tend to emphasize one or the other. This leads to a propensity to conflate, treating either agents or structures as byproducts of the other (Archer, 1995). Therefore, we adopted a non-conflationary approach to studying digitalization phenomena by adopting a theoretical device that gives equal prominence to structure and agency. To anticipate our later discussion, we draw on a strategy of analytical dualism by separating structure and agency in order to explore the relational processes of socio-technical change over time (Archer, 1995; Mutch, 2010).

This dialectics between structure and agency in IS has been a longstanding debate. However, a key focus in further advancing our understanding of digitalization is developing explanations as to why and how structure, culture and agency are brought together in such a way to produce new organizational forms or socio-technical structures (Leonardi, 2011). Therefore, to understand the locally emergent relationship between technology and organizational change, it is necessary to focus on situated instantiations by examining the specific interactions that play out in particular contexts (Leonardi, 2013).

Drawing on this premise, this study engages with an under-emphasized area in ICT4D research dealing with developing mechanism-based explanations that clarify how and why the structure, culture and agency mutually and emergently interact in ways that trigger particular digitalization outcomes. In line with this aim, Leonardi (2013) calls for IS researchers to explain IS phenomena by identifying specific mechanisms that clarify the interplay between the social and the material. Various IS researchers also highlight the value of identifying mechanisms for generating causal explanations of IS phenomena (Aaltonen & Tempini, 2015; Avgerou, 2013; Bygstad, 2010; Bygstad, Munkvold, & Volkoff, 2016; Mingers & Standing, 2017; Volkoff & Strong, 2013).

3 Theoretical foundation: Realist approach and morphogenesis

Given the socio-technical nature of digitalization, unpacking this process to identify the mechanisms that trigger organizational change requires an adequate ontological underpinning and a theoretical apparatus that can be used to study the interaction between the technology and macro-micro social contexts. For this, we draw on a critical realist perspective.

According to critical realism, reality is stratified; meaning there are several levels of reality (Bhaskar, 1978). These include the empirical, the actual and the real. The *empirical* consists of that which is directly observed or experienced and which can be accessed by our senses. The *actual* exists underneath the empirical and consists of events and actions (Bhaskar, 1978). Lastly, the *real* subsumes the domains of

the empirical and actual and comprises of underlying structures and mechanisms that give rise to events and empirical observations (Bhaskar, 1978).

Critical realism also asserts that reality is emergent, in that entities existing at one level are fixed in, but irreducible to, entities existing at another level (Fleetwood, 2014). Emergent properties arise from the relations that develop among entities. Lastly, reality is transformational. This concept is captured by Bhaskar's Transformation Model of Social Action (TMSA) and Archer's morphogenetic approach (Archer, 1995; Bhaskar, 1978). Agents do not simply create structures but rather transform and reproduce pre-existing structures. Thus, every action necessitates the pre-existence of structures, which agents exploit to trigger that action (Fleetwood, 2014).

3.1 The Morphogenetic Approach

The relationship between structure, culture, and agency and their systemic outcomes is the primary theoretical focus of the paper and which the mechanism-based explanation aims to uncover. For this, we draw on Archer's morphogenetic approach as the primary theoretical underpinning for conceptualizing the structure-culture-agency interplay (Archer, 1995). The morphogenetic approach proposes the principles of temporal separability and analytical dualism for examining the interplay between structure, culture and agency.

Accordingly, Archer (1995) distinguishes between three types of emergent property - structural emergent properties (SEPs), cultural emergent properties (CEPs) and people's emergent properties (PEPs) – and therefore three types of generative mechanism or causal power. SEPs are defined as “those internal and necessary relationships which entail material resources, whether physical or human, and which generate causal powers proper to the relations itself” (Archer, 1995, p. 177). SEPs are relatively enduring systems whose change primarily depends on material resources (Archer, 1995). SEPs relate to the allocation of resources, roles, or institutional arrangements. On the other hand, CEPs are properties of the cultural system and encompass the world of ideas, beliefs, theories and values, which can be contained in particular discourse. Lastly, PEPs are where human agency is exercised. This is also where agential relations produce emergent power in two ways; “they modify the capacities of component members (affecting their consciousness and commitments, affinities and animosities) and exert causal powers proper to their relations themselves vis-a-vis other agents or their groupings (such as association, organization, opposition and articulation of interests)” (Archer, 1995, p. 184).

Based on this, Archer (1995, p. 157) suggests two basic propositions in the morphogenetic approach:

- i. That structure/culture necessarily pre-dates the action(s) which transform it.
- ii. That socio-cultural elaboration necessarily post-dates those social interactions and actions which have transformed it.

Archer argues that these two premises mitigate the problem of conflating structure and agency by proposing analytical dualism; where agency and structure, although ontologically intertwined, are separated for the purpose of analyzing their dynamics (Archer, 2010). Uncovering and explaining the interplay between structure and agency is at the heart of Archer's morphogenetic approach. Here, the

particular focus is on the emergent process by which structure and agency shape and reshape each other to generate diverse outcomes. Archer also states that “what is pivotal are the conditional and generative mechanism operating between structure and agency”(Archer, 1995, p. 16).

The morphogenetic cycle consists of three temporally distinct analytical phases: *structural/cultural conditions* (a specific structure/culture which conditions but does not determine); *socio-cultural interactions* (actions and interactions of people organized in various ways as agents); and *structural/cultural elaboration* (transformation or reproduction of structural/cultural properties) (Archer, 1995). *Morphogenesis* occurs when social interactions result in transformation of preexisting structures; while *morphostasis* is the condition where the interactions reproduce the existing structures (Archer, 1995).

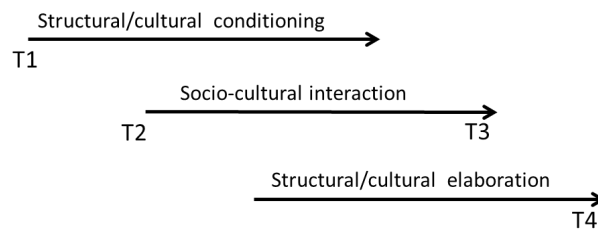


Figure 1. The morphogenetic cycle (adapted from Archer, 1995, p.193)

Time is a critical dimension in the morphogenetic approach. The sequence of the morphogenetic/static cycle begins at T1, which relates to prior structural conditioning of existing social reality. The subsequent period, T2 and T3, relate to the mediating action of agency through *social interaction*. Subsequently, emergent change results in *structural elaboration* by T4. The morphogenetic approach provides an apparatus to link organizational change that involve technology to broader economic and political structures (Mutch, 2010). This is especially relevant for understanding the broader context of ICT projects and implementation in developing countries (Njihia & Merali, 2013).

However, one of the criticisms of the morphogenetic approach is that specific attributes of technology remain unaccounted for (Mutch, 2010). Similarly, Gidden’s work also contains limited consideration of technology which has led to notable work in the IS field by researchers such as Orlikowski who brought structuration into discussion with technology (W. Orlikowski, 1992; W Orlikowski, 2000). Archer is less engaged in addressing the use and impact of technology in her work (Mutch, 2010). More recent work by Mutch (2010) has proposed a morphogenetic approach to technology. This study continues the development of a morphogenetic approach to conceptualizing the adoption of technology in organizations based on empirically based analysis. To do this, technology is incorporated into the morphogenetic cycle, namely in the analysis of social interactions and the elaboration of structures (Mutch, 2010). This requires understanding and explaining both the properties of technology and the nature of its change as a result of its association with structural conditions and social interactions.

Overall, realist social theory and the morphogenetic cycle provide a conceptual scaffolding for examining interactions between structure/culture, agency and technology and offers a relevant theoretical framing for identifying generative mechanisms.

3.2 Generative Mechanisms

Contrary to positivism and interpretivism, a critical realist view of causation is rooted in the concept of generative mechanisms (Bhaskar, 1978). Generative mechanism can simply be defined as causal powers or tendencies that explain an empirical outcome (Fleetwood, 2014; Sayer, 1992). They are inherent to social or physical structures, facilitating or hindering what can happen within a given context (Sayer, 2000). In IS phenomenon, the entities of mechanisms can consist of individuals, groups, organizations and IT artifacts.

According to the stratified reality of critical realism, generative mechanisms do not exist at the level of empirical events but rather at the domain of the real. Accordingly, establishing causation shifts from the examination of event regularities or the repeated succession of events to consider the conditions that make those events possible (Sayer, 2000). Empirically observable events can be likened to symptoms, which a doctor examines to make a diagnosis of the root cause.

Generative mechanisms are contingent, complex and conjunctural (Bhaskar, 1978). They are contingent because they often occur in open systems of the social world where a range of mechanisms exists and converge. It is complex and conjunctural because there are a number of entities and relations that can produce a chaotic and disordered series of mechanisms, each generating their own tendencies, thereby counteracting and reinforcing each other (Bhaskar, 1978).

Consequently, a focus of critical realist research is to identify sets of generative mechanisms and how their interactions triggered particular events. Developing such a comprehensive causal explanation of social phenomenon cuts across levels of analyses to include the actions of individuals/groups and the social context in which they are embedded (Avgerou, 2013). A number of approaches have been proposed for identifying mechanisms at different levels (Mingers & Standing, 2017).

A widely adopted perspective is the macro-micro-macro approach for identifying three distinct causal episodes (Coleman, 1986). Drawing on Coleman's work, Hedström and Swedberg's (1998) propose three types of mechanisms. First are situational mechanisms (macro-micro) which relate to contextual conditions that influence the beliefs, desires and actions of people. Second are action-formation mechanisms (micro-micro) which explain how the combination of individual desires, beliefs and opportunities generate a specific action. Lastly, transformational mechanisms (micro-macro) explain how the actions and interactions of actors are transformed into a collective outcome at the macro level.

A critical realist approach that resembles Hedström and Swedberg's macro-micro-macro categorization of mechanisms is Archer's morphogenetic approach. For Archer, generative mechanisms are emergent properties where "the relations between its components are internal and necessary ones rather than seemingly regular concatenations of heterogeneous features" (Archer, 1995, p. 173). Archer proposes three types of generative mechanisms consistent with the three types of emergent property in the morphogenetic cycle – structural, cultural, and people's emergent properties (SEPs, CEPs, and PEPs). Based on the critical realist stratification of reality (i.e. real, actual and empirical domains), Archer argues that "the morphogenetic approach makes no leap from the real to the actual, but rather dwells on the ground between them by analyzing the generative mechanisms potentially emanating from structures

(and cultures) as emergent properties and their reception by people, with their own emergent powers of self and social reflection” (Archer, 1995, p. 175). We build on concepts from morphogenetic approach to outline the conceptual framework for the research.

3.3 Conceptual Framework

The conceptual framework of the research is grounded in the aforementioned morphogenetic approach and is outlined in Figure 2. The arrows in the conceptual framework (Figure 2) are not intended to indicate propositions but dynamic relationships explained through the causal processes of mechanisms.

Structural conditioning: at T1, the first phase of the morphogenetic cycle, structures (institutions, roles, routines) emerge over time from the previous actions of human actors, but once in place form the conditions for exercising agency (Archer, 1995). In line with Mutch (2010), technology is not viewed as a structure in itself, rather technology has the capacity to mediate the properties of structures. Therefore, structures can both constrain and enable actors by mediating social interactions and by its properties being inscribed in technology (Mutch, 2010; Mutch, Delbridge, & Ventresca, 2006). From the case analysis in this study, two key structural conditions are identified and explored: (i) governance arrangements and (ii) architectural constellations.

Governance arrangement: refers to the distribution of decision-making rights among enterprise stakeholders, and the procedures for making and monitoring decisions (Weill & Ross, 2004). Recent studies have found that governance structures are key factors influencing the processes and outcome of digitalization initiatives (Henfridsson & Bygstad, 2013; Kierkegaard, 2015). Governance arrangement among institutional actors is identified as a key structural condition in our study.

Architectural constellation: refers to the components that make up a system, their properties and the relationships between them. Architectural constellations can be viewed as a pre-established structural condition relating to the assemblage of data, business process, and IT infrastructure. Such a view of architecture goes beyond its technical properties but also relates to a holistic system view of an organization’s health information infrastructure. Architecture is an important condition in digitalization (Braa & Sahay, 2012; Henfridsson & Bygstad, 2013).

Socio-technical interaction: T2-T3 corresponds to the next phase of the morphogenetic cycle, which refers to the actions and events taking place between T2 and T3. Here, the interplay between the properties of technology and agents’ social interaction transpire. Agents are enabled and constrained by preexisting structural conditions under which they operate (Archer, 1995). Aspects of structural properties can be inscribed into certain properties of technology which renders some features of the structure durable (Mutch, 2010; Yoo, 2013). These structural conditions are mediated by social interactions (Archer, 1995; Mutch, 2010).

An important consideration in this study is that the social interaction of agents is not only shaped by their engagement with each other and structural conditions but also by the properties of technology (Mutch, 2002). This dynamic relationship of technology with its social context is mediated by the action of agency through social interactions. Simply put, this refers to the action of diverse agents involved in the process

of technology development and implementation. Together, this phase of digitalization in the morphogenetic cycle is referred to as socio-technical interaction (T2 – T3).

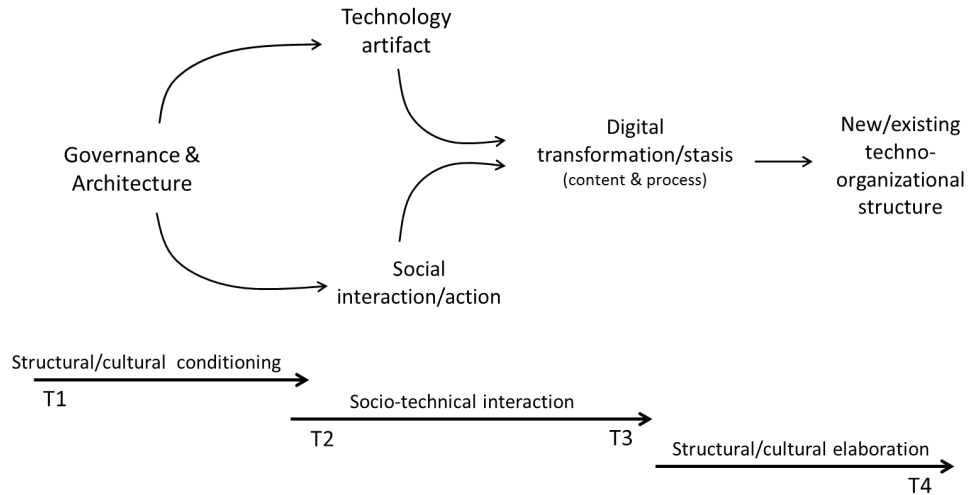


Figure 2. Conceptual framework: a morphogenetic approach to digitalization

Structural/cultural elaboration: at T4, the socio-technical interaction from the previous phase actualizes digitalization outcomes, which could be favorable or unfavorable. New socio-technical configurations could emerge resulting in some level of digitalization, that is, change where morphogenesis occurs. This is where socio-technical interaction results in the transformation of the pre-existing architectural constellations. On the contrary, morphostasis can ensue when the interactions reproduce the existing structures/cultures.

Table 1. Conceptual framework definitions			
	Concepts	Description	Examples
Structural/cultural conditioning	Governance arrangement	The structures framing the distribution of decision-rights and accountability frameworks in digitalization	<ul style="list-style-type: none"> Centralized/decentralized IT steering committee IT project office
	Architectural constellation	The structure of components and their inter-relationships that support an organization's function	<ul style="list-style-type: none"> Healthcare data Data management tools/procedures Business processes IT infrastructure
Socio-cultural interaction	Technology artifact	Set of hardware infrastructure, software applications, and informational content that serve specific functions of an organization	<ul style="list-style-type: none"> ERP systems Electronic medical record systems
	Social interaction/action	Agents interactions in collaborative initiatives to achieve outcomes of common interest	<ul style="list-style-type: none"> Meetings (formal/informal)
	Digital transformation/stasis	The application of digital capabilities to content and processes to improve efficiency and effectiveness	<ul style="list-style-type: none">
Structural elaboration	Techno-organizational structure (new/remaining)	Change/reproduction of structures consisting of networks of human, social and technical entities,	<ul style="list-style-type: none"> Transformation/stasis of IT governance arrangements

			<ul style="list-style-type: none"> • Transformation/stasis architectural constellation
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Drawing on the outlined conceptual framework and the theoretical underpinning of the morphogenetic approach, the study develops mechanism-based explanations in order to understand the distinct causal episodes that explain how and why particular digitalization outcomes occurred in the Ethiopian case. In line with this, two questions are proposed: (a) what are the generative mechanisms that influence the trajectory of health management information system digitalization in developing countries? and (b) how can these mechanisms inform the technical and social dynamics of digitalization in this context?

4 Method

The research approach was an in-depth case study of the national HMIS digitalization effort in Ethiopia. An in-depth case study research approach was selected because of its usefulness to examine a phenomenon that is broad and complex and to untangle a complex set of factors and relationships (Easton, 2010). The case study approach was also useful for explaining at a conceptual level, processes, actions, and/or interactions (Easton, 2010). The main unit of analysis is the process of digitalization in Ethiopia followed over a course of 4 years from 2012 to 2016.

4.1 Data collection

The data collection was conducted iteratively and involved participant observation, semi-structured interviews, and document reviews. The first data source was from longitudinal participant observations. From March 2012 to March 2013, data were collected from on-the-ground involvement of the first author with the eHMIS project in various activities including; implementation, training, support, and software prototyping by engaging with various local users. Documentation of events was carried out based on observations and interactions with a range of stakeholders in the Ethiopian Federal Ministry of Health (FMOH), two regional health bureaus (RHBs), and numerous districts and health facilities through various software prototyping, implementation and training engagements.

Project narratives of key events were documented to provide detailed insights on the case. These events included large scale implementations, trainings, and technical support efforts in particular regions during the period of the author's involvement. The main documentation method employed was retrospective journaling. The journaling was an iterative process including descriptive accounts of events among key actors and organizations involved, their roles, the overall progress and outcome of activities, and how they were managed.

Participant observation also allowed the study of the case as it unfolded (Lincoln & Guba, 1985). It offered a valuable insider perspective, enriching the researcher's understanding and the possibility to follow the case from different perspectives. This presented a far greater learning opportunity (about the inner workings of an NGO, the challenges of the digitalization process, and the role and rationalities of the various inter-organizational stakeholders) than could have been obtained using structured methods such as interviews or surveys. It provided contextual relevance, richness and sensitivity to historical and developmental processes not only to describe events but to understand why they occur (Lincoln & Guba, 1985).

Despite its advantages, this type of research raises concerns with bias. To mitigate potential biases, supplementary data was collected through interviews and document reviews. Project documents were used to corroborate observation data and for obtaining retrospective data for periods prior to the author's involvement. Additionally, the involvement of the second author, who was not part of the project, has allowed for objective input in informing the particular issues and concepts during the analysis and write-up.

The second data collection technique was semi-structured interviews conducted between January and March 2016 in Ethiopia. A total of 13 informants were interviewed: one from a major donor organization, six NGO staff, four from local government organizations and two from a multilateral organization. Participants were selected based on a purposive sampling strategy based on their involvement and familiarity in the case, their knowledge of the eHealth domain in Ethiopia, their working experience with government and NGO's and possibility to provide rich information and deep insight about the case (Patton, 2002). Accordingly, NGO staff, government staff and donor representatives were recruited for participation. Interview notes were used to capture the data from the interviews as some participants declined to be recorded. Recorded interviews were transcribed. Interview notes and transcripts were thermalized in order to inform case narrative and analysis (see Table 1). The third data source included archival documents including meeting/workshop minutes, project reports, national implementation strategy documents, and pertinent assessments reports of the digitalization initiative in Ethiopia. Both the document reviews and interviews were used to gather retrospective data for earlier periods in the project.

4.2 Data analysis

The data analysis was grounded in a critical realist analysis approach (Easton, 2010; Sayer, 2000). More specifically, the steps and principles for critical realist data analysis proposed by Bygstad and Munkvold (2011) was used to guide the analysis (see Table 1).

The first stage of the analysis involved preparation of the data for analysis. Here, accounts of the case were extracted from various sources by developing notes of observations, summary notes of interviews, and writing short summaries of key documents relevant to the case (Sayer, 2000). This stage was essential for producing an initial overview of the case and for condensing the data into brief summaries organized around key events.

The second stage of analysis involved repackaging and aggregating the data. Drawing on Miles and Huberman (1994), this involved identifying themes and trends in the data. The aim was to move from a descriptive to a conceptual level. Initially, a conceptual approach had to be identified that could provide an organizing schema and offer a relevant framing for the case. Given the focus on how particular structure-agency interplays influence the transformational change in the digitalization process, the morphogenetic cycle (Archer, 1995) was identified as a useful underpinning for organizing the events and concepts in the case. Accordingly, the unfolding of events in the digitalization phenomenon were grouped into the three temporal phases of the morphogenetic cycle.

For each of the emergent properties (i.e. structural, cultural, people), we set out to identify the generative mechanism that triggered observed outcomes. A process of retroduction was employed as outlined in Table 1.

Table 2. Data Analysis Process	
Stage	Activity/Outcome
1. Description of events and issues	<ul style="list-style-type: none"> • Chronological account of HMIS digitalization • Description of key events in the digitalization process developed and categorized into three distinct phases based on Archer (1995) (Section 6.1-6.3)
2. Identification of key entities	<ul style="list-style-type: none"> • Key entities (i.e. actors, organization, artifacts) identified informed by the theoretical focus and drawing on observation and interview data.
3. Theoretical re-description (abduction)	<ul style="list-style-type: none"> • How particular structure-agency interplays unfolded to influence the digitalization process identified as a key theoretical focus • Morphogenetic approach selected as the main theoretical underpinning (Archer, 1995)
4. Retroduction: Identification of candidate mechanisms	
a. Identification of immediate outcomes	<ul style="list-style-type: none"> • Concrete outcomes of digitalization identified for each phases of the morphogenetic cycle (Archer, 1995)
b. Analysis of interplay among key entities	<ul style="list-style-type: none"> • Interplay among human and technical entities examined based on critical realist perspectives (Fleetwood, 2014; Mutch, 2010).
c. Identification of stimulating and releasing conditions	<ul style="list-style-type: none"> • Sets of structural and cultural properties assessed for the conditions that stimulated and released the actualization of relational entities •
5. Analysis of selected mechanisms	<ul style="list-style-type: none"> • Candidate mechanisms and their actualization identified for each phases of the morphogenetic cycle (Archer, 1995) • Develop explanation of the causal process based on the interaction and dependency among interrelated entities and ensuing immediate outcomes
6. Assessment of explanatory power	<ul style="list-style-type: none"> • Empirical corroboration conducted to select the mechanism with the strongest explanatory power for the observed digitalization events and outcomes

First, low-level and high-level outcomes were identified for each emergent property. Through abductive reasoning, we deliberated on sets of internal and necessary relations whose interaction explained the observed low-level outcomes. Additionally, key stimulating and releasing conditions (i.e. conditions) were identified by examining their influence on the identified entities. Finally, these relational entities and their immediate outcomes were considered together to explain the emergence of high-level outcomes. Through this process, candidate mechanisms were identified for each phase of the morphogenetic cycle. Mechanisms with the strongest explanatory power related to the empirical evidence were then selected (Bygstad, et al., 2015).

Overall, mechanisms that correspond to one of the three emergent properties – structural, cultural and people’s (SEPs, CEPs and PEPs) were identified. Each mechanism (*M*) linked conditions (*C*) to outcomes (*O*), thereby, explaining the input condition for that mechanism to be triggered and its ensuing outcomes (see Figure 3). However, we also needed to analyze the links among the mechanisms. For this, we examined the extent to which the outcomes of an actualized mechanism were an input to a subsequent mechanism.

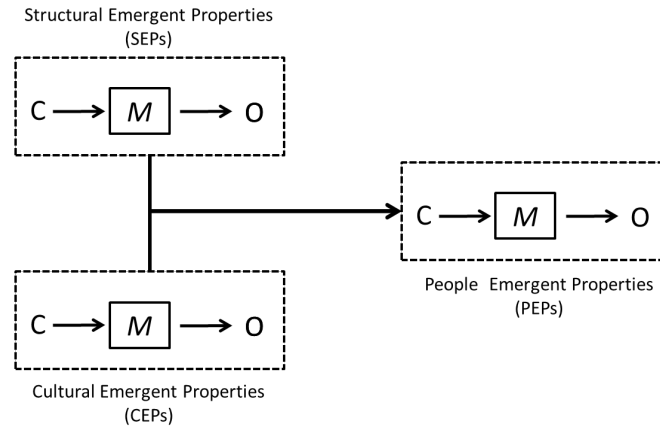


Figure 3. Concatenation of mechanisms

5 Case Description

This paper examines a case of a digitalization initiative called the eHMIS (electronic health management information systems) in Ethiopia. The eHMIS is the first nation-wide ICT implementation of its kind in the Ethiopian health sector. The system was developed by a donor-funded international organization; hereafter referred to simply as NGO. The eHMIS is a core system in the Ethiopian Federal Ministry of Health’s (FMOH) effort to digitalize various health services in the country. These efforts are part of a comprehensive 20-year plan; the Health Sector Development Program (HSDP), which aims to improve health service coverage and service utilization (FMOH, 2010).

The eHMIS project was initiated in 2009 with the aim of facilitating a more effective HMIS in the Ethiopia health system. The HMIS makes up the primary routine health data of the Ethiopian public health system that is arranged in a decentralized tier system consisting of health posts, health centers, hospitals, districts (Woredas), zones and regions. The HMIS includes a set of morbidity, mortality and service delivery data that are collected from various facility level registers. The aggregated data from facilities is recorded as indicators and compiled into reports. Reports are submitted to higher level administrative health institutions who then add their own administrative data and aggregate the reports from different health facilities and submit them to the next level until it reaches the FMOH (see Table 3). Overall, the HMIS tools aim to instill standardization of data collection and reporting across the country and support informed strategic decision making and management.

Table 3. HMIS architecture for data monitoring, aggregation and reporting			
Health Institution (No.)	HMIS data source(s) for monitoring	Frequency of data aggregation/ reporting	Amount of data (total reports generated annually)
Health post (HP) (16,640)	Own data	Monthly/ Quarterly	199,680
Health center (3,547)	Own data + HP report	Monthly/ Quarterly	242,244
Hospital (311)	Own data	Monthly/ Quarterly	3,732

Table 3. HMIS architecture for data monitoring, aggregation and reporting			
Health Institution (No.)	HMIS data source(s) for monitoring	Frequency of data aggregation/ reporting	Amount of data (total reports generated annually)
District/Woreda Health Office (WorHO) (817)	Own administrative data + HF report	Quarterly	245,512 (excluding hospital reports)
Zonal Health Department (ZHD) (62)	WorHO report + Hospital report	Quarterly	249,244
Regional Health Bureau (RHB) (11)	Own administrative data + WorHO/ ZHD report	Quarterly	249,288
FMOH	Own administrative data + RHB report	Quarterly	249,292

HF – Health Facility (i.e. health post, health center, hospital)

HI – Health Institution (all institutions including HF)

The eHMIS is the electronic equivalent of the paper reporting formats and indicators of the HMIS. The electronic system was not intended to replace all the paper-based HMIS registers at health facilities. Instead, it was designed to help health institutions to electronically aggregate, analyze and submit data to higher level institutions. Additionally, it would help expedite the reporting process by automating the aggregation of reports submitted by other health institutions. For example, in the paper-based HMIS, a particular district would have to manually aggregate all the reports sent from health centers under its jurisdiction and send it physically or by mail. This was not only time consuming but it was prone to data quality issues.

The eHMIS was designed as a stand-alone application, installed on individual workstations. To remedy infrastructural challenges, the NGO opted for a non-web-based application that would allow offline data entry and collation. Reports are submitted and received electronically through the system's internal e-mail feature by means of any available communication infrastructures including Code Division Multiple Access 2000 (CDMA2000), dialup, and broadband. Data can also be exported via removable media such as USB flash disk and CD where Internet connectivity is not available.

6 A morphogenetic view of digitalization

This section presents an analytical overview of the digitalization of the HMIS based on the conceptual framework and the three phases of the morphogenetic approach.

6.1 Structural/cultural conditioning (T1)

Two key structure/culture conditions that influenced the digitalization process were examined: (i) architectural constellations and (ii) governance arrangement.

Architectural constellation

The overall architecture of the HIS in Ethiopia can be characterized by complexity and diversity of disease specific vertical programs (e.g. HIV/AIDS programs, Malaria programs, etc.). More recently, much effort

has been invested in the harmonization of data sets, routinization of reporting procedures, and availing of resources and efforts to digitalize the paper-based HMIS. Over the past decade, the architecture of the HMIS has undergone major reforms in Ethiopia which are outlined below.

2006-2007: HMIS reform - standardization and integration of manual HMIS tools

The reform of the current HMIS started in 2006. The aim was to address fragmented data collection and reporting systems. The pre-existing tools for data management placed excessive burden on local health workers and were found to have multiple redundancies and mismatches across various health programs.

The restructured HMIS consists of 108 indicators, consisting of: family health (21), disease prevention and control (47), resources (28) and health systems (12). The tools for collecting these indicators were also standardized, which included 19 registers (e.g. antenatal care register), 11 tally forms (e.g. OPD diagnosis & treatment tally), and reporting formats (quarterly/annual service delivery & disease reports). Lastly, standard procedures for collecting, sharing, and storing data were also defined and instituted under the HMIS protocols.

2008-2012: National deployment of manual HMIS

By 2008, an integrated and standardized paper-based HMIS was developed and implemented in six of the nine regions in Ethiopia. The scaling efforts of the HMIS tools was successful with an estimated coverage of 85% by 2012 (FMOH, 2013). However, there were a number of challenges, especially at peripheral service delivery health facilities. Perhaps most difficult has been the use of the standardized HMIS, which was found to be inadequate across many health facilities. The FMOH cited fundamental challenges including: gaps in data processing, data completeness, reporting timeliness, and overall use of HMIS for decision-making at local levels.

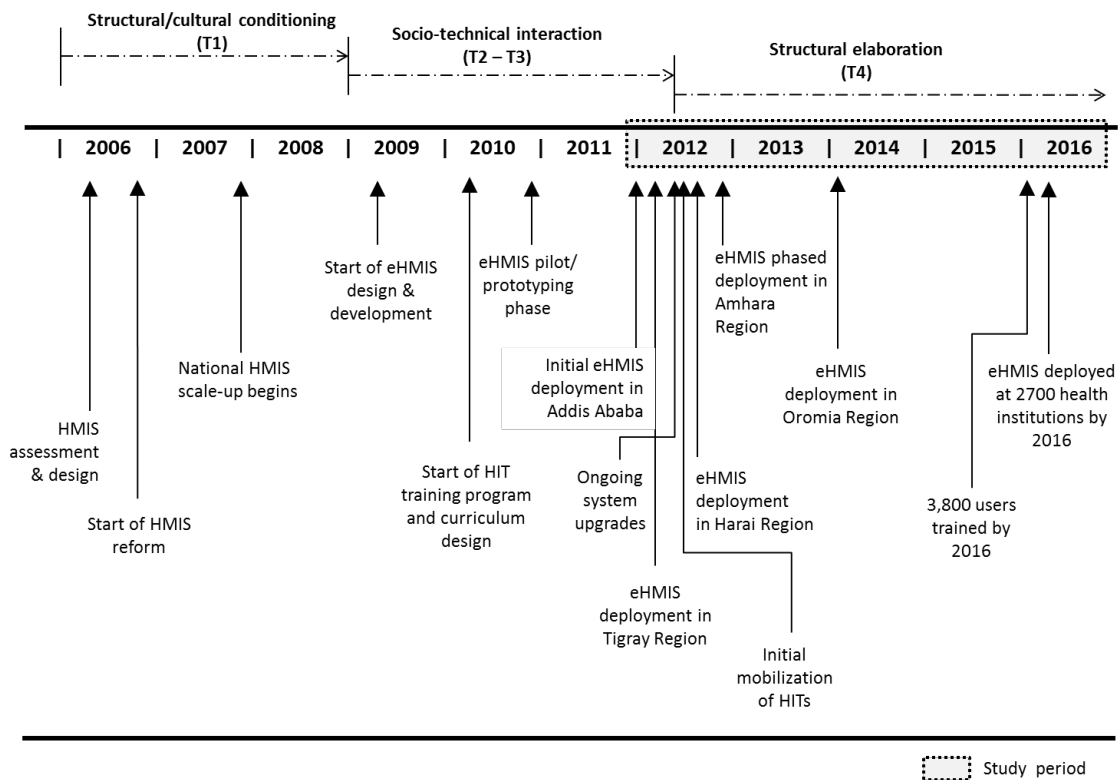


Figure 4. Timeline of the Ethiopian HMIS digitalization

Governance arrangement

The eHMIS digitalization process took place under two intertwined modes of governance: hierarchy and horizontal governance. The first is where regulation of various government health institutions is carried out by the institutionalized governance arrangements of the Ethiopian health system. This is characterized by hierarchical arrangements among the government’s health institutions. The hierarchical governance of the health system is a federated one, which allows health institutions (e.g. districts, zones, regions) autonomy to make administrative decisions over their designated local jurisdiction while also being overseen by higher health institutions. Interactions among health institutions are largely managed by formal structure, standardized practice and planning. Thus, the established HMIS standards (in terms of data indicator, tools, reporting procedures, district/Woreda-based planning) act as main governance and management tools in this hierarchy.

The HMIS digitalization process, although subsumed under the aforementioned governance structures, was predominantly based on collaboration with the NGO, which was outside the health system’s governance structure. For the NGO, the eHMIS was one of the main projects it was carrying out in the Ethiopian health sector. The project was funded by the US government and locally overseen by the Center for Disease Control (CDC) country office in Ethiopia. Much like many donor-funded development projects in the health context, the project was funded for a limited period putting pressure on the NGO to deliver quick results.

The NGOs operational structure and funding schema was largely based on the international development models of global health. Locally, its collaboration was characterized by horizontal collaboration of the NGO with various levels of government health institutions (i.e. FMOH, regions, zones, districts). As a result, there were no formalized governance procedures in terms of distribution of decision rights, division of labor on the project, and established approach for collaboration between the government and NGO.

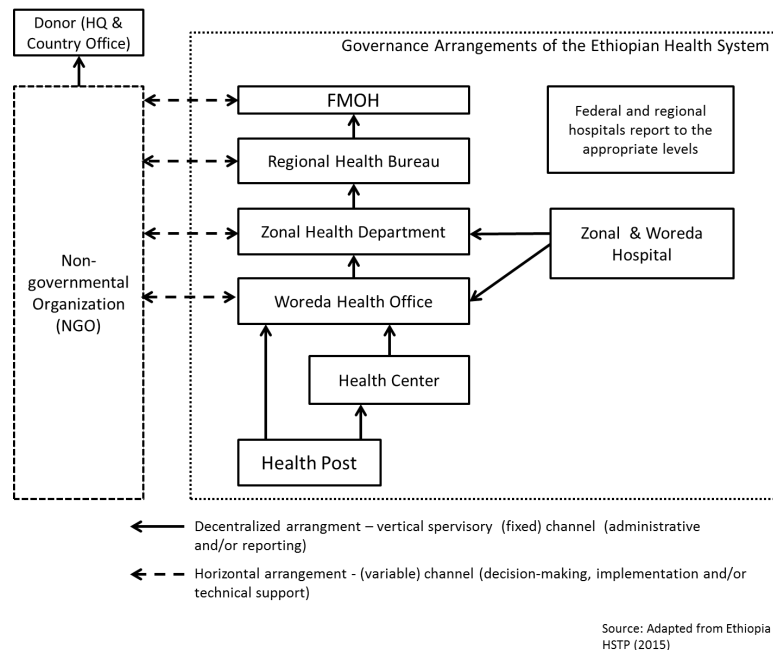


Figure 5. Governance arrangements around HMIS digitalization

6.2 Socio-technical interaction (T2-T3)

Socio-technical interaction is the second phase of the morphogenetic approach that deals with the actions and interactions during the development and implementation of the eHMIS. The collective decision-making in the HMIS digitalization process were mediated by a long-term and contested series of interactions and collaborations between NGO and government staff. These interactions refer to particular episodes around decision-making and negotiation between different stakeholders which were driven by three main interactional dynamics: (i) monopolizing the technology; (ii) mobilizing brokers; and (iii) establishing relational ties.

Monopolize the technology. The design and development of the eHMIS were controlled by the NGO primarily due to its technical capacity. Neither the FMOH nor regions had software developers or IT technical capacity to participate or monitor the design and development process. Activities such as software development, upgrades, bug fixes, maintenance/troubleshooting, initial data hosting, server maintenance, trainings, implementations and various project activities were exclusively carried out by the NGO. A report drafted by the FMOH HMIS unit states:

Troubleshooting and maintenance support is highly dependent on experts from the

collaborating partner. There are no capable personnel at RHB or sub-city level to provide troubleshooting and maintenance support... (FMOH eHMIS Supportive Supervision Report, June 2012)

This dominant role allowed the NGO to exercise its influence in major decisions. It also produced minimal transparency and accountability between the constituents. The NGO's control of the digitalization process was also made possible by its resource-based power. The NGO has carried the financial burden of the project investing millions of dollars annually. However, this has created an unsustainable financial and resource dependence on the NGO.

Establish relational ties. The NGO's legitimacy as a decision-maker was also a by-product of its strong personal ties with key FMOH and regional managers. The cultivation of such relations by NGO managers was a long-term process formed through norms of mutual gain and reciprocity, cultivated through years of interactions. For instance, the departure of the former Minister of Health, with whom the NGO had strong ties, was a concern for the project. One informant stated: *"the [NGO's] director does not have a close relationship with the new Minister of Health and PPF head [FMOH Policy, Plan and Finance Directorate]... PPF head is also not keen on [NGO] which is compromising the position of [NGO] and their continuation in country"*.

Establishing legitimacy also entailed struggles and negotiations over status and resources, and buy-in from donors. However, the NGO has successfully maneuvered this course for over a decade, establishing it as a central actor in the Ethiopian HIS domain. These relational ties have garnered the support and buy-in of the NGO, facilitating the project's continued funding beyond its initial grant period. .

Mobilize brokers. The NGO has also fostered its legitimacy at as a crucial decision-maker by recruiting intermediaries or brokers. Brokers are influential actors recruited by the NGO from FMOH and RHBs and offered better remuneration in order to both support the NGO's and push its interests by leveraging on their networks with government stakeholders. Over the years, the NGO has recruited a number of senior staffs from various government departments.

Brokers play an important decision-making and lobbying role through their personal interactions with local government. For example, in 2013, during planning of the eHMIS deployment in one of the largest regions in Ethiopia, an NGO employee, who had previously occupied a senior post in the FMOH, assumed the lead under the delegation of the NGO's management. Subsequently, negotiations and communication with the region's managers and pertinent zones were carried out by this individual. In addition to his previously established networks, shared ethnicity fostered rapport with government staff during interactions. Ultimately, this actor was able to leverage on the constituencies he represented; being from the particular region's ethnic group and speaking the local dialect. These shared norms are advantages a broker presents in the ethnic federalism of Ethiopia.

Overall, given the informality of the governance process in this context, the ability of the NGO to capitalize on the socio-political processes has been an important driver in the digitalization process.

6.3 Structural elaboration (T4)

Structural elaboration corresponds to the last phase of the morphogenetic cycle. In this section, we describe the extent to which new configurations have emerged, both from the technology and organizational perspectives.

Digital transformation/stasis

From the technology perspective, the national scale-up of the eHMIS began in 2012 with implementation in four regions including: Addis Ababa (51 sites), Tigray (60 sites), Harari (20 sites) and Amhara (163 sites), with varying degrees of implementation at health center, district, zone and regional levels. As of 2015, the eHMIS was reported to be implemented at 2,700 health institutions across the country (FMOH, 2015).

However, the scaling of the eHMIS has been sporadic with some regions making significant progress while other regions lag behind. Given the infrastructural context, the HMIS digitalization effort has also been confronted by deep structural challenges such as infrastructure (i.e. poor Internet and electricity coverage) and local financial commitment. Furthermore, some of the enduring challenges were by-products of the system's design and its specific properties namely, its programmability, addressability, and communicability (Yoo, et al., 2010).

Programmability: refers to the degree to which a digitalized artifact can allow new sets of logic to change its form and functions (Yoo, et al., 2010). In the case of the eHMIS, the system has a core set of functionalities (e.g. data entry, aggregation, analysis, validation rules, quality checks, and reporting). However, the software's architecture was not easily malleable to facilitate changes or expansions to its core functional components. The system's architecture was also not robust enough to accommodate emerging data sets, reporting requirements, and new demands from district-based planning (i.e. Woreda based planning) or other programs.

Additionally, the non-web-based design has led to a rigid system which hinders prompt and regular upgrades. System upgrades required NGO teams to be deployed to manually install the new version across hundreds of distributed installations. The process was time consuming, costly and prone to bureaucratic delays.

Addressability: is the property of the eHMIS which refers to: "the degree to which each digitalized artifact can be uniquely identified in a computing architecture" (Yoo, et al., 2010, p. 225). Addressability enables individual health institution systems to be accounted for and linked into the national HIS infrastructure. In the eHMIS, each health institution is designated a unique ID. However, it is only designated in the eHMIS and is not recognized by the FMOH or its constituents or other digitalized artifacts. In fact, there was no consensus among federal, regional and zonal levels regarding a single national health facility registry. The unique facility IDs in the eHMIS were purely used for facilitating reporting within the eHMIS and were not shared among other systems. Since these IDs were not supported by standardized identification procedures which allow recognition across the national HIS infrastructure, it hindered linkage or integration with other digitalized artifacts in the architectural constellation.

Communicability: is the capability of the digitalized artifact to send and receive data with other artifacts (Yoo, et al., 2010). In the eHMIS, existing communication protocols supported exchange of reports across health institutions among eHMIS applications. The malleability of the eHMIS to allow merging and sharing of HMIS data with other digitalized artifacts was still low and would require extensive programming and restructuring in terms of formatting and specifying data fields and defining shared standards to allow communicability.

Overall, the extent to which the eHMIS can accommodate emerging requirements was recognized as a concern in a recent evaluation which assessed a number of systems including the eHMIS. It states:

'eHMIS' software packages that are non-open source and non-web based, posing serious constraints for future expansion... There are some fundamental design challenges related to the absence of data warehouse approach, and stand-alone deployment. These systems will involve a cumbersome process of updating changes as well as challenges in coordinating their merging every month to develop consolidated reports and in providing support to distributed installations (FMOH, 2013, p. 25).

Given the eHMIS is a core system in the country's HIS infrastructure, its communicability has been deemed important in order to facilitate integration and interoperability requirements. These properties are necessary if the eHMIS is to serve as a backbone in Ethiopia's HIS architecture.

Techno-organizational structure/culture

Despite the widespread deployment of the eHMIS, organizational transformations have not followed suite. Transformation (morphogenesis) has been slow to emerge in the Ethiopia HIS context. The extent to which new configurations have emerged in both the HIS architecture and the governance arrangements in Ethiopian is not evident.

After initial implementation, the digitalization process continued to be subsumed under the preexisting governance structure, which was based on a project-based arrangement primarily controlled by the NGO. Consequently, government institutions continued to rely on the NGOs project-oriented operational structure and funding schema to support the systems ongoing operation. A 2013 national assessment of the eHMIS states:

The original decision of the Ministry was to aim for an eHMIS technical systems development that would take place as a collaborative activity between the partners and the Ministry technical team within the premises of the FMOH. However, that did not happen, with consequences for the development of capacity of the Ministry team, (for example, related to the understanding of the software, the code, and processes of technical support) (FMOH, 2013, p. 139).

As it stands, the FMOH, regional and district level institutions have limited ICT capacity for full uptake and ownership of the eHMIS. Both the FMOH and regions lack qualified IT staff to support this digitalization initiative, which is to span over 4000 institutions. This has produced excessive reliance on the NGO. The national assessment goes on to state that there is "strong dependence on (NGO) at all levels for a range

of functions, including software, software support, infrastructure, training and others. This reduces capabilities of the health systems to become self-reliant and sustainable” (FMOH, 2013, p. 101). Given these setbacks, the digitalization project has done little in the way of addressing institutional gaps and in reconfiguring the techno-organizational structure and culture of local organizations.

7 Analysis: mechanisms of HMIS digitalization in Ethiopia

We identified four mechanisms for the digitalization of the HMIS to the eHMIS: (i) projectification (ii) informatization, (iii) embedded inscription, and (iv) scaling. In the following sections, we outline the relational entities of each mechanism.

7.1 The projectification mechanism

The first mechanism explains the cultural emergent properties (CEPs) of the digitalization process. A key cultural condition in the eHMIS case was the international development frameworks that promote project-based approaches to development. The ideas and values propagated by project-based approaches have not only led to the proliferation of development projects but they have become adopted as the central modality of international development (Heeks & Stanforth, 2014). Projects have also become primary instruments for digitalization. These widely accepted norms have shaped the context in which stakeholders operate, predisposing them to pursue certain courses of action in carrying out digitalization.

In this regard, we identified both stimulating and releasing conditions that triggered a set of culturally-mediated behaviors in the case. First, we identified the dominant development discourse around project-based development as a stimulating condition that endorsed the project-based approach for HMIS digitalization in Ethiopia. This discourse, rooted in the mainstream management literature and the efficiency practices of new public management promoted projects as a modality through which digitalization can be effectively achieved in developing countries. In line with this, the eHMIS project was seen as a series of technical and capacity transfers mediated by NGO experts. The project-based approach was expected to sidestep the ineffective institutions of local ministries in order to accelerate decision-making processes and problem-solving. It was also viewed as a more effective way of reacting to unanticipated and irregular situations that digitalization faces in this context. Thus, according to this dominant discourse, successful projects were considered synonymous with successful development (Mosse, 2005).

This enduring discursive and cultural phenomenon has had conditioning effects on the digitalization process in Ethiopia. It has framed the overall coordination and partnership that has ensued between local government stakeholders and the NGO. From the outset, a distinction existed between the beneficiaries and the experts that would deliver the technology. The experts not only possessed the technical competence but the financial backing, elevating them as owners of the project and the key change agents (what Archer refers to as corporate agents) in what was touted as a collaborative development initiative.

Secondly, a key releasing condition that reinforced this emerging phenomenon was project grants. The NGO leading the eHMIS project has been the recipient of multi-million dollar annual grants from its US

government donor. Its continued funding has not only provided the NGO with the resource capacity to fund project activities, including the assembly of a highly remunerated technical team, but it has also garnered the NGO and its eHMIS project legitimacy among local stakeholders.

These stimulating and releasing conditions have bolstered the control of the project by NGO including: ownership of project funds, technical resources and overall project activities. Consequently, the project arrangement and its instruments have produced political subtleties that have created and sustained power asymmetries in the digitalization initiative which we will consider further in our later discussion.

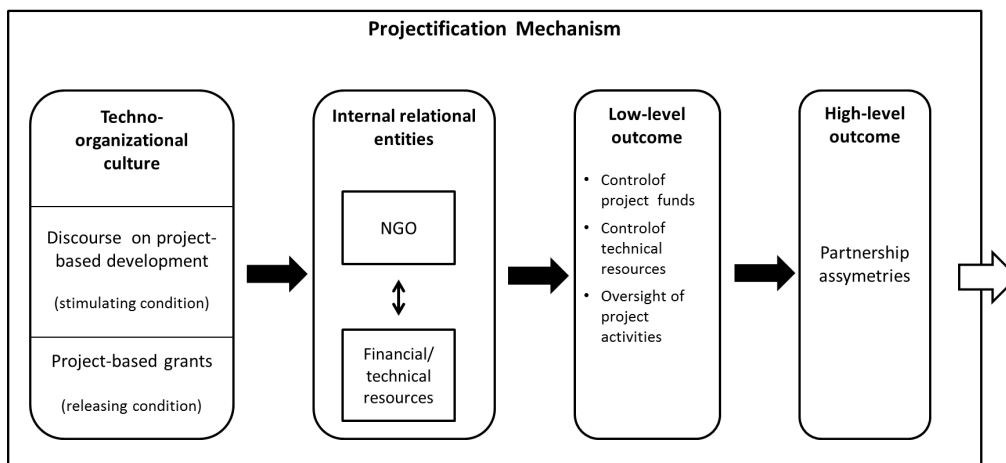


Figure 6. The projectification mechanism

Together, we refer to this as the *projectification mechanism*; a process by which partnership asymmetries are produced as projects become primary instruments for organizing work and transferring resources in digitalization.

7.2 The informatization mechanism

Within the Ethiopian health system, a key structural emergent property (SEP) for HMIS digitalization has been the preexisting data and its architectural constellation in the manual (paper-based) HMIS. An important attribute of the manual HMIS was the high-volume and high-variety of data it supported. The HMIS comprised a variety of data including: resources (e.g. HR, logistics, lab & blood bank indicators), health system (e.g. service coverage indicators), family health (e.g. reproductive health indicators), disease prevention and control (e.g. HIV-AIDS, malaria indicators). The volume of HMIS data was also magnified by the estimated 21,390 health institutions that constitute the public health system in Ethiopia. Collectively these institutions produce about 249,292 reports annually. This has produced difficulties with collecting, tabulating, storing, analyzing and visualizing these large data assets. We identified this volume and variety of data as a stimulating condition towards digitalization. Additionally, the local government’s reform initiative of the manual HMIS was recognized as a crucial releasing condition for the digitalization strategy. Both these stimulating and releasing conditions have elicited various features of the HMIS we will discuss below.

At a basic level, the manual HMIS provides health facilities with the capacity for collecting (Feature (Feat) 1 in Table 1) patient level data at points of service delivery using registers (e.g. antenatal care register).

These registers contain the defined data sets that are to be recorded at each health facility (e.g. pregnant woman tested for HIV). The recorded data sets enable the aggregation and calculation (Feat. 2) of indicators (e.g. proportion of pregnant women tested for HIV). Finally, the manual HMIS enables health facilities the reporting (Feat. 3) of indicators using the standardized reporting forms. Together, we refer to these set of features of the HMIS as basic features.

However, these basic features can only be realized in combination with data standardizing features which allow standardized recording (Feat. 4-5) and reporting (Feat. 6) of data sets/indicators across all health institutions. Overall, the basic and data standardizing features have been simultaneously employed by public health institutions in varying degrees across Ethiopia. However, factors such as the organizational context, availability of HMIS tools and user capabilities have affected the broad utilization of these features across some health institutions.

Table 4. Manual HMIS Features	
Basic Features:	
1.	Collecting and tallying patient level data and minimum data sets
2.	Calculating defined indicators
3.	Reporting data through a single channel
Data Standardizing Features:	
4.	Standardizing minimum data sets and recording formats
5.	Standardizing indicators
6.	Standardizing reporting formats

Additionally, not all features of the manual HMIS can be realized at the same time with some features being utilized earlier than others. In the HMIS case, three groups of advanced HMIS features were identified (Table 4). These include: *analyzing*, *process standardizing* and *controlling* features. These features contribute to achieving multiple goals including: efficient and accurate data synthesizing capability (Feat 1), enhanced data analysis and use (Feat 2-3), standardized processes for data collation at all levels (Feat 4), standardized storing and reporting procedures (Feat 5-6), and improved data security and quality (Feat 7-9).

Table 5. Manual HMIS Advanced Features	
Analyzing Features:	
1.	Compiling data from multiple health institutions
2.	Synthesizing high-volume and high-variety health data
3.	Visualizing and monitoring longitudinal health data
Process Standardizing Features:	
4.	Standardizing data aggregation and indicator calculation procedures
5.	Standardizing data storage and management procedures
6.	Standardizing data reporting procedures
Controlling Features:	
7.	Controlling which individuals/institutions can access and perform each transaction
8.	Guiding and validating data entry and reporting
9.	Controlling timeliness and completeness of reports

The aforementioned advanced features in Table 4 and 5 offer local health institutions the potential to achieve three broad outcomes:

- (1) Integration: single source for each data item, one report and one reporting channel in order to organize and simplify data (Table 4: Feat 1, 2, 3)
- (2) Standardization: standardized data-sets, indicators and forms (Table 4: Feat 4, 5, 6) and standardized procedures for data collation, storage and reporting (Table 5: Feat 4, 5, 6) in order to harmonize available data
- (3) Optimization: optimize available data through data analytics, visualization, and management (Table 5: Feat 1-3 and Feat 7-9) in order to create value from data

A strong temporal and structural dependency was identified between the three groups of outcomes and their features. The realization of the optimization required that the preceding features of integration and data standardization be first realized.

However, unlike the standardization and integration features, the immediate outcomes of the optimization features were not realized in the manual HMIS. Optimization refers to the extent to which data generates value through its extraction and transformation. This highlights the enduring problem of too much data and not enough information at local health institutions. Why the optimization features have not been realized in Ethiopia is attributed primarily to missing features of the manual HMIS.

This need for optimization in order to generate value from data assets has influenced the push for the Ethiopian HMIS digitalization strategy. The strategic direction towards digitalization was initially drafted by the HMIS reform team in 2008 which, outlines key strategic actions needed for HMIS reform (FMOH, 2008). Among the five thematic areas identified was to “appropriate technology”. The strategies include the aim to “establish customized HMIS software system at woreda, sub-city, zone, regional, and federal levels; procure and install required hardware; train staff in basic computer literacy and in HMIS electronic system” (FMOH, 2008, p. 44). An early benchmark set for this strategy was to have “80% of all RHBs, ZHDs, and WorHOs with required infrastructure installed eHMIS” (FMOH, 2008).

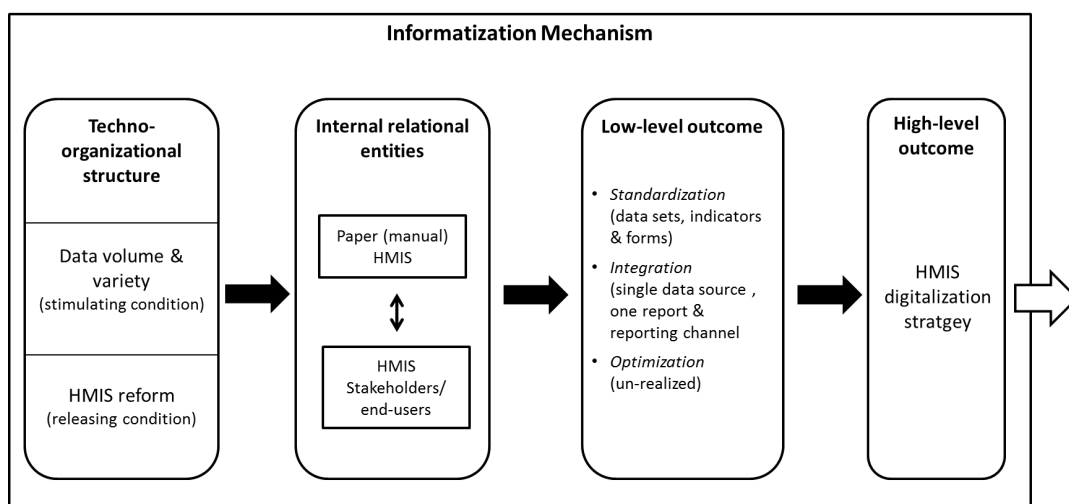


Figure 7. The informatization mechanism

Together, we refer to this as the *informatization mechanism*; the process by which high-volume and high-variety data produce a demand for its optimization through digitalization. The outcome of this mechanism is the HMIS digitalization strategy which aims to produce enhanced insight, decision making, and process automation.

7.3 The embedded inscription mechanism

Beyond structural and cultural emergent properties, the interactions and relations of people (PEPs) themselves have emergent powers (Archer, 1995). This is also where agents mediate the conditional influence of preexisting structural and cultural properties, but also transform or reproduce them through their actions and interactions.

Two conditioning effects of the structural/cultural context were identified in the eHMIS case. First, the outcomes of the previously actualized mechanisms (i.e. asymmetric partnership and digitalization strategy) were stimulating conditions for the ensuing digitalization activities. For instance, through the structured distribution of resources in the *projectification* mechanism, the organizations have been pre-grouped as change agents of digitalization (i.e. NGO) and recipients (i.e. government institutions). This has influenced the extent to which government institutions participated in digitalization activities.

Second, the relational embeddedness of the NGO in strategic alliances with its state constituents was also a key releasing condition. Embeddedness refers to the degree to which change agents are deeply entrenched in the social fiber of the institutional context and whose opportunities for action are consequently enhanced. These alliances which, became the primary governance modalities in the project, predisposed the digitalization to predominantly informal processes. The NGO has achieved its embeddedness by; establishing relational ties with key government actors and by enlisting brokers from national and regional health institutions.

Additionally, these interactional dynamics that ensued between the NGO and state institutions have influenced how they collaborated in the design and development of the digital artifact. Consequently, the embeddedness achieved by the NGO was not apart from the technology artifact. The NGO's monopoly of the technology has made its role indispensable in the strategic pursuit towards digitalization. This control has also enabled it to govern how other stakeholders participated in digitalization activities.

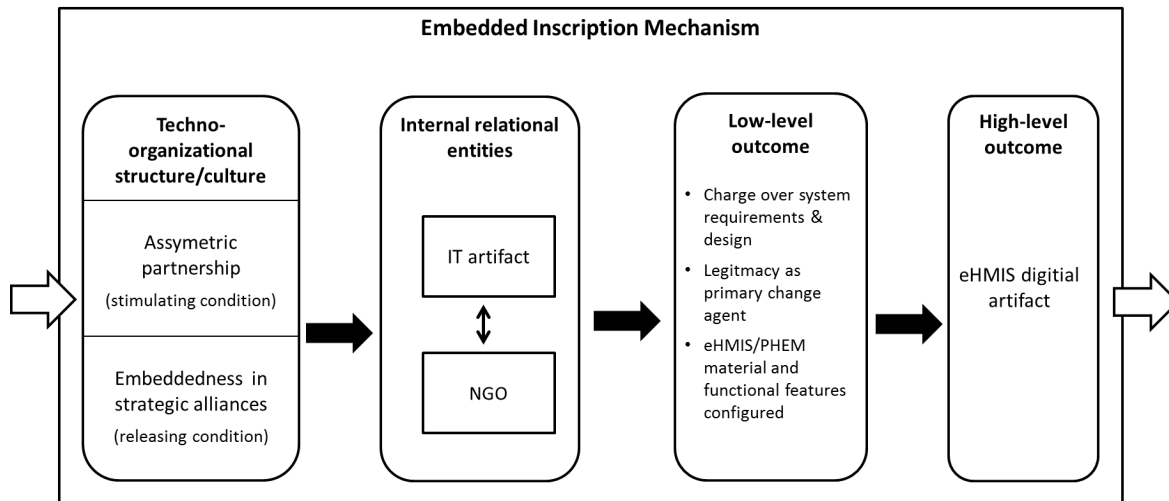


Figure 8. The embedded inscription mechanism

Together, we refer to this as the *embedded inscription mechanism*; the process by which strategically embedded actors pursue opportunistic modes of interaction to influence digitalization decisions. Along with the NGO's institutional legitimacy and control of the eHMIS system's design, the main outcome of this mechanism was the particular design of the eHMIS artifact.

7.4 The scaling mechanism

The final mechanism is *scaling*. It explains how the outcome of the *embedded inscription mechanism* is transformed into a collective outcome – national HMIS digitalization. The success of the HMIS digitalization ultimately depended on its capacity to scale. The NGO's rapid implementation efforts, although seemingly effective initially, uncovered two key underlying issues that hampered the sustainable scaling of the eHMIS.

The first was the configurability of the eHMIS. Configurability or technical malleability determine the extent to which the properties of digital artifacts can be reshaped to accommodate emerging needs. As previously discussed, these properties include: programmability, addressability, and communicability. In the eHMIS, these were partially realized through considerable workarounds.

With regards to *programmability*, the system's overall architecture was not easily malleable to facilitate changes or expansions to its core functional components. In term of *addressability*, the eHMIS had a way of uniquely identifying each institution. However, it was inadequate in the degree to which each eHMIS installation could be uniquely identified in a computing architecture to allow *communicability* with other digitalized artifacts. Fully actualizing these configurability features (Feat 1-3 Table 6) has proven difficult give the current software architecture of the eHMIS. Even in the early periods after deployment, the eHMIS has been confronted with the demands for adaptability as data sets, indicators, procedures, number of health facilities, and organizational arrangements changed and new requirements emerged in the ever-evolving health sector. So far, the NGO has coped with these demands, although in a makeshift and improvisational manner leveraging on extensive financial and technical resources.

Table 6. Configurability and Diffusion Features

<p>Configurability features:</p> <ol style="list-style-type: none"> 1. Programmability of the technology allowing changes to its form and functions 2. Communicability of the technology allowing sending and receiving data with emerging IT artifacts 3. Addressability of the technology enabling identification and linkage with new IT artifacts into the information infrastructure
<p>Diffusion of institutional features:</p> <ol style="list-style-type: none"> 1. Deploying the technology through more user adoption and institutional buy-in 2. Scaling local skills and institutional capabilities

Secondly, only realizing configurability was not sufficient. Diffusion is necessary for successful digitalization of the HMIS. Diffusion refers to the spread of both the technology in terms of more user adoption and the propagation of institutional capabilities (Sahay & Walsham, 2006). Thus far, a fundamental challenge in the scale-up of the eHMIS across Ethiopia has been the scaling of skills and local learning among health institutions both in data management and the use and ongoing management of the system's operation. This lack of institutional capacity at the FMOH and regional bureaus is a concern for sustainable digitalization.

Thus far, trainings, on-site technical assistance and sensitization workshops have been activities carried out by the NGO to build local capacity. Additionally, the health information technician (HIT) curriculum has been instituted in some technical and vocational education and training sites in Ethiopia. This program has mobilized a cadre of trained HMIS workforce and aims to fill an essential human resource gap. This is perhaps the most institutionally rooted initiative the NGO has introduced. Even though challenges remain around the quality of the curriculum, turnover, and poor career structures, the program has been deemed a key input for digitalization success.

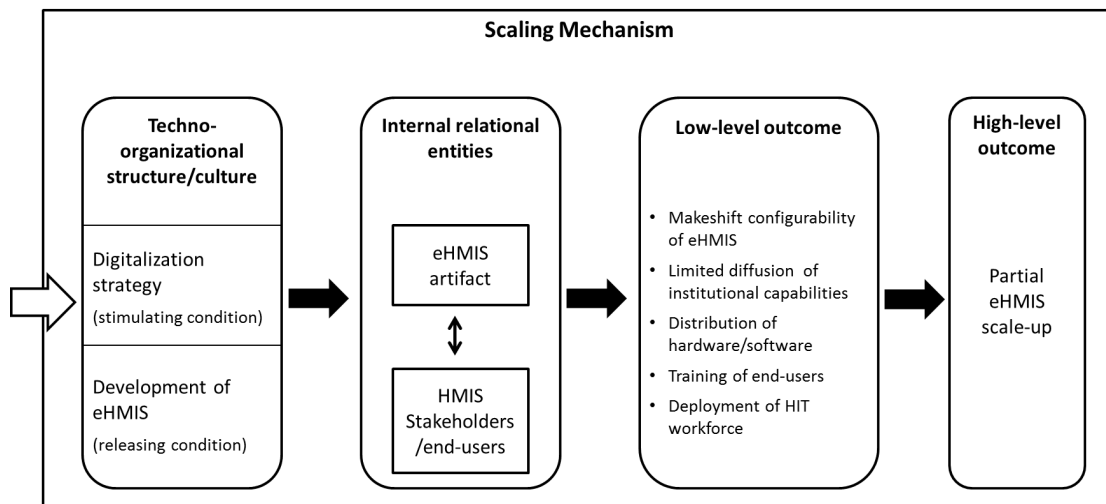


Figure 9. The scaling mechanism

Overall, we refer to the *scaling mechanisms* as the process by which digitalization spreads in terms of the propagation of institutional capabilities while allowing the adaptability of its properties.

Table 7: HMIS Digitalization Mechanisms	
Mechanism	Definition
Projectification	A process by which partnership asymmetries are produced as projects become primary instruments for organizing work and transferring resources in digitalization.
Informatization	A process by which the need to gain value from data produces a demand for its optimization through digitalization.
Embedded Inscription	A process by which strategically embedded actors pursue opportunistic modes of interaction to influence digitalization decisions.
Scaling	A process by which digitalization gains institutional traction spawned by capabilities and the malleability of the digitalized artifact

8 Discussion and implications

8.1 Tracing contextual contingency through causal mechanisms

Understanding the relationship between digitalization and its broader context has been identified as a longstanding area of focus in the extant ICT4D research (Avgerou, 2008, 2017; Walsham, et al., 2007). Two particular challenges are raised in this regard: (i) the choice of where one starts in analyzing the key conditions of a particular context and (ii) how these conditions affect the ideas and actions of people involved in digitalization.

In order to deal with these challenges, we first propose that an adequate theoretical underpinning is necessary to guide the researcher in narrowing and conceptualizing potential contextual conditions. In this study, Archer's morphogenetic approach has been useful in reframing context in terms of structural systems which have structural emergent properties (SEPs) and cultural systems which have cultural emergent properties (CEPs). These presuppose different types of generative mechanisms that can explain contextual conditioning. These are of course broad categories and therefore require that the scope or boundaries of the research to which the morphogenetic approach is applied be determined based on the particular problem area (Archer, 1995).

The aforementioned issue is also related to the second challenge of determining how particular contexts condition. A key theoretical proposition that Archer puts forth is that there are internal and necessary relations within and between social structures/cultural systems. These relations exist among key components that are internal to the particular structural or cultural system and which are necessary for them to have emergent properties or causal powers. Uncovering these relational entities of contextual mechanisms can help researchers pinpoint and understand how particular contextual factors enable or constrain.

Accordingly, the contextual mechanisms identified in this study have put forth the internal and necessary relations of both a CEP (i.e. projectification) and SEP (i.e. informatization) in the eHMIS project. Both mechanisms illustrate the cultural and structural emergent properties and their conditioning effect on agents. The *projectification* mechanism demonstrates how dominant discourse around project-based development backed by financing schemes shaped development practice thereby generating specific

liabilities. The outcome of this mechanism was the asymmetric partnerships that ensued between the NGO and local government institutions.

On the other hand, the *informatization* mechanism explains how the structural emergent properties of the Ethiopian health system's data architecture conditioned agents with strategic directional guidance. More specifically, it draws on the components of the institutional context (i.e. data reform initiatives) and material resources (i.e. data assets & data management infrastructure) to trace a number of emerging features, their level of utilization and their immediate outcomes.

These mechanisms may be evident in other related projects. For example, both the *projectification* and *informatization* mechanisms hold in the extensively studied HMIS digitalization case in South Africa called the District Health Information System (DHIS) (Braa, Hanseth, et al., 2007; Braa & Hedberg, 2002; Braa, et al., 2004; Braa, Monteiro, Sahay, Staring, & Titlestad, 2007). The favorable digitalization outcome of the DHIS points to the actualization or lack of actualization of the aforementioned mechanisms. However, given that mechanisms are contingent on particular macro-micro conditions, the presence and sequence of mechanisms are likely to vary across cases. Overall, the contextual mechanisms identified in this study tackle the aforementioned theoretical challenge by explaining what it is about a specific context that is relevant and why and how it matters.

However, identifying the internal and necessary relational entities to uncover generative mechanisms can be a complex and analytically messy process. For instance, given that a number of internal and necessary relations can exist in a particular mechanism, some are likely to be stronger, weaker or more apparent than others. According to Bhaskar (1975, p. 47), untangling these entities and their relations calls for "blending of intellectual, practio-technical and perceptual skills". This also speaks to the challenge of distinguishing between various candidate mechanisms in open systems. Given the lack of clear criteria outlined by critical realism, Sayer (2000) suggests that the mechanisms (i.e. their sub-components and relations) that offer the strongest explanatory power based on the empirical evidence and causal depth should be selected.

8.2 Navigate the macro-micro domains by concatenating causal mechanisms

The complexity of digitalization in the development context means that there are numerous mechanisms that exist and act on each other. Although not possible to uncover all, by identifying sets of mechanisms, their contingency and immediate outcomes, researchers can build a more defensible explanation of multi-level digitalization phenomena.

In examining the interaction among sets of mechanisms, Henfridsson and Bygstad (2013) offer a unique perspective. Using the context–mechanism–outcome approach of Pawson and Tilley (1997), they examine the configuration of three distinct mechanisms and the outcomes they generate in the evolution of information infrastructures.

In this paper, we put forth a different perspective for concatenating related mechanisms that account for the systemic and social (i.e. macro-micro) dimensions. Here, a key theoretical challenge is to determine how a mechanism behaves in social systems in light of other mechanism(s) that operate at the same or different hierarchical levels (Mingers & Standing, 2017).

First, we draw on the typology of mechanisms proposed by Archer’s morphogenetic approach (i.e. SEPs, CEPs & PEPs) to identify the types of mechanisms that fit at the different analytical levels. This approach of concatenating mechanism is also similar to that proposed by Hedström and Swedberg (1998). Accounting for different types of mechanisms that correspond to macro and micro-level processes has proven to be a beneficial way of configuring mechanisms in order to navigate the macro-micro domains.

However, purely identifying different categories of mechanism that correspond to the different levels may not, in itself, be sufficient for explaining how specific mechanisms enforce or counterbalance each other. Consequently, one could be left with three or more mechanisms whose interaction is not clear. Moreover, such categorization may cause researchers to focus on the parts of the process at the expense of the dynamic unfolding whole.

Given that the outcome of a specific mechanism depends on the actualization of other mechanism(s), further explanatory theorizing requires analysis of how the outcomes of earlier enacted mechanisms produced conditioning effects on succeeding mechanisms (see Figure 10). For example, the outcome of the *projectification* mechanism was the asymmetric partnerships that ensued between the NGO and local government institutions. Asymmetric partnership was in turn a stimulating condition in the *embedded inscription* mechanism as it influenced how stakeholders interacted and how system development and implementation activities were carried out. Similarly, the outcome of the *informatization* mechanism (i.e. digitalization strategy) was a stimulating condition for the *scaling* mechanism.

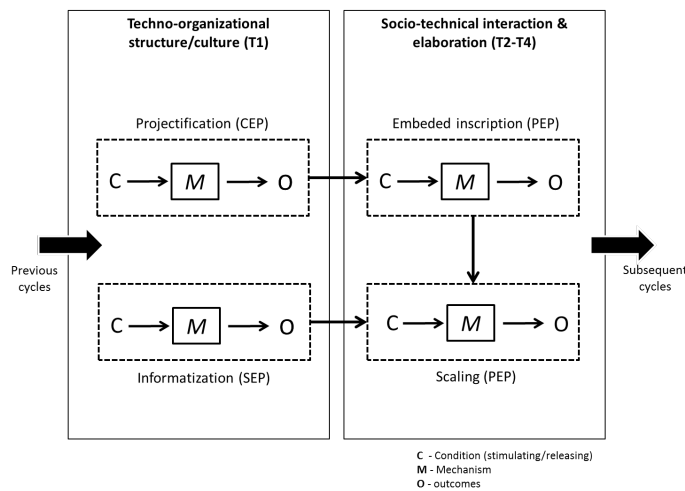


Figure 10. Concatenation of mechanisms in the digitalization of the HMIS

However, in concatenating mechanisms this way, the outcomes and conditioning effects of the identified mechanisms may not be coherently associated with each other. This may require an iterative process of working between the data and set of concepts to consider potentially missing mechanisms or relational entities within each mechanism.

In summary, the morphogenetic cycle provides a useful framing for linking generative mechanism that relate to emergent properties of different levels/strata. The use of temporal separability and analytical

dualism which, Archer propose in contrast to Giddens, is a valuable approach for IS researchers examining how structure, culture and agency interact and mutually emerge in IS phenomena.

8.3 Practical implications

The mechanisms identified in this study offer strategic issues in developing country digitalization initiatives. Three fundamental gaps are identified from the identified mechanisms:

- *Projectified development*: projects as primary modalities for digitalization have created partnership asymmetries between NGO and local institutions hindering sustainable development.
- *Poorly governed inter-agency collaboration*: lack of formalized arrangements around multi-stakeholder collaboration has led to informal politics and individual relations becoming primary modes of decision-making resulting in poor accountability and regulatory environments.
- *Gap filling at the neglect of institutional capacity development*: total dependency on external partners as NGO assumes a gap-filling role thereby replacing rather than building local institutional capacity.

The project-based development approach in the Ethiopia case has seen the project as accelerated technical transfers facilitated by NGO experts. However, this arrangement has evaded engagement with deep institutional issues which lie at the heart of sustainable development. Such an approach essentially skews the fundamental ideals of development which requires a long-term process of experimentation and innovation through which local stakeholders learn and thereby build their competencies and confidence. Short-term project-based approaches that focus on development, rapid implementation and hand-over of IT systems to local institutions bypasses this process of local engagement, empowerment and participation.

However, there are potential tensions that require consideration, especially around managing the demands of short-term needs with more long-term concerns. Researchers have proposed the need to establish institutional processes that facilitate the coordination of project-based interventions with government agencies in order to minimize dependency of short-term technical support arrangements (Kimaro & Nhampossa, 2005; Manda, 2015). A move away from the project mindset in development requires a gradual cultural shift (in ideas, beliefs, and values) towards '*alternatives to project-based intervention*'. However, creating such cultural shifts is likely to encounter various conflicting forces. Among such forces are those identified in the *projectification* mechanism, namely; dominant discourse on project-oriented development and project-based funding arrangements. Addressing these areas will require a long-term multi-level engagement due to the vested interest of various actors.

In line with this, the governance of collaboration and partnerships among interorganizational actors is a key aspect of the HMIS digitalization that has been overlooked in Ethiopia. The mobilization and organization of agency implicated in the *embedded inscription* mechanism is where unfavorable strategic shifts can occur in digitalization. Relational embeddedness can be simultaneously enabling and constraining to successful digitalization. On the one hand, it can help deal with challenges of uncertainty,

facilitating information exchange, decision-making and coordination among collaborating partners (Uzzi, 1997). Conversely, social embeddedness can have negative effects on digitalization when it functions as the sole mode of control for governing how stakeholders should collaborate in development projects. The informality of governance in such digitalization projects comes with potential downsides for local governments. We suggest that local institutions design the context for temporary project-based organizations (e.g. NGOs). Since the two organizational forms must fit together and serve the strategy of the local government, appropriate project governance institutions and coordination arrangements need to be established in order to garner lasting digitalization outcomes.

We argue that addressing these areas can improve the developmental potential of such initiatives by positioning local institutions to actualize the *informatization* and *scaling* mechanisms. Both mechanisms fundamentally highlight gaps in institutional capacity and the transitioning of NGO-led initiatives to local health institutions.

9 Conclusion

This paper has examined the digitalization of HMIS in a developing country context. Drawing on a critical realist approach, four generative mechanisms of HMIS digitalization have been identified. The first is the *projectification*, which is the process by which partnership asymmetries are produced as projects become primary instruments for organizing work and transferring resources in digitalization. The second is *informatization*, which explains how strategies for digitalization emerge as the increasing volume and variety of data generates demands for its optimization. Thirdly, the *embedded inscription mechanism* is where key change agents leverages on their socio-political networks to influence the digitalization process. The last is the *scaling mechanism*, which relates to the technical malleability of the digitalized artifact and its spread in terms of user adoption and diffusion of local skills.

This study has adopted Archer's morphogenetic approach and builds on earlier insights that relate the morphogenetic approach to IT and organizational transformation (Horrocks, 2009; Mihailescu, Mihailescu, & Schultze, 2015; Mutch, 2010; Njihia & Merali, 2013). However, one of the limitations with employing Archer's approach is delineating the time period of each cycle (T1-T4). The strict categorization of our case into fixed periods proved to be challenging as there were a number of overlapping events. Based on studies that have applied the morphogenetic cycle, including Archer's own empirical work in education, the approach may be more suited to longitudinal studies that draw on historical data in order to develop a more concrete delineation across the three stages. Perhaps more importantly, the use of Archer's temporal categories can also hide the dynamism in the process of digitalization, forcing researchers to freeze certain processes into time periods.

This study also demonstrates that mechanism-based explanations can be useful in the theory-building process in IS research. However, we foresee potential limitations and challenges with examining mechanisms. First, the identification and focus on one mechanism at the exclusion of another may produce research that partially explains a phenomenon. Secondly, the lack of clear criteria in critical realism around selection among candidate mechanisms leaves much choice to researchers which can introduce potential arbitrariness or partiality.

Overall, our study demonstrates the analytical and explanatory capacity of the morphogenetic approach for studying the complex process of digitalization. Critical realism has also presented a useful perspective with its philosophical base to highlight the stratified, emergent and transformative nature of the digitalization phenomena.

10 References

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Governance lessons from an interorganizational health information system implementation in Ethiopia

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Abstract

The paper investigates interorganizational health information system implementation in a developing country health sector and the influence of the sociopolitical context that constitutes the institutions of the global health system. It argues that a comprehensive understanding of interorganizational system (IOS) implementation should include the study of the institutional context and its stakeholders who exhibit complex social and political attributes that influences its implementation and trajectory. This paper charts this course by examining the key governance dimensions of coordination and alignment. Building on this, the study challenges the viability of the unstructured institutional arrangements and the ensuing development modalities for health information system implementation, which are largely facilitated by international nongovernmental organizations and leverage on information and communication technology. The paper concludes by discussing the implications of the study. These include (1) the influence of unstructured interorganizational relations, at both the organizational and sector levels, on IOS adoption, (2) how the social and political behaviors of opportunistic interorganizational participants are implicated in the IOS adoption process, and (3) the role of strategic alignment, largely driven by the informal interorganizational relationship and social dimensions, on the prioritization and fit between IOS technological and organizational components.

KEYWORDS

alignment, coordination, health information systems, interorganizational systems, IT governance

1 | INTRODUCTION

Interorganizational systems (IOSs) are network-based information systems (ISs) that are adopted and used by two or more organizations (Cash & Konsynski, 1985; Steinfield, Markus, & Wigand, 2005). Interorganizational systems allow information sharing across organizational boundaries and therefore include the collaboration of various interorganizational stakeholders (Boonstra & de Vries, 2008; Cash & Konsynski, 1985). Although both the economic and sociopolitical have been identified as factors in IOS implementation, there has been limited empirical research on IOS from the sociopolitical perspective (Premkumar & Ramamurthy, 1995). Much of the IOS research has relied on economic-oriented analysis to examine the benefits of IOS for gaining competitive advantage (Premkumar & Ramamurthy, 1995). However, IS implementations are also social phenomena that are socially and historically shaped (Klecun & Cornford, 2005). In the IOS literature, the adoption of IOS has been viewed as largely driven by interorganizational relations (Kumar & van Dissel, 1996; Premkumar & Ramamurthy, 1995). As a result, there is a need for IOS research that adopts a sociopolitical perspective to examine the social and political forces in interorganizational relationships and their influence on IOS adoption (Boonstra & de Vries, 2008; Premkumar & Ramamurthy, 1995).

Furthermore, the analysis of interorganizational relations and configurations has been primarily focused on single adopters of IOS or multiple single adopters (Lyytinen & Damsgaard, 2011). Lyytinen and Damsgaard (2011, p. 497) propose the consideration of the active adoption

population, shifting away from single or independent adopters to study the IOS adoption by examining the “families of interdependent organizations” who bring with them specific capabilities, strategies, and structural arrangements. Additionally, Chatterjee and Ravichandran (2004) argue that IOS analysis should identify the levels of abstraction and analyses to provide better understanding of the interaction and causal associations across interorganizational levels.

Within the health sector, various factors in the implementation of IOS have also been explored. Payton (2000) in her investigation of an inter-organizational health care IS identified various implementation factors. Government policies, competitiveness among interorganizational actors, cooperative participation, the quality of management, and information sharing were all identified as factors that influenced organizational decision making and overall IOS implementation activities.

On the basis of these gaps, this paper examines the adoption of IOS in the multilevel interorganizational context of a developing country health sector, which presents a useful empirical grounding to examine the influence of international, national, and subnational stakeholders and related sociopolitical factors on IOS adoption. The study considers the following: (1) information technology (IT) innovation in relation to organizational change, (2) the organizational together with the national and international contexts, and (3) the social, political, and institutional forces of the IOS adoption process looking beyond merely technical or rational decisions. To examine the broader context and the sociopolitical factors, the research adopts an interdisciplinary perspective by drawing on the global health governance literature.

Global health is defined as “the goal of improving health for all people in all nations by promoting wellness and eliminating avoidable disease, disability, and death. It can be attained by combining population-based health promotion and disease prevention measures with individual-level clinical care” (Institute of Medicine, 2009). The global health system consists of traditional actors such as national ministries of health and the World Health Organization (WHO) in addition to an increasing variety of actors that include NGOs, civil society, private firms, and private philanthropists.

As a result, governance has emerged as an important development agenda in global health because of the need for more effective collective action by heterogeneous stakeholders (Dodd & Olivé, 2011; Dodgson, Lee, & Drager, 2002; Fidler, 2007). Although the call for governance reform in global health is also evident in eHealth (the use of information and communication technology (ICT) to support health services and management), it has not received sufficient focus in the health sector information and communication technology for development (ICT4D) research. The study aims to fill this gap by examining the IOS adoption process from the governance dimensions of alignment and coordination. By adopting a contextualist approach, the paper aims to show, through the case of the electronic health management information system/public health emergency management (eHMIS/PHEM) IOS in Ethiopia, how the implementation of IOS in developing countries is entrenched in the interests of multiple interorganizational partners, the sociopolitical context, and the dynamics of the technological infrastructure. Through this line of analysis, it also examines whether the current health information system (HIS) strengthening model, largely facilitated by international NGOs and leveraged on ICT, makes sense as the dominant approach to foster development in the HIS domain.

The paper is structured accordingly; the next section describes the interorganizational context and introduces the key governance dimensions of coordination and alignment. In Section 3, the research method is outlined. In Section 4, the Ethiopia eHMIS/PHEM, a national IOS implementation led by an NGO, provides a common example of how large-scale IOSs are being introduced in the developing country health sector. On the basis of the empirical evidence from the case, Section 5 examines the challenges of the endeavor and implications of the IOS based on analysis of interorganizational interdependence and coordination. Section 5 also discusses the notion of alignment and highlights the influence of competing sociopolitical interests in the IOS adoption process. Section 6 presents a discussion of the study's implication to the mainstream IS research. Concluding remarks follow.

2 | BACKGROUND: THE INTERORGANIZATIONAL CONTEXT OF GLOBAL HEALTH DEVELOPMENT

The study of the wider external context in which ISs are embedded has been identified as a key focus in both IOS (Robey, Im, & Wareham, 2008) and ICT4D research (Avgerou, 2001; Walsham, 1993). The global effect on the process of IOS adoption in developing countries is perhaps most visible in the health sector. Over the past decades, the developing country health sector has experienced a dynamic shift (Clark et al., 2017). Between 2000 and 2010, development assistance for health has increased fivefold from approximately \$7 billion to \$35 billion (Dieleman et al., 2015). This trend has resulted in the proliferation of new stakeholders and institutions, new tactics to delivering assistance, new targets, and new funding schemes (Schemeil, 2013). However, the diversity and innovation of the complex set of donors and NGOs combined with the enthusiasm and involvement of politicians, activists, and philanthropists have raised concerns about the lack of coherence in global health development (Dodd & Hill, 2007; Fidler, 2007). These issues have been corroborated by increasing evidence that the lack of effective harmonization among the diverse actors may disrupt and weaken rather than improve fragile health systems (Bourguignon & Platteau, 2015; Buse & Walt, 1996).

2.1 | Governance and unstructured plurality

This state of plurality in global health has resulted in the development of complex hybrid organizations that have come to represent contradictory strategies and tactics (Fidler, 2007; Schemeil, 2013). Hybrid organizations are characterized by organizations that include diverse stakeholders

who pursue numerous and at times conflicting goals, and can engage in inconsistent undertakings (Besharov & Smith, 2014). This state of global health has been referred to as “unstructured plurality” (Fidler, 2007). The desire to bring order has led to the predominance of the “aid effectiveness” agenda, which calls for a governance intervention (Dodd & Hill, 2007).

Governance refers to “all mechanisms within an organization that broadly determine how organizational resources are used to move the organization forward and resolve conflicts between its various stakeholders” (Mair, Mayer, & Lutz, 2015, p. 716). Fidler (2007) refers to these governance challenges as “open-source anarchy,” a condition where State and non-State actors both access and shape the governance space.

In view of this, the desired arrangement of governance and its mechanisms in global health has been an ongoing debate dominated by two predominant positions. On the one end, there is an argument for a state-centric approach where governance and accountability is located in a single institution (Dodgson et al., 2002). This perspective is in line with a centralized approach to addressing fragmentation in global health (Fidler, 2007). The second perspective is one that embraces a less linear form of governance. It asserts that both State and non-State actors should have access to the governance space in a more structured way (Dodd & Hill, 2007; Fidler, 2007). Finding the balance between a strong center and the anarchic reality of multiple actors, processes, and channels is a paradox of global health governance that continues to generate wide discussion.

In recent years, global health governance reform efforts of national and international donor agencies have been focused on two key dimensions of governance: alignment and coordination (Buse & Walt, 1996; Dodd & Hill, 2007; OECD-Paris, 2005; OECD-Rome, 2003). In this effort, various mechanisms have emerged, a predominant of which has been the sector-wide approach (SWAp) (Cassels, 1997; Walford, 2007). Sector-wide approach as a concept emerged in the 1990s with two main aims: first, to ensure alignment and harmonization among policies, budgets, and institutional arrangements and second, to foster better coordinated interaction and information sharing between government and donors (Cassels, 1997). More recently, these overarching objectives have been bolstered by the Rome and Paris Declaration on Aid Effectiveness (2003, 2005). These declarations reaffirm commitments at the global and country levels to coordinate and align aid delivery and implementation (OECD-Paris, 2005; OECD-Rome, 2003). The fundamental principles of the aid effectiveness agenda include the following:

1. Alignment: Donor countries should align behind developing country, set strategies and objectives, and use local systems.
2. Harmonization: Donor countries should coordinate, simplify procedures, and share information to avoid duplication.
3. Managing for results: Developing countries and donors shift focus to development results and results get measured.

However, successful adoption of SWAps has been limited to a few developing countries (Dodd & Hill, 2007; Walford, 2007). These initiatives have been common mantras in global health's push for aid effectiveness that have not had tractions on the ground (Walford, 2007). The limited success of these efforts reflects underlying contradictory institutional forces among donors, within States and between donors and States (Dodd & Olivé, 2011; Hill, 2002). However, global health continues to retain a conceptual appeal to SWAp's aims of coordination and alignment (Hill, 2002).

2.1.1. | Coordination

Coordinated management of aid and development activities of numerous donors and NGOs in the developing country health sector has been a longstanding challenge (Buse & Walt, 1996). Coordination involves tasks, protocols, and decision mechanisms designed to ensure aligned actions between interdependent actors (Thompson, 1967). Within the health sector, coordination refers to:

Any activity or set of activities, formal or non-formal, at any level, undertaken by the recipient in conjunction with donors, individually or collectively, which ensures that foreign input to the health sector enable the health system to function more effectively, and in accordance with local priorities, over time (Buse & Walt, 1996, p. 175).

The definition draws attention to who is coordinating whom, what and to which ends. Consequently, coordination has become a key health policy agenda for a number of reasons (Buse & Walt, 1996; OECD-Paris, 2005). First, to manage the increase in the number and diversity of international development agencies whose initiatives and activities have been incoherent (Buse & Walt, 1996; Cohen, 2006). Second, to address the escalated complexity, confusion, and the potential for conflict (Cohen, 2006). Third, to mitigate the proliferation of projects that have become a burden on recipient ministries and local institutions by shifting from a project focus to sector assistance (Buse & Walt, 1996; Walford, 2007).

This study examines coordination among State and non-State actors in the IOS adoption process by using Thompson's (1967) “interdependence” view of the organization. According to Thompson (1967), the need for coordination arises from the interdependence of organizational participants on one another. Thompson (1967) classifies three types of interdependence. First, in pooled dependency, organizational units share resources but are otherwise independent. Second, sequential dependency, where units work in series where output for one unit is input to another. Third, in reciprocal dependency, units exchange work among themselves often in an interactive manner. The type of coordination mechanisms adopted depends on the type of interdependency (Mintzberg, 1993). Therefore, pooled interdependency requires coordination by standardization, for sequential interdependency, coordination by plan is appropriate, and reciprocal dependency calls for coordination by mutual adjustment (Thompson, 1967). Organizations that exhibit pooled, sequential, and reciprocal interdependency are the most complex in terms of coordination and place heavy burdens on communication and decision making (Thompson, 1967).

2.1.2. | Alignment

Within the global health literature, alignment is a key aim of the aid effectiveness agenda (OECD-Paris, 2005; OECD-Rome, 2003). It aims to ensure congruence of donor countries' development efforts with local strategies and systems (Dodd & Hill, 2007). Furthermore, within the IOS literature, interorganizational cooperation required among various stakeholders highlights the need for alignment as a relevant focus of analysis (Lyytinen & Damsgaard, 2011). Although largely neglected in IOS research, alignment has been an extensively researched topic in the IS management literature. In IS management, alignment is commonly defined as the fit between business strategy, IT strategy, business infrastructure, and IT infrastructure (Henderson & Venkatraman, 1993). Generally, strategic alignment is the fit between business needs and IS priorities (Chan & Reich, 2007).

However, the alignment research has been criticized for neglecting to consider important real-life phenomenon due to its mechanistic perspectives (Ciborra, 1997). The informal structure (Chan, 2002) and the social dimensions (Reich & Benbasat, 1996) of alignment have been found to be significant factors of alignment. Moreover, the levels of analysis in alignment research have predominantly been at the organizational level, project level, and individual/cognitive level (Chan & Reich, 2007). Lastly, analysis of IOS adoption has failed to account for the presence of alignment among the set of factors that influence successful adoption (Lyytinen & Damsgaard, 2011).

The interorganizational context of the developing country health sector and its effect on the IOS adoption process presents a relevant empirical grounding to explore the neglected sociopolitical dimensions of alignment. Although the notion of alignment has different connotations for the global health and IT management domains, a similar thread exists between the two. Both perspectives identify alignment as a dimension of governance that aims to foster coherence, fit, and integration (Chan & Reich, 2007; Dodd & Hill, 2007; Henderson & Venkatraman, 1993).

3 | METHOD

The study is a naturalistic inquiry of the eHMIS/PHEM implementation in Ethiopia. Naturalistic inquiry allows the study of the real world as it unfolds (Lincoln & Guba, 1985). It presents many advantages by offering contextual relevance and richness and sensitivity to historical and developmental process not only to describe events but also to understand why they occur (Lincoln & Guba, 1985).

The eHMIS/PHEM case, which is the largest implementation of its kind in the Ethiopian health sector, offered an ideal opportunity and a strong learning potential. The case was also selected because it reflects many of the challenges and opportunities that national ministries of health face in implementing HIS in this context.

As a subset of naturalistic inquiry, participant observation was adopted as a research method relevant to the health domain, where the investigator was a part of the setting and the process being studied (Sofaer, 1999). The author's role in the NGO initially involved a research responsibility but gradually transitioned to a coordination and management role. Initial research activities included investigation of the initial eHMIS/PHEM implementation in Tigray involving both end users and the NGO's implementation team. As the project scale-up continued, my role shifted more to project activities.

The participant observation involved a 14-month long involvement in an NGO eHealth project where the investigator was able to make use of unstructured observations and conversations. Participant observation presented a far more greater learning opportunity (about the inner workings of an NGO, the challenges of the IOS adoption process, the role and rationalities of the various interorganizational stakeholders, and the mismatches between NGO expectations and the actuality of the project) than could have been obtained using structured methods such as interviews or surveys (Lincoln & Guba, 1985).

Participant observation also offered the possibility to participate with interorganizational partners at the various contextual levels: donor, NGO, health facilities, districts, regions, and national Ministry of Health. For example, involvement in the IOS projects in Ethiopia presented occasions to participate with donors, for instance, during donor implementing partner meetings; at the national level with the Federal Ministry of Health (FMOH) leadership through gatherings such as status update and implementation planning meetings; at the regional level through collaborations with Regional Health Bureau (RHB) staff during IOS implementation and trainings; and lastly, at the local level with districts and health facilities during on-site implementations, support, and troubleshooting where opportunities to engage in conversation with various stakeholders such as health facility heads and data custodians offered the opportunity to understand the local context.

The contextual approach adopted is also consistent with the view that the process of IOS adoption in developing countries cannot be simply studied and understood by focusing on the local administration alone or the technological features in isolation (Avgerou, 2001). Rather, it needs to consider together various actors involved in the IOS adoption process (Avgerou, 2001).

3.1 | Data source

Ongoing data collection was conducted from two data sources. The first data source was from longitudinal participant observation in the implementation process of the eHMIS/PHEM, which provided accounts of various events. Over this time, data were collected from macrolevel and on-the-ground involvement of the author with the eHMIS/PHEM project in various activities including implementation, training, and support by engaging with various local users (Appendix A). In line with this, the study was also informed by interactions with a range of stakeholders in the Ministry of Health, two RHBs, and multiple districts and health facilities throughout the implementation process. Specific project narratives

of events and personal stories were documented to provide detail and insights into the eHealth project and process. A secondary data source was archival documents including meeting/workshop minutes, project reports, national implementation strategy documents, assessments, issue logs, and pertinent international reports.

3.2 | Data analysis

Contextualism was used as a mode of analysis (Pettigrew, 1985). Drawing on Pettigrew (1985), three levels of analysis were first identified on the basis of their empirical and theoretical associations. Subsequently, two phases of analysis were performed: (1) a processual analysis that involves the description of the sequential unfolding of historical events and (2) a vertical analysis that traces the interconnections of key constructs between higher and lower contextual levels, namely, the level of the organizational or subnational, national, and international organizational contexts within which the IS innovation process unfolded (Avgerou, 2001). For the first level of analysis, a descriptive data summarization, collation, and organization was performed to produce case description and accounts of key events. Second, at an analytical level, reflection and interpretations of selected constructs provided insights on the contextual levels by drawing on the event analysis and document review process. The multilevel contextual analysis was adopted to account for the nature of IS adoption in developing countries that transcends pure mandate and strategy but is rather shaped by institutional pressures, trends, and local or international constraints (Avgerou, 2008; Ciborra, 2005).

Potential drawbacks of naturalistic inquiry, namely, the conflation of ideological and empirical claims or lack of boundary between what is observed and the observer's related responses and interpretations in the study setting, were minimized by various means. Both credibility and confirmability were concerns enhanced through prolonged engagement at the study setting to identify salient characteristics of both the context and the IS adoption process. Second, peer debriefing was used to test insights from the study with an uninvolved peer, to receive their input to discharge personal bias. Third, triangulation was performed by drawing on data from relevant project-level documents and national and international papers in global health governance to corroborate interpretations.

4 | INTERORGANIZATIONAL SYSTEMS FOR HEALTH SECTOR DEVELOPMENT

4.1 | The global context: the information revolution and ICT

The aid effectiveness agenda of global health has also been a focus in HISs development efforts (AbouZahr & Boerma, 2005; Lippeveld et al., 2002). Health information system refers to the broad set of tools, procedures, and regulations around health data collection, dissemination, analysis, and use. Data have been deemed vital for development initiatives such as the sustainable development goals and its recent push for "data revolution" through new funding streams for strengthening data capabilities (UN-IEAG, 2014). The global health preoccupation with outcome-based development on which much of public health practice is founded has led to an impulsive rush to collect data (Evans & Stansfield, 2003). However, the multitudes of often fragmented and incoherent initiatives over the decades have done little to improve the poor state of HIS in many developing countries (AbouZahr & Boerma, 2005; WHO-HMN, 2007). The information revolution has led to a "gathering storm" where developing countries gather more information than they know what do with and where most information goes up but is rarely used locally (Evans & Stansfield, 2003). Over the same period, the region has been inundated with studies reflecting their HIS inefficiency, data unreliability, and underreporting as a result of cumbersome and fragmented tools and the lack of human technical capacity to collate and analyze data (WHO-HMN, 2007).

These setbacks, recognized by the donor community, called for a collaborative effort similar to the SWAp but customized to HIS (Evans & Stansfield, 2003). In 2003, further efforts to address these HIS gaps led to the initiation of a new global collaboration called the Health Metrics Network (HMN). The HMN had a mandate to strengthen national HIS in developing countries by improving the platforms from which health information management and use might be facilitated in a more sustainable way (WHO-HMN, 2011). The HMN also promoted the development of national HIS strategic plans and the use of ICT to strengthen country HIS (WHO-HMN, 2011). In 2007, HMN's efforts were bolstered by the World Health Assembly who passed a resolution (WHA60.27) entitled "strengthening of health information systems," which urged Members States, stakeholders, and the WHO to take specific steps to support the strengthening of HIS (WHO, 2007). This resolution further legitimized the "HIS strengthening" mandate as an area of development focus. Despite these efforts, the HMN has gone the way of SWAPs and may other optimistic donor harmonization and collaboration efforts. The HMN was disbanded in 2013; however, many national HIS strategic plans, including Ethiopia's, are motivated by the HMN framework, which aimed to improve and bring order to the fragmented HIS domain (Evans & Stansfield, 2003; FMOH, 2010).

In the mandate to strengthen HIS in developing countries, ICT was also identified as a useful development instrument (WHO-HMN, 2007). However, the current state of eHealth in developing countries has become a tangible reflection of the unstructured plurality of global health (Evans & Stansfield, 2003; WHO-HMN, 2011). eHealth in this context has been riddled with duplication, uncoordinated efforts, and fragmentation (WHO-HMN, 2011). Additionally, organizational change concomitant with technology implementation has not received adequate focus (Braa, Monteiro, & Sahay, 2004).

4.2 | The national context: Ethiopia's HIS strategy and IOS adoption

Ethiopia's push for HIS strengthening is framed within the aforementioned broader context. As a point of departure, the national HIS strategic plan is outlined to frame the specific IOS adoption. The Ethiopia FMOH's national HIS strategic plan sets out to achieve five strategic objectives (FMOH, 2012):

1. strengthen HIS governance, legislation, coordination, and leadership;
2. improve, strengthen, and institutionalize HIS resources;
3. improve health data coverage;
4. improve health data management and quality; and
5. strengthen and institutionalize information use for evidence-based planning, performance monitoring, feedback, and action at all levels.

These aims are part of a comprehensive 20-year program, the Health Sector Development Program, which attempts to improve health service coverage and utilization (FMOH, 2010). The HIS strategic objectives highlight key gaps in the general status of HIS in Ethiopia. These include inadequate basic foundations of a good HIS, ie, policy, a comprehensive plan, coordination mechanisms, sufficient investment, and local data management, analysis, and use capacity in part due to the limited health information workforce (FMOH, 2012).

In line with these objectives, the standardization of reports and routine data indicators in the health management information system (HMIS) and disease surveillance system of PHEM have been a primary focus, identified as important areas of HIS strengthening in the country's health reform effort (FMOH, 2010).

The eHMIS/PHEM IOS

The IOS under analysis is a national system called the eHMIS/PHEM. The eHMIS/PHEM was developed by a donor-funded international organization, hereafter referred to as international development partner (IDP). The eHMIS/PHEM is a key HIS in the FMOH's effort to digitize HMIS and disease surveillance reporting systems in the country.

The eHMIS/PHEM is embedded within the Ethiopian public health system, which is arranged in a decentralized four-tier system consisting of primary health care units (PHCUs), district hospitals, zonal hospitals, and specialized hospitals. The PHCU is composed of a health center with five satellite health posts. Depending on the region, the PHCUs are administered by a three-level administrative division consisting of districts health departments or woreda health offices (hereafter referred to as districts), which report either to the zonal health departments or directly to the RHBs. Together the health care system is made up of over 4100 health institutions (excluding health posts) (Figure 1).

The HMIS consists of a set of morbidity, mortality, and service delivery indicators that are compiled into reports at health facilities. These reports are submitted to higher level administrative health institutions that further aggregate these reports with administrative data and submit them to the next level until it reaches the FMOH. The HMIS tools aim to instill standardization of data collection and reporting across all health institutions in the country to support informed strategic decision making and management.

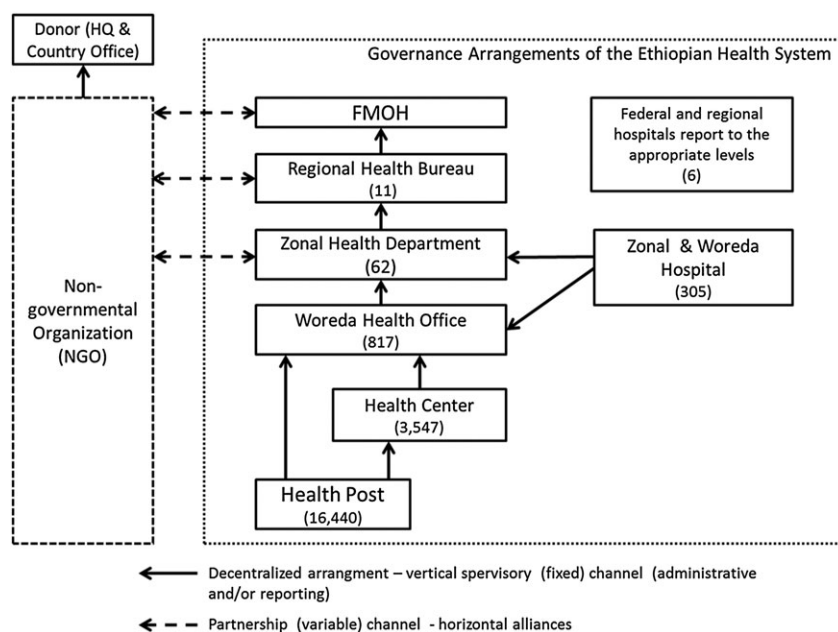


FIGURE 1 Governance arrangements around electronic health management information system/public health emergency management project. FMOH, Federal Ministry of Health

The eHMIS is the electronic equivalent of the indicators and paper reporting format of the HMIS and is a system that enables health institutions to electronically aggregate, analyze, and submit data to higher level institutions. Reports are submitted and received electronically each month through the system's internal e-mail feature. The HMIS, however, only makes up part of the country's overall HIS.

The PHEM software supports the national routine disease surveillance system called PHEM that aims to ensure nationally coordinated, comprehensive surveillance and response systems. The PHEM addresses disease surveillance of immediately notifiable infectious disease (eg, measles, cholera, and yellow fever) while the HMIS deals with routine health data. Essential activities within PHEM include disease detection, reporting, analysis, response, monitoring, and preparedness (EHNRI, 2012). The aim of the PHEM system is to facilitate prompt reporting and provide some level of data analytics capabilities. Public health emergency management includes 20 (13 daily and 7 weekly) reportable diseases. At the periphery, disease surveillance reporting is carried out at health posts, health centers and districts by health workers, and designated surveillance officers (EHNRI, 2012). The weekly and daily PHEM reports are sent to higher level health institutions and ultimately to regional surveillance units and to the Ethiopian Health and Nutrition Research Institute (EHNRI), the arm of the FMOH responsible for managing PHEM among other tasks.

The pilot and prototyping phase of the eHMIS/PHEM began in 2011 in East Shewa Zone and Adama and Bishoftu Special Zones in the Oromia region. Piloting at the three zones involved implementing the eHMIS software at 15 health centers, 2 hospitals, and 13 districts. As of March, 2012, all institutions within the three zones had entered and electronically submitted 16 months of HMIS data. Building on the pilot experience and as of 2013, the eHMIS/PHEM was implemented in four regions in Ethiopia with varying degrees of implementation at health center, district, zonal, and regional levels. A total of 2781 computers and accessories were distributed, and 3806 professionals were trained on the system (FMOH, 2014). Overall, the implementations included Addis Ababa (51 sites), Tigray (60 sites), Harari (20 sites), and Amhara (163 sites).

4.3 | The local context: malaria hot spots eHMIS/PHEM implementation

To unravel the social and politics dynamics at play in the IOS implementation among the multiple agencies, the paper draws on specific events around the implementation initiative of the eHMIS/PHEM system at health facilities in malaria hot spot areas in one region of Ethiopia.

In July, 2012, just prior to malaria season in various malaria prone regions of Ethiopia, a rapid implementation of the eHMIS/PHEM system was planned for selected health institutions in malaria epidemic-prone areas referred to as "malaria hot spots." The purpose of the rapid implementation was to equip health facilities in these areas with the computerized PHEM system enabling them to collect and disseminate timely information to critical stakeholders, hence facilitating rapid response to malaria outbreak. The implementation was planned in malaria hot spot districts and health centers identified by FMOH/EHNRI in five regional states of Ethiopia, namely, Tigray, Amhara, Oromia, SNNPR, and Benishangul-Gumuz. An ambitious big-bang implementation effort was planned targeting the implementation of the PHEM system in 346 health institutions dispersed across the five regions and requiring the training of 1067 end users (Figure 2).

The events relayed relate to the deployment of the PHEM in one region where a team of IDP staff was mobilized to implement the eHMIS/PHEM at 4 districts, 5 hospitals, and 26 health centers. From the outset, the implementation faced a number of challenges. Upon arrival, the IDP team discovered that the region was not aware of the PHEM implementation. After being informed by the team about the implementation plan,

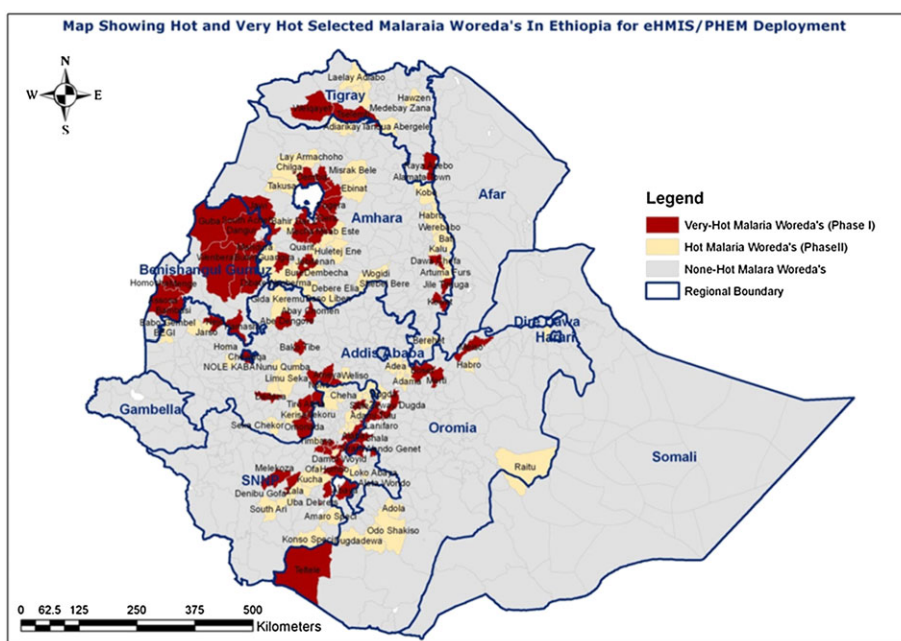


FIGURE 2 Map of malaria hot spot electronic health management information system/public health emergency management (eHMIS/PHEM) implementation

the RHB management declined to go forward with the PHEM implementation. This ensued in a highly charged state of affairs and negotiations lasting a number of days between the IDP and the RHB where top managers of both the FMOH and RHB got involved to resolve the conflict.

In addition to being uninformed of the malaria PHEM initiative, the region's HMIS management had a number of reasons for halting the eHMIS/PHEM implementation. Among the reasons were outstanding software issues the region had logged and reported to the IDP, which the IDP had not addressed. As a result, there was a general dissatisfaction with the IDP and specifically with the way the eHMIS systems had been supported after implementation. This fueled the RHB's doubt over the rapid scale-up.

To address the software issues and more importantly to ensure the region's cooperation in the PHEM implementation, the IDP staff presented an updated version of the eHMIS software to the region's HMIS management, which were then installed on all HMIS computers at the RHB. However, the RHB wanted all districts and hospitals that had been using the eHMIS in the region to also be updated with the latest version. Given that the IDP was stretched in capacity in light of the large-scale PHEM implementation in the five regions, the IDP management tried to go through FMOH to push the implementation of the PHEM and forgo the software updates in the region. This backdoor effort further intensified tensions between the IDP and RHB management. Ultimately, after the failed negotiation effort, the IDP decided to comply with the RHB and the team was mobilized to update the eHMIS in 60 health institutions across the Tigray region over the next 2 weeks while the malaria hot spot PHEM implementation was halted.

The lack of coordination between the FMOH, IDP, and RHB resulted in an implementation initiative, which failed to involve important participants and account for a number of local concerns. Firstly, the RHB and its PHEM units were surprised when the IDP team showed up with computers to train and implement the PHEM solution. They were uninformed and unaware of the implementation plan. However, the FMOH was responsible for sending formal communication to the region. Secondly, the region's PHEM unit did not agree with the selected malaria hot spot health facilities citing that there were more severe malaria-prone health facilities. Thirdly, the RHB HMIS unit was reluctant because health information technicians who work as data custodians had not yet been deployed at the health facility level. Fourthly, the RHB HMIS unit was not willing to share the computers that were initially promised for HMIS use for purely PHEM purposes. Although one of the reasons why the eHMIS/PHEM software was amalgamated into one application was to address the scarcity of computers at peripheral health institutions, the RHB was not made aware of this.

Lastly, the rapid implementation efforts of the PHEM system were recognized by the RHB as a reoccurring theme of big-bang implementations without capacity to sustain them. In March of 2012, during the initial implementation of the eHMIS at 46 districts and 14 hospitals in the same region, 18 NGO staff had been mobilized for the implementation over a 3-week period. However, following deployment, only one IDP staff embedded within the RHB was responsible for providing ongoing support together with RHB HMIS staff.

Overall, across the country, the ambitious and distributed big-bang implementation of the eHMIS/PHEM in malaria hot spot areas also required the training of 1067 end users between July and August of 2012. Since trainings were computer based, accessing enough computers in such a short period was a challenge, which was partly addressed by collaborating with local colleges to use their computer labs. Nevertheless, accommodating such a large group in such a short period was not possible and trainees in various venues were forced to share computers compromising the quality of the training.

5 | ANALYSIS AND DISCUSSION

5.1 | Coordination and interorganizational interdependency

Drawing on Thompson's (1967) view of interdependence, the interorganizational coordination in the eHMIS/PHEM IOS implementation process is further examined. The Ethiopian public health sector is a hierarchical interorganizational arrangement that exhibits largely pooled and sequential interdependency. The government health sector generally operates under a structured hierarchy where regions, zones, districts health institutions, and peripheral health facilities share common resources, are decentralized, and operate in a semiautonomous manner. Therefore, the government interorganizational relationship exhibits pooled interdependency as well as sequential interdependency through their planning and data sharing processes. These interdependencies are largely managed by formal structure, standardized practice, and planning. Established standards (in terms of data indicator, tools, collation and reporting procedures, and district/woreda-based planning) act as main coordination mechanisms.

However, the introduction of a new actors (ie, IDP) in the interorganizational context created a loosely structured relationship in the IOS adoption process increasing the level of coordination ambiguity in the interorganizational alliance. The unstructured involvement of the IDP added reciprocal interdependency among interorganizational actors involved in the IOS implementation process. As a result, the lack of structure in the interorganizational relationship was a factor to the conflict that ensued.

Moreover, sequential interdependence, largely coordinated by use of schedules and plans, was poorly carried out in the IOS implementation. For instance, the decision to deploy the eHMIS/PHEM system at malaria hot spot areas was a result of an eHMIS/PHEM demo and update meeting between the NGO and FMOH top management. During the meeting, it was decided that within a period of 6 weeks leading up to malaria season, the largest (346 sites) and most distributed (five regions) implementation of the PHEM system would be performed. This single implementation effort was larger than the combined implementations of the eHMIS/PHEM the IDP had managed to performed since initial scale-up started in early 2012. The distributed nature of the implementation that spanned the length of the country made the deployment

logistically challenging and demanded extensive coordination. The implementation was a task local and regional health institutions were neither equipped nor prepared to handle. Decisions and planning in the IOS implementation process were primarily devised between the NGO and the FMOH, leaving out key regional actors. This led to ambiguity among the regional partners about the IOS implementation that further increased uncertainty and eventually led to disagreement.

Consequently, ensuring buy-in and agreement from uninformed regional actors was informally carried out and led by the NGO whose legitimacy in the interorganizational structure was poorly defined. The reciprocal interdependence among the interorganizational actors in the IOS implementation process called for mutual adjustment and ad hoc management in the absence of structured coordination mechanisms among the interorganizational actors. In the case relayed, it is evident that there is a general absence of governance mechanisms that manifest in uncoordinated arrangements for formal participation, decision making, and negotiation among key interorganizational partners. Consequently, the responsibility, monitoring, and accountability of tasks were also poorly defined among the interorganizational stakeholders.

According to Thompson (1967), organizations that have pooled, sequential, and reciprocal interdependence are the most complex. Furthermore, coordination by mutual adjustment that depends on a high level of ad hoc activity can reduce structure and in turn increase uncertainty in the interorganizational relationship (Kumar & van Dissel, 1996). In the IOS implementation process, as a result of the loosely structured organizational arrangements where coordination by mutual adjustment prevails, important coordination aims are thwarted. Two key aims of coordination explored in this case are IOS implementation effectiveness and interorganizational equity. According to Buse and Walt (1996), effectiveness and equity are also objectives of coordination in the health sector.

To address misaligned strategies and tactics, the aid effectiveness agenda of the international development community has called for certain coordination mechanisms to ensure that various development activities are harmonized in achieving local objectives (OECD-Rome, 2003). However, the modalities to achieve them have been a key contention (Dodd & Hill, 2007).

In the eHMIS/PHEM initiative, the accountability of tasks with regard to budgeting, implementation, and ongoing maintenance lacked adequate coordination mechanisms compromising the projects effectiveness. As a result, what has ensued is local organizations who have failed to take ownership of the eHMIS/PHEM system, many local health institutions even referring to the eHMIS/PHEM as the "IDP's system." With this comes an expectation, by regions and districts, that the IDP is responsible for maintaining and covering system-related costs. In an eHMIS sensitization workshop in March, 2012, regional staff voiced these expectations and concerns: "we expect FMOH/[IDP] to aid us with equipment and also other partners to help us fill gaps" and another participant stated: "we will need budget supplement." In general, these concerns in the eHMIS/PHEM project highlight concerns about local capacity, ownership, and the overall lack of institutionalized coordination around the support of local institutions in the IOS implementation. These challenges compromise effective IOS development and have been identified by the WHO as gaps in its assessment of the HIS in Ethiopia (WHO-HMN, 2007).

In addressing these issues, the general push by international organizations has been towards governance that has more formal coordination structure, direction, and policy coherence (Fidler, 2007). Nonetheless, the notion that the current state of unstructured plurality requires rationalization, centralization, and harmonization of governance strategies has been challenged by some critics who propose less linear and more diverse forms of governance (Dodd & Hill, 2007; Fidler, 2007). Despite such views, it is evident that States are the central actors and that "non-State actors simply cannot shoulder the burden of building and operating the kind of comprehensive public health capabilities" (Fidler, 2007, p. 13). There is global consensus articulated by the Organization for Economic Cooperation and Development (OECD), International Monetary Fund, World Bank, and the United Nations that coordination should be driven and owned by recipient governments (OECD-Paris, 2005; World Bank, 1993). In the eHMIS/PHEM, these shifts to State-driven coordination are not evident nor are State actors seemingly willing or ready to take on this responsibility in the presence of the well-funded and more technically apt NGOs. However, looking forward, the sheer scale of thousands of dispersed installations in larger regions such as Amhara (960 sites) and Oromia (1550 sites) presents an unmanageable coordination effort and scope for a single NGO to manage. These activities would need to be transitioned to enduring organizational structures.

5.2 | Alignment in IOS implementation

The notion of alignment among interorganizational stakeholders is further explored to elucidate the underlying social and political forces at play. The notion of alignment from the IS literature and global health governance is used to analyze the IOS implementation process by focusing on three main areas: (1) alignment between IT and business infrastructure, (2) strategic alignment among interorganizational stakeholders, and (3) alignment of interorganizational rationalities.

5.2.1 | Alignment between IT and business infrastructure

One of the core agreements outlined in the Paris Declaration for scaling-up more effective aid and development is: "increasing alignment of aid with partner countries' priorities, systems, and procedures and helping to strengthen their capacities" (OECD-Paris, 2005, p. 1). "Capacity building" has been a widely used mantra in international development. However, within ICT, there is a taken-for-granted notion of IOS implementation that ignores the complex organizational transformation process (Avgerou, 2008). These rationalities are rooted in underestimation of the effort required to transfer ICT skills and knowledge to foster new organizational norms and practices in developing countries (Ciborra, 2005). These are long-term and incremental development efforts (Braa et al., 2004). However, the rapid national scale-up of the eHMIS/PHEM has added pressure for accelerated transformation of local health institutions that has been unrealistic.

In the IOS implementation, the capabilities of IT management, software development and updates, server maintenance, and technical support all exist within the IDP and little effort has been focused, by both the IDP and the FMOH, on transferring and developing these capabilities at national and subnational health institutions. Currently, the FMOH, regional, and district level institutions have little to no ICT capacity for full uptake and ownership of the eHMIS/PHEM. A 2013 national review of the national Health Sector Development Program states: "partners' support is mainly focused on supporting different information systems rather the building the overall ICT capacity" (FMOH, 2013, p. 111). Similar concerns were voiced by one regional staff during an eHMIS workshop: "previous electronic systems have been deployed but there is poor follow-up after that, they [IDP] need to support us to the end and FMOH needs to recognize the gap in structure at the regions." The mere design and scale-up of a technology in an undeveloped and unsustainable institutional context is insufficient and cannot in itself be considered development.

The challenges faced by the IDP in building institutional ICT capacity in this context are understandable. Pragmatically, where does one start to build the ICT capacity of over 4100 distributed health institutions? It seems unrealistic to place this burden on one NGO. Moreover, it could be argued that focus should start at the top, at FMOH and regional levels (Gebre-Mariam & Frujtier, 2017). Even then, the financial, technical, and political effort necessary to carry out radical organizational transformation requires a long-term commitment. However, most NGOs are funded on short-term grants (Dodd & Hill, 2007). Another consideration is whether the IT function should exist within health institutions that are already strained. Alternative approaches through public-private partnerships and intersectoral collaborations with ICT ministries and universities have also been adopted in some developing countries (WHO, 2012). This paper does not aim to explore the validity of these varying approaches. However, what is highlighted is the continued unsustainable efforts of the donor, the IDP, and the FMOH in funding and scaling-up eHealth solutions despite a clear institutional IT capacity development method being defined.

The reasons for the lack of focus on fundamental institutional and structural issues are multifaceted. Perhaps most importantly, the IDP's unwillingness and inability in this endeavor reflects underlying anxieties that many NGOs face (Clarke, 1998). The IOS implementation process that involves IT innovation and organizational change requires both the institutionalization of IT and deinstitutionalization of traditional organizational structures and practices (Avgerou, 2000). Such efforts would entail challenging an "elite-driven politics" that would compromise the NGO's position (Clarke, 1998). As a result, the IDP relies deeply on existing social and institutional forces for its support and ongoing existence. By not disrupting the existing structures, the IDP's indispensability is ensured ironically reflecting the disparity between aid and its development outcomes.

5.2.2 | Strategic alignment among interorganizational stakeholders

The HIS strategies at the global and national levels and the actual HIS strengthening efforts on the ground also exhibit contradictions. At the global level, the broad aims are to strengthen institutional capacity to collate, analyze, and use health data (WHO, 2010; WHO-HMN, 2011). At the national level, similar objectives are echoed with objectives of strengthening institutional capacity around governance, legislation, data management, quality, and information use (FMOH, 2012). From these strategic objectives, the underlying institutional capacities especially around data management, quality, and use are identified as the overarching challenges and focus areas (FMOH, 2012; WHO, 2010; WHO-HMN, 2011).

However, the HIS development efforts by the IDP and its donor funds, as illustrated through the eHMIS/PHEM case, do not align with these strategic objectives. In fact, the displacements of national priorities are evident as a result of the energy and salience placed on the objectives of the donor and IDP. The IDP's primary efforts in Ethiopia have not been dedicated to strengthening the core institutional HIS capacity identified in the national HIS strategy. Instead, the efforts have been on developing and implementing ICT solutions without addressing obvious institutional data management gaps. Despite this, for close to a decade, the IDP has been in country funded as a primary HIS strengthening partner of the FMOH.

The aim of this line of analysis is to pose critical questions around the notion of HIS development. More specifically, does ICT-based system implementation facilitate the development of data management, quality, and use capabilities in health institutions and where can it hinder it? To an extent, the eHMIS/PHEM can facilitate standardization of indicators and reporting formats across health institutions where the scale-up and use of the manual HMIS has been a challenge (FMOH, 2010). Additionally, data collation burden and timely reporting can be potentially improved through such systems (WHO-HMN, 2011). These are perhaps the foremost benefits of the eHMIS. However, the eHMIS is a system for purely entering, submitting, and analyzing aggregated morbidity, mortality, service delivery, and administrative data. Therefore, it is not a primary data source nor does it replace health facility paper-based data collection tools or ensure data quality assurance of these tools. As a result, the mere implementation of the eHMIS cannot address core data management issues at the health facility level, where most data originate (Mate, Bennett, Mphatswe, Barker, & Rollins, 2009).

The notion that HIS strengthening is enabled by eHealth solutions whereby poor local use of data, burden of data collation, low transmission rates, poor data quality, and completion rates would be addressed is not evident (Mate et al., 2009). These are predominantly knowledge-based institutional practices that are not addressed merely by digitizing data and information flow (Mate et al., 2009; Piette et al., 2012). Consequently, the evidence for the improvement of data management capacity through eHealth solutions in developing countries is limited and isolated (Mate et al., 2009; Piette et al., 2012). The assessment of Mate et al. (2009) of 316 clinics in three districts in South Africa demonstrated poor data quality (12.8% accuracy rates) and subpar transmission rates (50.3% of the time) despite the use of a widely adopted database at district level. According to the study, the major point of breakdown in term of data integrity was the data collation process before submission to the database (Mate et al., 2009).

Similar data management capacity gaps in Ethiopia are apparent at the periphery where the eHMIS/PHEM has been implemented. For instance, in the Tigray region, of the 46 districts, only 35% had designated full-time data clerks or HMIS staff. Among health centers, 90% ($n = 201$) of the 223 health centers in the region did not have designated data custodians. The HMIS activities were performed on part-time basis by nurses and health officers (who are often the most qualified clinicians on-site and who also act as heads of health centers). Additionally, many who assumed data clerk responsibility had not been trained on the HMIS indicators and tools. As a result, many challenges ensued during data collection. For instance, in a number of occasions, the validation rules embedded in the eHMIS for indicators such as antiretroviral therapy cumulative ever started, an indicator whose value should never decrease on successive reports, caused frustration among data clerks who complained of the system not accepting the values they were entering.

The misaligned strategy to implement the eHMIS/PHEM despite these underlying institutional gaps undermines the role of the system. In light of these gaps, there is a concern that data clerks simply aggregate data and submit reports to the next organizational level without fundamental knowledge about the indicators they report. It is no surprise then that there is a lack of local capacity for more demanding tasks such as data quality assurance, data analysis, and information use (FMOH, 2012). These are development gaps at the core of HIS. However, the strategy of enabling health facilities with ICT does not address these capability gaps.

Given this, seeking the sustainable implementation and institutionalization of the eHMIS/PHEM system, which itself requires a radical institutional capacity building effort, is an inconsistent strategy. On the contrary, the implementation of the eHMIS/PHEM can delay the realization of the core HIS strategies since it diverts efforts towards the development of ICT capabilities, which do not necessarily address the health sector's challenges of local capacity for data quality, analysis, and use. As a result, in the eHMIS/PHEM project, the correlation between the system's implementation and development of core HIS capabilities is not clear-cut or significant. It would seem what matters are transformation and learning capabilities, as highlighted by the national HIS strategic goals, which are not necessarily supported by efficiency-enhancing applications (Fukuda-Parr, Lopes, & Malik, 2002).

The argument put forward is not that ICT does not add value to support health data management in this context nor is *de facto* undesirable. Various benefits of the eHMIS/PHEM have been highlighted. However, despite these perceived benefits, the hybrid interorganizational setting and the state of unstructured plurality distort aspirations and priorities away from key strategic aims that should be at the forefront of HIS development efforts. Moreover, initiatives such as the eHMIS have often supplemented the "gathering storm" where collected information goes up but is not used locally (Chilundo & Aanestad, 2005; Evans & Stansfield, 2003). As a result, the implementation of such systems is consistent with donor efforts that prioritized the urgent need for data collection over long-standing local capacity building (AbouZahr & Boerma, 2005).

5.2.3 | Alignment of interorganizational rationalities

Surely, these key HIS development concerns are not lost to donors and NGOs. So, why do donors continue to fund NGO projects that are unsustainable and potentially counterproductive? The contradictory rationalities of interorganizational development stakeholders have often been highlighted as a potential reason (Escobar, 2011; Nair, 2013; Schemeil, 2013). As Schemeil (2013, p. 224) highlights: "once created and filled with human agents, institutions tend to persist if only to suit their personnel's ambitions: bureaucrats create their own work and set their own norms in order to stay forever." Self-preservation, adaptation, and "survival at all cost" seem to be predominant drivers for most NGOs (Schemeil, 2013).

Similarly, in this study, the ideology of the IDP like many NGOs contradicts underlying development objectives (Nair, 2013; Schemeil, 2013). For example, in the case of the malaria hot spot PHEM implementation, the IDP did not challenge the feasibility of the rapid implementation since it accelerated the implementation of the PHEM system, which had struggled to scale-up. The IDP's push for the rapid implementation and scale-up was, in part, due to pressure from its donors who are generally sensitive to rates of implementation. It is also often the case among bilateral donors who themselves are accountable to constituents in their country and who face demands to demonstrate results that are preferably quick and measurable (Buse & Walt, 1997). Consequently, the legitimacy and continued funding of NGOs depends on swift and measurable outputs while long-term and unquantifiable development efforts become relegated priorities.

In the self-preservation endeavor of the IDP with its donors and local ministry, it has carved out a niche in the HIS domain under the "HIS strengthening" mandate in Ethiopia. In doing so, it has capitalized on an unexploited and seemingly long-lasting cause by successfully expanding its mandate and reinventing itself within the interorganizational alliance. It has accomplished this by, first, building networks with local government where strong buy-in from top FMOH management facilitates ongoing involvement in country. Establishing oneself as a key international implementing partner within the crowded health domain is a long-term political process (Schemeil, 2013). Here, the role of brokers is significant where key and influential actors from FMOH and RHBs have been recruited and offered better remuneration to carry out the IDP's mandate by leveraging on their social networks with government stakeholders. In this sense, the IDP contradicts its development mandate. Instead of strengthening local institutional capacity, it weakens it to build its own.

Second, the IDP's enlargement of mandate in the interorganizational alliance has been carried out by expanding its scope of eHealth solutions in various subdomains within HIS. In 2007, the IDP was involved in the manual HMIS reform process that it continues to support with the printing of HMIS tools. Since then, the IDP has reinvented itself as an IT firm having locally developed a suite of eHealth solutions including the eHMIS/PHEM, electronic medical record (EMR), human resource ISs, geographic information system (GIS), and community level mHealth systems. The IDP has even been involved in website design for the FMOH and its constituents. This is impressive, especially since the IDP does not have previous

experience with IT management or software development in this or other contexts. Its primary domain of expertise is public health given its academic affiliation with a public health department of an international university. For the IDP, its expansion through mandate enlargement is a key differentiator and a competitive advantage that ensures survival. However, the level of effort required for the development, implementation, and institutionalization of each of the aforementioned systems in the developing country context is an immense undertaking as evident from the eHMIS/PHEM case. As it stands, the IDP does not have the institutional capacity, both financially and in terms of workforce, to adequately manage and support all these solutions. Unfortunately, neither do government organizations.

Leveraging on the aforementioned approaches, the IDP has been able to set new challenges while pursuing new initiatives. In this effort, the IDP has also carried out self-promotion by marketing itself as a capable development partner in the interorganizational alliance. For example, the IDP has regularly set up stands to show off its EMR solution to the public at local ICT exhibitions in Addis Ababa and to the international development community at conferences such as the 16th International Conference on AIDS and STIs in Africa hosted in Addis Ababa in 2011. Additionally, the FMOH Annual Review Meetings, where local and international stakeholders meet to discuss the performance of the health sector, has been a useful promotional platform for the IDP. As part of the proceedings, area health facilities are selected for site visit by delegates. The IDP has taken advantage of this opportunity by implementing its suite of eHealth solutions (ie, eHMIS/PHEM, EMR–Medical Registration Unit module, and CHIS) weeks before the site visit to show off its products even hiring health information technicians to enter a year of retrospective data in the eHMIS.

The sense of competition among NGOs to validate their technical prowess to ensure continued local legitimacy and donor funding is evident (Schemeil, 2013). It is no surprise then that alignment through a participatory framework among interorganizational NGO stakeholders is not common as it works against them (Nair, 2013). For instance, there are two NGOs that have been identified as key actors in the Ethiopia HIS roadmap. Besides their involvement in the technical working group to draft the national HIS strategic plan, these NGOs have had no collaboration in over 7 years of working in HIS strengthening in Ethiopia. On the contrary, there has been a rivalry between them, each citing its eHMIS solution as superior to the other. Even though both NGOs are in country to foster HIS development, their failure to leveraging on each other's expertise and experience highlights their underlying intent, that of self-preservation. The lack of collaboration can also be linked to the donors, as these two NGOs are funded through different channels, whose Ethiopia country offices have had a history of disagreement. Therefore, the inherent interests of specific interorganizational stakeholders (ie, NGOs and donors) influence their decisions and course of action in the IOS implementation process contradicting the overarching development mandate for which they exist.

6 | CONTRIBUTIONS AND IMPLICATIONS FOR IS RESEARCH

This study, framed within the ICT4D research stream, has a number of contributions and implications for the mainstream IOS research. Through analysis of an IOS implementation in a developing country context, the study has presented a complex picture of the IOS implementation process that contrasts from commonly presented cases in the mainstream IS research field. In the IS field, limited attention has been given to the interplay between IS adoption and its wider sociopolitical context (Avgerou, 2001). Sociopolitical analysis has primarily focused on the organizational and interorganizational links at the workplace practice and has not adequately engaged with macro-micro political and social analysis in the IOS implementation process (Avgerou, 2008).

However, within the IOS research stream, macrolevel contextual factors (eg, government pressure and institutional/cultural forces) that influence IOS implementations have been explored (Robey et al., 2008). Nevertheless, underexplored areas within the IOS literature were identified. First, there have been limited studies that examine the sociopolitical forces at play among interorganizational stakeholders in the IOS implementation process by focusing on the broader sector or industry (Robey et al., 2008). Much of the broader interorganizational relationship analyses in the IOS literature have been primarily based on economic perspectives (Chatterjee & Ravichandran, 2004). Second, the analysis of interorganizational relations and configurations has been primarily focused on single adopters of IOS or multiple single adopters (Lyytinen & Damsgaard, 2011).

This study contributes to filling these gaps by (1) demonstrating that social and political forces in interorganizational relationships have a significant impact on decisions and activities in the IOS implementation process; (2) showing that the IOS implementation process in the public health sector of developing countries is influenced by participants at both the organizational and sector levels and extends beyond the organizations who adopt and use the IOS to include IOS owners and initiators; and (3) demonstrating that social and political behaviors of opportunistic participants in the interorganizational alliance influence both the process and trajectory of the IOS implementation in a direction that favors the interests of technically and financially dominate members of the interorganizational alliance.

6.1 | Alignment in IOS

Although alignment is an extensively studied topic in the management IS literature, the levels of analysis in alignment research have predominantly been at the organizational level, project level, and individual/cognitive level (Chan & Reich, 2007). The study extends strategic alignment to the interorganizational and sector levels by showing that (1) the informal interorganizational structure and related sociopolitical dimensions are important drivers for strategic alignment among interorganizational partners; (2) misaligned strategic alignment among interorganizational stakeholders

can reduce the fit between priorities and activities of various stakeholders; and (3) misaligned strategies between interorganizational partners can hinder the concomitant development of the organizational and IT infrastructure in IOS adopting organizations.

The capacity for change agents to gain legitimacy with local stakeholders is also a key facet of the sociopolitical process in cultivating alignment in IOS implementation (Sahay, Monteiro, & Aanestad, 2009; Sahay, Sæbø, Mekonnen, & Gizaw, 2010). An implementation case from Tajikistan (Sahay et al., 2010) demonstrates that the mere technical superiority of a solution is not necessarily sufficient to enforce change but requires the nurturing of strong alignment with powerful entities. Sahay and Walsham (2006) also discuss a case in the health sector of India where digitalization efforts initially gained momentum leveraging on buy-in and rapport with key government officials. However, the initiative was halted, despite early success, because of elections that resulted in the change of key personnel who had previously championed the initiative. As identified in the Ethiopia case, alignment with key officials is necessary, which is largely fostered through sociopolitical means.

The poorly administered partnership between NGO and government organization in Ethiopia were also attributed to the informal or unstructured governance arrangements in the IOS implementation. This is also where misaligned strategies between interorganizational partners have emerged between the NGO and government constituents (Gebre-Mariam & Fruijtjer, 2017).

6.2 | Coordination and structure in interorganizational alliances

The course of the IOS implementation in Ethiopia was also found to be dependent on the degree of structure among interorganizational stakeholders. Unstructured interorganizational arrangements, due to lack of clarity about the distribution of decision rights, assigned roles, information flows, and overall coordination between stakeholders, have led to contradictory activities in the IOS implementation process. The lack of structure and prespecified coordination arrangements require dependence on mutual adjustment as a predominant coordination mechanism resulting in the IOS implementation process being susceptible to conflict and the shaping of the IOS in a way that is advantageous to opportunistic stakeholders (Gebre-Mariam & Fruijtjer, 2017). As a result of loosely structured organizational arrangements where coordination by mutual adjustment prevails, the study demonstrates that effectiveness of an IOS project and equity among interorganizational adopters can be compromised (Kumar & van Dissel, 1996; Payton, 2000).

A characteristic that was evident in the eHMIS/PHEM was the key role of interorganizational relations and brokerage in IOS implementation. The relations between multiple agencies (ministries of health, local health institutions, donors, and NGOs) have important inferences for the analysis and governance of IOS projects in this context. Alvarez (2004, p. 13) in his study of a national HIS project in Ecuador addresses this challenge; he states that: "conceptualisation of IS implementation as the inter-play of diverse professional and technical groups, which may hold conflicting or competing agendas and ideologies, has important implications for the management of IS projects." What is also commonly recognized by development practitioners is that the relationship between organizations is not governed in a structured way but rather depends on the relationships of organizational leaders (Lister, 2000).

7 | LIMITATIONS

The paper has limitations regarding its scope and generalization. There is a potential risk of attempting to overgeneralize the conclusions of the study beyond the context of government organizations that rely on donor funds and NGOs. Nevertheless, the research is relevant in establishing an analytical relationship among the concepts explored. Additionally, as demonstrated by the study, interorganizational contextual analysis may be carried out by identifying empirically and theoretically connectable levels of analysis and describing the process under study (Pettigrew, 1985). However, transposing the contextual levels is perhaps the most challenging aspect of the multilevel interorganizational analysis. As a result, sociopolitical dynamics at certain levels were emphasized and studied more in-depth over others.

8 | CONCLUSION

This study has presented insights into the contextual implications of the IS implementation process in a developing country. The study has elucidated the unstructured plurality that manifests in contradictory strategies, development modalities, and institutional arrangements in this context. The dominant approach to foster ICT-based development in the HIS domain has been through an international NGO whose approach has contradicted its development agenda.

The paper argues that unprecedented investments in eHealth initiatives by donors are imbalanced with alternate and perhaps necessary forms of initiatives that constitute institutional and human development. As the eHMIS/PHEM case points out, the idea of putting IT in the lead has penetrated the mentalities of the NGO, its donor, and the FMOH as a paramount modality for development in the HIS domain. The paper challenges this undisputed and taken for granted notion. Additionally, the study demonstrates that decisions made throughout the course of an IOS implementation process are only partly based on rational and well-defined approaches. As a result, the shaping of an IOS implementation encompasses various sociopolitical factors that transcend merely rational and technical dimensions.

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APPENDIX A. PROJECT ACTIVITIES (IMPLEMENTATIONS, SUPPORT, AND TRAININGS)

Place/Sites	Time/Duration	Activities/Role	Actors Involved
Tigray region (nine sites in Mekelle area)	March 2012 (2 wk)	Week 1: training HMIS officers (training assistance) Week 2: eHMIS implementation (planning and on-site support)	<ul style="list-style-type: none"> Regional HMIS staff District and hospital data clerks NGO staff
Amhara region (six sites in Bahir Dar and Adet cities)	September 2012 (2 wk)	Annual review meeting site preparation	<ul style="list-style-type: none"> Health center heads and data clerks Community health workers
Amhara region (19 sites in four zones)	December 2012 (2.5 wk)	eHMIS troubleshooting and upgrade	<ul style="list-style-type: none"> District, health center, and hospital data clerks One regional HMIS/IT officer
Amhara region (Bahir Dar)	June 2012 (1 wk)	eHMIS and PHEM training (trainer)	<ul style="list-style-type: none"> Zone and regional disease surveillance officers EHNRI staff NGO staff
Tigray region (10 sites)	August 2012 (2 wk)	Malaria hot spot eHMIS/PHEM implementation (planning and on-site support)	<ul style="list-style-type: none"> Regional HMIS managers Regional HMIS officer District and hospital data clerks NGO staff
Amhara region (Bahir Dar)	January 2013 (2 wk)	Two rounds of eHMIS training (trainer)	<ul style="list-style-type: none"> Zone, district, and health center data clerks NGO staff