Historical analysis of the institutional dynamics surrounding the implementation of health management information systems in developing countries: The case of Mozambique

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List of Acronyms and Abbreviations

CDC	Centers for Disease Control and Prevention
CPLP	Community of Portuguese Language Countries
CPRD	*Centro de Processamento de Dados*
CEDSIF	Center for Development of Financial Information Systems
DHIS	District Health Information System
DHIS2	District Health Information System version 2
EPI	Extended Program for Immunisation
DIS	*Departamento de Informação para Saúde*/ Department of Information for Health
DTIC	*Departamento de Tecnologias de Informação e Comunicação*/ Department of Information, Communication and Technologies
eSIP-Saúde	*Sistema Integrado de Gestão de Recursos Humanos da Saúde/* electronic Personnel Information System for health
E-Caf	Sistema de cadastro de de funcionários e agentes do Estado
EMR	Electronic Medical Record
FRELIMO	*Frente de Libertação de Moçambique/* Movement for the Liberation of Mozambique
HCM	*Hospital Central de Maputo*/Maputo Central Hospital
HDI	Human Development Index
HMIS	Health Management Information System
HISP	Health Information Systems Programme
HIV	Human Immunodeficiency Virus
ICT	Information, Communication, and Technology
IDRC	International Development Research Centre from Canada
IMF	International Monetary Fund
IOF	*Inquérito Sobre Orçamento Familiar/* Household Budget Survey
Jembi	Jembi Health Systems
Jhpiego	Johns Hopkins Program for International Education in Gynecology and Obstetrics
LMIC	Low- and Middle-Income Country
MB-SIS	*Módulo Básico*
MB-SIS Anexo	*Módulo Básico Anexo*
Mcel	*Moçambique Celular, SA*
MISAU	*Ministério da Saúde*/ Ministry of Health
MDM	*Movimento Democrático de Moçambique/* Democratic Movement from Mozambique
MOASIS	Mozambican Open Architecture Standards and Information Systems
MoH	Ministry of Health
MOPHRH	*Ministério das Obras Públicas, Habitação e Recursos Hídricos*/ Ministry of Public Works, Housing and Water Resources
NHIS	National Health Information System
NORAD	Norwegian Agency for Development Cooperation

OASIS	Open Architectures, Standards, and Information Systems
OpenMRS	Open Medical Record System
OAU	Organisation of African Unity
PALOP	*Países Africanos de Língua Oficial Portuguesa*/ Portuguese-speaking African countries
PARPA	Action Plan for the Reduction of Absolute Poverty
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
PESS	Health Strategic Plans
PESIS	Health Information System Strategic Plan
PRSP	Poverty Reduction Strategy Paper
RENAMO	*Resistência Nacional Moçambicana* / Mozambican National Resistance
SADC	Southern African Development Community
SIP	Public Servants Information System
SIFIn	*Sistema de Informação da Formação Inicial*
SIFo	*Sistema de Informação da Formação Contínua*
SISTAFE	State Financing Information System
SIS-Compact station	*Sistema de Informação de Saúde* – Compact Station
SIS-MA	*Sistema de Informação de Saúde para Monitoria e Avaliação*
SIS-Malaria	*Sistema de Informação de Saúde* – Malaria Module
SIS-COVID	*Sistema de Informação de Saúde* - Covid-19 Module
SIS-HOSP	*Sistema de Informação de Saúde* - Hospital Module
SIS-Prog	*Sistema de Informação de Saúde* Program
SIS-TB	*Sistema de Informação de Saúde* – Tuberculosis Module
SIS-VE	*Sistema de Informação para Vigilância Epidemiológica/* System for Epidemiological Surveillance
TDM	Telecommunication of Mozambique
Tmcel	Mozambique Telecom, SA
UEM	*University Eduardo Mondlane*
UiO	*University of Oslo*
UniLúrio	*University Lúrio*
UniZambeze	*University Zambeze*
WHO	World Health Organisation
PRODESI	*Programa de Desenvolvimento do Sistema de Informação para Saúde/* Health Information System Development Program

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Abstract

This thesis examines the influence of institutional dynamics on the implementation of historically grounded health management information systems, particularly in Low- and Middle-Income Countries (LMICs). The study aims to contribute to research in Information and Communication Technologies for Development (ICT4D) and Information Systems (IS), focusing on strengthening Mozambique's health system. It explores retrospectively the evolution of the District Health Information System (DHIS), initially piloted in Mozambique in 2000 and reintroduced in its second version (DHIS2) in 2012, achieving nationwide formal adoption in 2016.

An interpretive approach is employed to conduct a longitudinal historical study, tracing advancements and setbacks in Mozambique's national Health Management Information System (HMIS) over approximately two decades. The study constructs a historical narrative using temporal bracketing (Mills et al., 2010b) and thematic analysis (Braun & Clarke, 2006) to organise and analyse extensive data. The research period is divided into three phases: Phase 1 (2000-2007) focuses on the introduction of digital health to strengthen HMIS; Phase 2 (2008-2014) on HMIS restructuring; and Phase 3 (2015-2020) on the reestablishment and scaling of digital health systems within HMIS.

The theoretical historical analysis is underpinned by an analytical framework informed by institutional theory and a multi-level analysis strategy, examining developments at institutional, organisational, and individual levels. This multifaceted approach provides alternative explanations for HMIS implementation trajectories and addresses the core research question. The study also investigates the reciprocal influences between technology and context, highlighting the critical roles of human agency and the material aspects of the technological artefact.

The outcomes of this study include (1) the development of a historical narrative detailing the implementation of HMIS in an LMICs context and a methodology for conducting such historical analyses; (2) the formulation of arguments that counter the failure narrative in IS research, elucidating the mutual shaping process between technological artefacts and their implementation contexts; (3) the establishment and exploration of interlinkages between three institutional concepts, thereby enhancing understanding of the emergence and development of institutional entrepreneurs, taking into account relevant institutional, socio-political, and technological dynamics; and (4) a deeper insight into the entrepreneurial actions accompanying HMIS implementation processes and their practical implications. This thesis reinforces the significance of historical studies as a valuable approach in IS and ICT4D research, particularly in understanding HMIS implementations in the public sector within LMIC contexts.

Keywords: Historical reconstruction, Historical analysis, Institutional dynamics, Institutional change, Institutional contradictions, Institutional entrepreneurship, Institutionalisation.

Chapter 1 : Introduction

This thesis concerns understanding the institutional dynamics shaping historically grounded HMIS implementation processes in a Low- and Middle-Income Country (LMIC) context. I adopt an interpretive approach, informed by multiple analytical concepts drawn from institutional theory, to explore this historical process of Mozambique's National HMIS implementation and evolution over a 20-year timeframe.

This chapter is organised into six sections. I first introduce the research motivation in section 1.1 and then expose the research problem and aims of the study in section 1.2. I provide a theoretical overview and introduce the analytical framework in section 1.3. This is followed by section 1.4, in which I describe the research design, the context and the research method adopted for the study. Section 1.5 is dedicated to outlining the expected theoretical and practical contributions. I conclude the chapter with section 1.6, outlining the structure of the rest of the thesis.

1.1 Research motivation

I have undertaken this study to address persistent concerns about the health sector's slow progress in LMICs despite substantial investments in digital technologies (Khubone et al., 2020, p. 1). The World Health Organisation (WHO) defines health systems in its 2000 report, 'Health Systems: Improving Performance', as a collective of "organizations, institutions, and resources" designed to support endeavours that enhance health (WHO, 2000, p. xi). This global undertaking acknowledges that advancements in health are instrumental to human and social development. Moreover, the report recognises the inherent challenges in developing a health system that meets evolving expectations, which include political, economic, and social trends (ibid). Understanding the enduring obstacles that hinder the health sector's evolution and thwart local and global aspirations for societal advancement is crucial for research, policy, and practice. The plea to action expressed in the Alma-Ata Declaration of 1978 still echoes in today's Sustainable Development Goals (SDG) - Agenda 2030, emphasising the imperative of leaving no one behind. Current development agendas continue to advocate for enhancements in the health sector, propelled by the United Nations' SDG 3: "Ensure healthy lives and promote well-being for all at all ages" (UN, 2015, p. 16).

Over the past century, the healthcare sector has seen reforms as part of continued efforts to ensure health as a fundamental human right (WHO, 2000). These reforms have included decentralising health systems, enhancing management practices, implementing digital health

systems, strengthening capacities, and other targeted interventions. Acknowledging the importance of information as a vital resource, significant emphasis has also been placed on bolstering information management and governance. Digital health systems have become indispensable in supporting healthcare provision and management, offering the potential for comprehensive overviews, scenario analyses, and informed decision-making. It is crucial to recognise that implementing such digital health systems is inextricably linked to the contexts in which they are deployed and developed. In this thesis, I analyse the historical context from an LMIC country to provide valuable and comprehensive insights into the implementation of Information and Communication Technology (ICT) enabled HMIS projects, considering the specific material influences of the technology. Since many LMICs experience similar complex contextual conditions when engaging with HMIS and other interventions, I believed my analysis would contribute to more generalisable findings.

The motivation for conducting this research arises from multiple interconnected reasons, including practical insights, theoretical curiosity, and the need to understand a complex empirical phenomenon. Practical insights developed from me as a citizen of Mozambique and having interactions and discussions with my colleagues in the university who had started to research the phenomenon from the early 2000s. They witnessed the rise and fall of the DHIS-based HMIS application in the country. I was aware that the system had been discontinued and was seen as a 'failure', yet 15 years or so later, the same digital application was being adopted and scaled as the national system. This practical insight motivated me to understand why this was the case and the dynamics underlying these rather dramatic shifts.

Theoretically, I wanted to understand, from a historical perspective, the process by which these changes have unfolded over time, how the past has influenced the present, and if such an analysis could help me discern some repeating patterns along the process. My reading of the literature, including research findings from Mozambique, highlighted various snapshots and findings that I found inadequate in responding to the practical insights I was wanting to pursue theoretically. For this pursuit, I was attracted by the potential which institutional theory provided me. After all, what was common and enduring over this nearly 20-year period of my analysis was the institution of the Ministry of Health, its structures, policies and practices, including efforts to adopt technology. However, the context within which the ministry was working varied over the years, for example, coming from a situation of post-conflict where the country had not one information systems PhD to a decade later when there were 7 PhDs in the field of health information systems. The context had undoubtedly changed, which was

influencing the implementation process. Understanding this mutual interaction between the context and process was arguably an under-researched puzzle which I wanted to examine.

This work is essential as it intersects the interests of many stakeholders participating in HMIS implementations within the LMIC context. It carries theoretical importance to IS scholars, particularly those involved in ICT4D and Health Information Systems research studies, as it aims to depict institutional dynamics influencing related processes over time. Thus enabling them to design and develop adequate research, capacity building, and innovation projects accordingly. Since it aims to analyse former interventions and related outcomes, it is also of practical importance to inform health managers on how those positively influenced previous and ongoing HMIS implementations. Thus developing awareness about less effective and best practices while enabling informed planning, policy development and coordination of new related projects.

1.2 The research problem and aims

A health system comprises principles, policies, norms, and regulations, integrating people and technologies to operationalise the structures, functions, procedures, and practices of the health sector. My analytical focus is on HMIS, which is purposefully designed and implemented for strengthening the everyday operations at both clinical and administrative levels at a national scale. Serving as the backbone of the entire health system, HMIS interconnects all its components, ensuring a smooth flow of health data and information across various administrative tiers, in both physical (paper-based) and digital formats. It is vital to acknowledge that both the health system and HMIS are dynamic, continually evolving entities.

The empirical phenomenon of national HMIS implementation is complex and intriguing, which I believed was interesting and relevant to study. Technological advancements present new opportunities by integrating digital solutions within existing HMIS frameworks; however, they also introduce additional layers of complexity. These complexities give rise to new institutional dynamics, representing processes which explain “why things move as they do” and are typically associated with the “study of change” (Schatzki, 2019, pp. 5–6). In turn, technology is not something that can be studied in isolation, as it would make the analysis very deterministic, but it needs to be examined as intertwined and alongside social, political, cultural and infrastructural conditions. This makes the empirical phenomenon extremely rich and complex to study, especially when put within a temporal and longitudinal frame.

To engage with my practical, theoretical and empirical motivations, I employ institutional theory as a comprehensive framework to analyse institutional changes influencing the implementation of digital solutions, including existing organisational practices, legacy systems, policies and regulations. HMIS implementations evolve continuously over time and are best conceptualised as a process[1] (Langley et al., 2013; Schatzki, 2019). The transformations brought about by the implementation process can be characterised by scrutinising events or processes and their outcomes. These involve altering characteristics from one stage to another, leading to changes, resistance, and unforeseen consequences. It is essential to thoroughly visualise these outcomes and endeavour to comprehend how HMIS implementations evolve over time, as this offers valuable learning opportunities and the potential for further enhancements. Exploring events, processes, and change (or resistance to it) necessitates an examination of the roles played by the actors directly involved in these activities and their essential observation from within. Nevertheless, this insider viewpoint may be constrained due to the actors' immersion in the very context where these transformations take place, which can render some changes less immediately noticeable.

HMIS implementation process studies have provided insightful information to the IS domain, highlighting that their success factors extend far beyond the availability of essential resources and technological infrastructure (Chilundo, 2004; Kimaro & Nhampossa, 2007; Krishna & Walsham, 2005; Madon, 2006; Mosse, 2005). As these processes are intrinsically dependent on the context where they unfold it is crucial to explore the institutional, socio-political and technological dynamics in place and their influences. Earlier ICT4D have examined long-term HMIS implementations where technological artefacts were introduced, developed and reintroduced in various moments in the same context, resulting in different outcomes and divergent levels of success (Gizaw et al., 2022; Madon, 2006). In this research, my principal aim is to thoroughly document the evolution of Mozambique's National HMIS over time, which shared similarities and also particular differences with these existing studies. This includes pinpointing the established institutions and the engaged actors (organisations and individuals[2]), their objectives, the activities carried out, the contradictions that arose, and the results attained.

[1] I identify with Heraclitus's view of reality, where it is perceived "not as a constellation of things but as one of processes" (Langley et al., 2013, p. 5). Schatzki (2019, p. 11) distinguishes substances (things) and processes through their essence, where the former is defined by "what they are" and the latter is defined by "what they do". Thus, processes exist in a continuous state of 'becoming'.

[2] Historical reconstruction may be enriched with the direct participation of the actors involved in the described story, who can share their experiences in the first person, providing some coherence to the data collected from various sources (Hirschheim & Klein, 2012).

This groundwork paves the way for the ensuing examination to discern patterns of actions[3] and the strategies implemented (whether by design or inadvertently[4]) by the various actors participating in the process. A narrative analysis of this kind offers alternative interpretations of how the processes unfolded and contributed to the outcomes related to the development of the HMIS.

A fundamental aspect of my analysis is recognising that HMIS implementation processes do not emerge or progress in a vacuum. Thus, I have conducted a holistic inquiry to understand the broader evolution of various technological artefacts and the corresponding institutional processes introduced in Mozambique's health sector over two decades. This study's analytical focus is to acknowledge the importance and grasp the mutual influences of organisations, institutions, technologies, and resources that have shaped the HMIS's transformations.

To conduct a retrospective examination of a phenomenon and develop a longitudinal narrative, it is necessary to develop a methodology appropriate to discern historical patterns (Immergut, 1998; Porra et al., 2014). This involves investigating the behaviours and interventions of the individuals and organisations involved within situated socio-political and technological contexts constituted by politics, conflicts, culture, digital interventions and other conditions. My historical approach focuses on combining information from diverse sources (such as archives and interviews) to enable the analysis and interpretation of data from a multilevel and multi-sectoral perspective[5] (Bryant et al., 2013b; Suddaby & Foster, 2017). My analytical approach combines various elements interpreted from the context, at the time and place of the occurrences, including the participants' agency over time, which shapes the processes in situated contexts (Cloutier & Langley, 2020).

IS implementation studies have been conducted in relatively short periods of time which limits analysis of the unfolding developments of implementation processes (Williams & Pollock, 2012). Mason et al. (1997b) emphasised that IS research had not seriously embraced historical research, a lack which still endures (Dias et al., 2023). I seek to contribute to these debates (Bryant et al., 2013b; Porra et al., 2014) to emphasise the value of such research and support

[3] (Lawrence, 1999, p. 167) argues that conscious and unintentional patterns of action can be identified within organisations' actions, as "all forms of organisational strategies can be defined as patterns of actions that occur within an institutional context".

[4] Within an organisational setting, strategies may be developed from conscious ideas and intentions to produce specific outcomes or be realised unintentionally associated with other purposive strategies in place (Lawrence, 1999).

[5] Suddaby and Foster (2017) suggest four combinations of History used to study institutional changes, including History-as-Fact, History-as-Power, History-as-Sensemaking, and History-as-Rhetoric. Each of these is associated with different methods and approaches to explore the object in the study.

long-term and multi-site studies (Williams & Pollock, 2012), including the role of individual actions (Langley et al., 2013).

This study aims to analyse the hidden patterns of human actions and technological development tendencies and provide a broader overview of the mutual transformations between the context and the technological artifact. Through this analysis, this study aims to contribute insights that promote sustainable HMIS initiatives in LMIC contexts, given the unanticipated nature of consequences. I have tried to understand these dynamics based on the following research question:

> *How do the institutional dynamics shape historically grounded Health Management Information Systems implementation processes in Low- and Middle-Income Countries context?*

This is operationalised through the following sub-questions:

> *(a) What are relevant institutional dynamics, and how do they change over time?*
>
> *(b) How do these dynamics shape Health Management Information Systems implementation processes over time?*

1.3 Theoretical overview and analytical framework

My research objective is to analyse the processes of change associated with implementing a digital HMIS, acknowledging that such processes do not occur in isolation. Prior practices and artefacts, often already in place before new technology is introduced, create an 'installed base' (Aanestad et al., 2017) that influences the trajectory of future implementations. This necessitates an analysis of the historical context of implementation within a socio-technical framework. My analytical approach is inspired by institutional theory and integrates history as a methodology to retrospectively construct and analyse the HMIS implementation processes.

I recognise the potential of history as a means to "explore the past as a source of alternatives for the future" (Immergut, 1998, p. 19). Porra et al. (2014, pp. 549–550) observe that, while historians concur that the essence of history is to understand change over time, they employ diverse methodologies to elucidate the mechanisms of such change, whether through single or multiple theoretical frameworks. These methodologies provide valuable insights into contemporary phenomena by viewing them through the prism of the past (Bryant et al., 2013b; Immergut, 1998; Langley et al., 2013; Suddaby & Foster, 2017). Process studies underscore the importance of scrutinising changes in phenomena over time, taking into account the

uncertainties introduced by contextual influences and human decision-making that impact the trajectory shifts (Cloutier & Langley, 2020).

Institutional theory offers a pertinent avenue for conducting historical research (W. R. Scott, 2001; Thornton et al., 2012), unravelling the complexities inherent in particular temporal and spatial contexts. Within IS research, information infrastructure theory (Aanestad et al., 2017) has embraced a historical perspective to advance understanding of institutional change dynamics, albeit with a pronounced emphasis on technology. My research methodology capitalises on the strengths of both institutional theory and information infrastructure theory to forge a comprehensive understanding of how technology influences institutional dynamics through time.

Gregor's (2006) taxonomy categorises theories into functions for analysis, constructing explanations, providing justifications, and even attempting to predict future developments. Institutional Theory aligns most closely with Gregor's type II classification when it is used purely for explanatory purposes without testable propositions or with type IV when it is applied to both explain and predict future outcomes, incorporating testable propositions and causal explanations (Gregor, 2006, p. 620). In this thesis, I have adopted Institutional Theory as a type II and a process-type theory to retrospectively analyse and explain the HMIS implementation processes[6]. Thus, seeking explanations for *how* and *why* the events unfolded as they did while providing supporting information of *when* and *where* they occurred rather than predicting future developments. By discerning patterns of events, the theory can also be used to look into future possibilities, which I have not attempted to do in my thesis.

Contemporary Institutional theory draws on its foundational disciplines and other fields, such as Information Systems (IS) and Information and Communication Technology (ICT4D) (Alvesson & Spicer, 2019; Avgerou, 2000). It aims to elucidate the mechanisms of institutional change, particularly focusing on the role of agents within their institutional contexts (Hall & Taylor, 1996; Immergut, 1998; Seo & Creed, 2002). The theory incorporates notions like power, pressures, contradictions, strategic actions, institutional entrepreneurs, and others to deepen the analysis of change (Koning, 2016; Lawrence, 1999; Thelen & Conran, 2016). ICTs are increasingly viewed as institutions in their own right (Avgerou, 2000), aiding in the analysis of technology-mediated change processes.

[6] Although I am conducting a historical analysis, my final goal is not to describe *"what is"* because several studies have already highlighted the various enablers or barriers that influence implementation projects. Instead, my focus is to pursue further understanding of *how, when, where and why* these have implications within the overall implementation processes.

Institutional processes are replete with contradictions (Seo & Creed, 2002). As individuals and organisations are influenced by the logics of existing institutions, contradictions may emerge from the varying interests, resources, and power imbalances among relevant actors. Addressing these contradictions holds the potential for both resistance to and facilitation of change. My theoretical approach involves dissecting contradictions – understanding why they manifest and how they are addressed – as part of my endeavour to comprehend change, or the absence thereof.

My analytical framework hinges on three principal concepts: institutional contradictions, institutional entrepreneurship, and institutionalisation. Table 1 below encapsulates these concepts, which I will explore in greater detail within the context of the historical evolution of HMIS implementation processes.

Table 1. Summary of key concepts adopted from Institutional Theory as a lens in the current study.

Concept	Definition
Institution	An institution represents a social order or pattern that has reached a particular state or property (Jepperson & Meyer, 2021)
Institutional Contradiction	"… ruptures and inconsistencies both among and within the established social arrangements …" (Seo & Creed, 2002, p. 225)
Institutional Entrepreneurship	"…represents the activities of actors [institutional entrepreneurs] who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones…" (Maguire et al., 2004)
Institutionalisation	"… the process by which an institution attains a stable and durable state or property …" (Currie, 2011, p. 3)

I draw upon Seo and Creed's (2002) framework to analyse the linkages between those three core concepts. This framework was formulated to elucidate the paradox of embedded agency and the role of praxis in navigating institutional contradictions that arise during institutionalisation. My adaptation of this framework seeks to gain a holistic view and an integrated understanding of how human and technology roles influence institutional dynamics over time. By integrating the notion of institutional entrepreneurship, I underscore the significance of institutional entrepreneurs[7] and their strategic actions in tackling institutional contradictions and fostering the processes of institutionalisation. In my analysis, I replace Seo and Creed's (2002) concept of 'praxis' with 'mediation mechanisms' to broaden the scope for including other potential mediators, such as digital technologies. This adaptation is depicted in Figure 1 and expounded upon subsequently.

[7] Institutional entrepreneurs are those "actors who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones …" (Maguire et al., 2004).

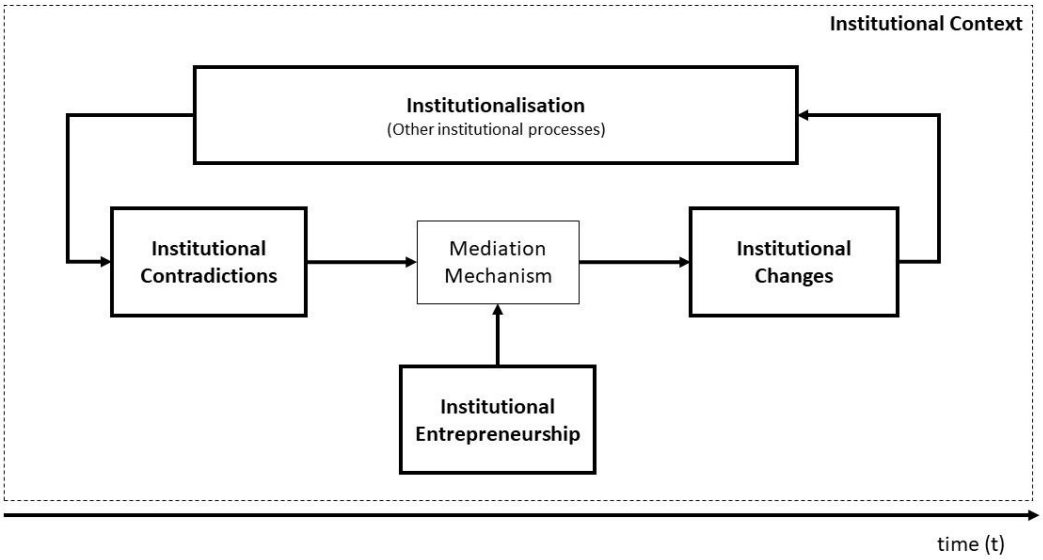


Figure 1. Analytical framework adapted from Seo and Creed (2002).

Firstly, the analytical framework examines how institutional pressures and power asymmetries shape the emergence and evolution of institutional contradictions. Society is seen as a multi-level inter-institutional system comprising various institutions involved in distinct processes (Avgerou, 2000; Thornton et al., 2012; Volkow, 2003). While new institutions may stem from these social processes, they can also undergo institutional transformation, disruption, or maintenance (Lawrence & Suddaby, 2006). Jepperson (1991) posits that these processes, which could lead to resistance or institutional changes, are instigated by institutional contradictions—representing divergent positions, statements, or even inconsistent situations. The sources of institutional contradictions explored include infrastructural limitations, regulatory constraints, human-led limitations, and those arising from technological artefacts, all within the specific post-conflict, resource-scarce context of Mozambique.

Secondly, the framework delves into how individuals and organisations confront their institutional environment's status quo. Confronted with institutional contradictions, potential change agents, known as institutional entrepreneurs, may step in to mediate and facilitate change processes (Seo & Creed, 2002). These agents need legitimacy, backing, and resources to intervene, which might be provided by influential groups, whether internal or external to the organisation. This scenario is termed the paradox of embedded agency (ibid). Present research seeks to analyse the conditions under which this happens, taking into account that organisational and individual behaviours are shaped by the very institutions they aim to transform (Garud et al., 2007). Understanding the efficacy of actions in specific conditions and how entrepreneurs navigate the paradox of altering institutions of which themselves are products of is deemed essential.

Subsequently, the framework aids in examining the entrepreneurial actions, as an array of actions and strategies employed by those actors to effect change and, ultimately, to contribute to the development of institutionalisation processes. It emphasises the role of the institutional entrepreneur in institutionalising the technological artefact and partaking in other institutional processes. It steers the analysis towards processes such as capacity building and skill development, positioning and intentions, mobilisation of resources, collective action, and legitimation. The aim is to decipher how institutional entrepreneurs enact their strategic agency to accomplish their goals: creating and adopting, institutionalising, re-institutionalising (transforming), or de-institutionalising (disrupting) institutions. The discerned patterns of action provide a foundation for explaining how institutional dynamics have influenced the trajectories of HMIS implementation.

These varying perspectives are partially explored and linked with the three phases discussed in chapters 5, 6, and 7. The synthesis of this analysis is presented in chapter 8.

1.4 Research design, setting and method

The study provides a detailed historical account of the Mozambican HMIS's evolution. Acknowledging that this development spanned various periods and locations, I traced the implementation journey of a specific technological artefact. The focus was on the District Health Information System (DHIS) software, which was initially introduced to Mozambique in 2000 through a pilot of its first version and, two decades later, has become the national standard. This progression was not direct or unchallenged; it experienced numerous fluctuations, including discontinuation in 2007, followed by a resurgence in 2012 with its second iteration (DHIS2), gradually garnering the necessary backing and recognition to be adopted nationally. A multitude of actors, some recurrent and others new, alongside a variety of institutional processes, directed these shifts. The methodology I adopted was specifically designed to unravel these intricate and dynamic processes.

1.4.1 Research setting

The empirical study was carried out in four provinces in Mozambique. Three of these provinces were sites for the initial DHIS pilots in 2000: Gaza, Inhambane, and Niassa. The fourth site, a province where DHIS in its second version (DHIS2) was piloted in 2014, is also the national

capital, designated Maputo City[8]. Figure 2 illustrates the location of these sites on the Mozambican map.

Figure 2. Maps illustrating the empirical sites. Source: Google Maps.

At the outset of my project, I had the privilege of visiting two districts in Maputo Province: Moamba and Matola. This initial visit was crucial as it allowed me to acquaint myself with the context of the health sector and test the interview guide and survey I planned to utilise during subsequent fieldwork visits. The fieldwork encompassed trips to health directorate offices, hospitals, and health units at both the provincial and district levels. In 2019, I conducted visits across four districts in Inhambane Province (Inhambane, Jangamo, Cumbana, Maxixe), three in Gaza Province (Xai-Xai, Chibuto, Bilene), and four in Niassa Province (Cuamba, Caronga, Metarica, Lichinga). During the 2022 fieldwork, my journey in Inhambane Province included the districts of Inhambane and Maxixe, while in Gaza Province, I visited Xai-Xai and Chokwe. In Maputo City, the fieldwork involved visits to the Directorate of Planning and Cooperation (DPC) at the central level within the Ministry of Health.

1.4.2 Research design

I employed a historical study design to retrospectively explore the 'why' and 'how' behind the historical shaping of the HMIS implementation process, complementing this with insights into contemporary processes.

[8] Mozambique has two provinces associated with the name 'Maputo'. The first designated Maputo City, the country's capital, and the second designated Maputo Province. I visited both provinces during the fieldwork, although I only collected data in Maputo City (the fourth site mentioned above).

Investigating a long-term phenomenon can benefit from retrospective analysis and a multi-level approach that spans from the individual to societal levels (Mills et al., 2010b, p. 5). I constructed the longitudinal description as a historical reconstruction by integrating temporal bracketing (Mills et al., 2010b) with a thematic analysis (Braun & Clarke, 2006). This approach enabled me to organise a vast array of heterogeneous data and lend a cohesive narrative to my account of the phenomena under investigation.

My research context is divided into three temporally bracketed, analytically interconnected phases, each interpretatively reconstructed. Each phase corresponds with the beginning and conclusion of three distinct HMIS implementation processes that correlate with the introduction of DHIS in Mozambique, as depicted in Table 2.

Table 2. Timelines of HMIS developments and DHIS implementation in Mozambique.

Digital HMIS implementation in Mozambique: Historical Phases (2000-2020)					
Phase HMIS Process (Period)	Phase 1: Strengthening the HMIS (2000-2007)	Phase 2: Restructuring the HMIS (2008-2014)	Phase 3: Establishing the new HMIS and Continuity (2015-2020)		
DHIS	DHIS 1.3 pilot	Attempt to reintroduce DHIS 2.13	Adoption of DHIS 2.16	Scaling up	Institutionalisation process

Source: adapted from Collinson and Sahay (2022).

I employed a qualitative approach based on multiple methods of data collection and analysis [9] including primary and secondary sources. My aim was to comprehend the socio-political and technological evolutions within the distinct historical periods of the setting. This involved gathering data from a multitude of sources about organisational structures and practices, engaging in dialogue with involved parties, and examining policies, both formal and informal. This approach enabled me to pinpoint pivotal events and processes to construct my analysis and interpretations of the three phases. Phase 1 spans from 2000 to 2007, a time when initial efforts were made to introduce a new, globally developed technological artefact to enhance the HMIS. An agreement to pilot the DHIS was reached, accompanied by complementary interventions such as technical modifications and capacity-building activities in both higher education and in-service sectorial training. However, this period was marked by challenges, resulting in the technological artefact not being adopted. The subsequent period, 2008 to 2014, which I denote as Phase 2, saw sustained and substantial attempts to improve the HMIS,

[9] I had the opportunity to participate in two informal discussions with a historian from the Mozambican Historic Archive Directorate. I considered this very important since he conferred legitimacy to the methods selected.

including efforts to reintroduce the DHIS in its updated version. Though the immediate adoption of this technological artefact did not occur, this era was pivotal in underscoring its potential to support the HMIS. The third phase, from 2015 to 2020, witnessed the adoption and integration of DHIS2 into a more consolidated HMIS implementation process. This period is characterised by the institutionalisation efforts of DHIS2, a process which is presently ongoing.

1.4.3 Data collection method

Data collection spanned from 2018 to 2022, covering both retrospective and contemporary developments, as depicted in Figure 3. I gathered secondary data pertinent to the context and the HMIS implementation processes from 1975 to 2022. The primary data were acquired during fieldwork using the data collection instruments detailed below (as included in Appendix 1).

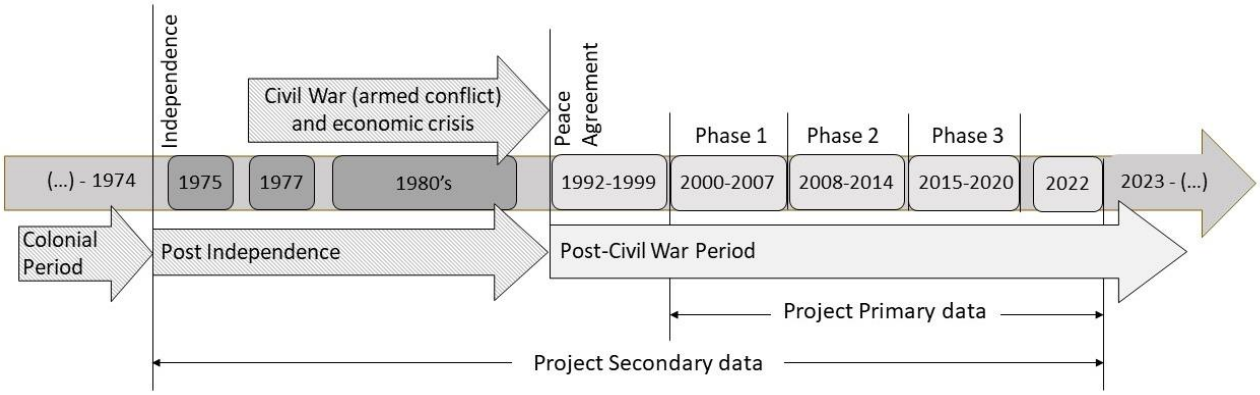


Figure 3. Two data types were collected for the overall project.

I utilised a combination of interviews, examination of archival information and other documents, observations, and surveys as my primary data collection techniques. I initially identified key individuals involved in the early stages of DHIS implementation in Mozambique and, by employing a snowballing strategy (Parker et al., 2019), I subsequently located other relevant participants to interview. In adherence to ethical principles, I ensured all participants were anonymised. However, given that some had prominent roles and could be easily recognised through these, I explicitly addressed this in the informed consent forms provided to participants (see Appendix 3). In total, I conducted 41 semi-structured interviews and reviewed available archival material and documents in both physical and digital formats.

My fieldwork encompassed visits to the Directorate of Planning and Cooperation (DPC) at the Ministry of Health at the central level, as well as to health directorate offices, hospitals, and health units at the provincial and district levels. Although direct observations would have been ideal for engaging with the study's subject (Yin, 2018), I minimised the use of this technique,

largely due to travel restrictions imposed by the COVID-19 pandemic, which significantly constrained my fieldwork activities at the sites. Additionally, not having been directly involved in the DHIS2 implementation, I sought to establish a rapport with the sites. I conducted informal on-site observations during my visits, which enabled me to inspect the original implementation locations, note changes, and take photographs of physical artefacts mentioned by interviewees. Furthermore, I engaged in discussions and meetings with participants active in the implementation processes. This approach granted me a certain level of connection with the individuals involved, the places where implementation unfolded, and the utilisation (or lack thereof) of the technological artefact.

My study was conducted within the Health Information Systems Programme (HISP) framework, a research and development initiative from the Department of Informatics at the University of Oslo (UiO) (Adu-Gyamfi et al., 2019). HISP's activities span globally across various countries, with support from local HISP groups, including the one from Mozambique (UiO, 2022a). A local HISP group in Mozambique was informally established in the late nineties by researchers from Eduardo Mondlane University (UEM) (Braa et al., 2004). Its local network grew over the years and is now formally represented by Saudigitus[10] (HISP, 2023b). Being affiliated with the HISP Mozambique team granted me insight into the local developments concerning DHIS. While I was not directly involved in the HMIS implementation, my primary focus was on conducting research through the historical analysis of the process. I was actively involved in two DHIS2 training academies held in Mozambique, which offered me the chance to interact with a variety of health officials. Furthermore, as part of the training programmes at the University of Oslo (UiO), I am involved with the IS research group, which investigates the connections between local HISP groups and their implementation efforts. These multiple associations enabled me to closely monitor the software's progress, furnishing data essential for my study.

Using the collected information, I created a data corpus comprising narratives describing the evolution of the National HMIS over 20 years, encompassing the various implementation processes. This corpus was then systematically analysed, guided by my theoretical perspectives.

[10] Saudigitus has been established as an international organisation, since besides supporting DHIS2 implementations in Mozambique, it supports other African countries from the southern region and the Portuguese-speaking African countries (*Países Africanos de Língua Oficial Portuguesa* - PALOP) (Saudigitus, 2023).

1.4.4 Historical reconstruction and analytical approach

The historical reconstruction and analysis approach evolved concurrently, with one supporting and feeding the other. A three-step analytical process[11] guided the study: a preliminary analysis, a thematic analysis, and a theoretical historical analysis employing institutional lenses.

Step 1 – Preliminary analysis supporting temporal bracketing: This initial phase of the study involved identifying information sources, assessing their availability and reliability, and mapping these sources to gather pertinent materials. This included pinpointing relevant groups of actors and inviting them to participate in the project, as the "seeds" and laying the groundwork for the snowball sampling method (Parker et al., 2019, p. 3). Both physical and digital archives, scientific repositories, organisational websites, and oral sources were deemed relevant at this stage. The collected materials comprised documents, theses, dissertations, and articles detailing the evolution of the HMIS in Mozambique and the initial DHIS implementation efforts. This phase was instrumental in reinforcing the research design and steering the data collection process. It facilitated the adoption of the temporal bracketing method, defined the profiles and selection of participants, and aided in the preparation of the fieldwork instruments. The outcomes included delineating the three analytical and interconnected phases (temporally bracketed), creating a map of potential participants, and identifying pertinent sources of information. These results informed the subsequent phases of data gathering and the historical reconstruction process carried out in the next analytical step.

Step 2 – Thematic analysis enabling historical reconstruction: Following the data collection phase as outlined in the fieldwork plan, the approach at this juncture was not strictly inductive, diverging from those who implement a Grounded Theory approach (Braun & Clarke, 2006). I entered the study with a research question that was informed by institutional thought, yet the data collection tools were not tailor-made to answer this question directly. The semi-structured interview guide I crafted featured open-ended questions designed to elicit detailed information on HMIS and DHIS development within the research setting, while deliberately avoiding limiting the exploration of concepts that could bolster the development of my theoretical analytical framework. Insights from the preliminary analysis were invaluable in directing discussions with study participants.

This methodology aligns most closely with a hybrid inductive approach (Fereday & Muir-Cochrane, 2006; Sarker et al., 2000), characterised by its inductive nature but also shaped by

[11] Although the process is described linearly since it involved a reflective exercise, it unfolded in a recursive pattern throughout the study.

the broader precepts of institutional theory, specifically the dynamics of institutions and institutional change. Through thematic analysis, I constructed a historical narrative that became the centrepiece of the historical reconstruction effort. Identifying key concepts within this narrative was crucial to formulating the analytical framework that underpins the theoretical historical analysis.

Step 3 – Theoretical historical analysis: The historical narrative revealed three core institutional concepts: institutional contradictions, institutional entrepreneurship, and institutionalisation, each reflective of the dominant forces at play during the HMIS implementation over the specified period. These concepts informed the development of the analytical framework used for the historical analysis.

Institutional contradictions highlighted the challenges and opportunities for change inherent in the process. A notable contradiction identified across two phases was the 'discrepancy between governance demands and the constraints of financial resources and infrastructure'. This posed a challenge during the initial phase of DHIS implementation but was later seen as an opportunity that led to the adoption of DHIS2 in the subsequent phase. Institutional entrepreneurship was critical in identifying and exploring the emergence and development of change agents and entrepreneurial actions throughout the various phases. For instance, one of the identified institutional entrepreneurs participated in three phases with different roles. He was involved and developed his profile: (Phase 1) a medical doctor in the setting, a researcher at Eduardo Mondlane University (UEM), played different roles along the process. He was a PhD student at UiO involved in the DHIS pilot implementation and later became a manager in the Ministry of Health with decision-making authorities with respect to HMIS implementation (Phases 2 and 3). I interpreted his role as an institutional entrepreneur, representing a hybrid form of being both from the "inside" and "outside", bringing in novel forms of legitimacy and resources to initiate and institutionalise change.

Institutionalisation, in turn, helped me to explore the patterns of actions related to the unfolding institutional processes while paving the way for the adoption and institutionalisation of the technological artefact supporting the HMIS. A significant pattern identified was the development of capacity-building initiatives through education, which integrated existing formal educational structures (formal courses at universities, schools, or institutes) with new strategies, including regional and in-service training programs. This multiplicity of educational and training approaches appeared to be mutually reinforcing throughout the three phases.

The themes that emerged for the historical narrative were closely tied to the three phases demarcated by the temporal bracketing strategy. The analytical framework was used to discern which themes persisted or evolved during and between these phases over the study period.

In the first phase, the narrative highlighted the myriad complexities inherent in HMIS implementations. Various external factors, such as the nation's historical, political, economic, social, technological, environmental, and legal contexts, were seen to influence the health sector and were acknowledged as potential sources of institutional contradictions (Avgerou, 2000; Farjoun et al., 2018). These factors collectively shaped the persistent institutional contradictions observed. A prominent contradiction of this phase was the readiness of the setting—encompassing human, technical, infrastructural, regulatory, and financial limitations—versus the Ministry of Health's urgency to implement a consistent digital HMIS. This contradiction, surfacing in the early nineties with the initial attempts to introduce digital health solutions, persisted throughout the review period. Along with other contradictions, it generated a range of opportunities, actions, and outcomes, such as the introduction of DHIS and the development of supporting capacity-building programs for its pilot implementation.

In the second phase, the dynamics appeared to be largely influenced by the various actors engaged in HMIS implementation, drawing focus to themes of institutional entrepreneurship. Through this lens, multiple actors were identified as key players in the implementation process over the twenty-year span. Examination of their roles uncovered pivotal entrepreneurial actions, such as synergies between 'research, education, and practice'. For example, an institutional entrepreneur identified during this phase—a local researcher from UEM who was involved in the first phase—was subsequently appointed to a significant role by the Ministry of Health. His contribution was instrumental in rallying collective efforts and mediating institutional contradictions along with the ongoing developments (Engberg-Pedersen, 1997; Seo & Creed, 2002).

In Phase 3, my research shifted focus towards the processes of institutionalisation to investigate the conditions under which the existing institutional dynamics led to successful HMIS implementations. Although some institutional contradictions identified and analysed were persistent throughout the overall analysis period, their significance varied across different phases as incremental investments in the country helped to gradually mitigate the impact of resource scarcity. For example, DHIS was not adopted during Phase 1 but became adopted and institutionalised in Phase 3 with the introduction of its second version. One explanation for this could be attributed to the institutional context: in Phase 1 the digital context was in its formation stage, while by Phase 3 it had achieved better stability (Fligstein, 1997; Greenwood & Suddaby,

2006; Maguire et al., 2004). Another contributing factor was the evolution of the technological artefact itself, which underwent significant changes, creating new opportunities within the setting.

The analytical framework facilitated the examination of the interplay among institutional contradictions, institutional entrepreneurship, and institutionalisation, and how it influenced the HMIS implementation processes. For instance, while assessing the enduring contradiction of 'Multiple stakeholders with poorly aligned and often contradictory interests', I could investigate opportunities for change. In this context, the role of an institutional entrepreneur who participated across the process in various capacities was scrutinised. The actions of this institutional entrepreneur were pivotal in mobilising and unifying these disparate stakeholders towards the collective aim of adopting and institutionalising the HMIS in the setting (Bruton et al., 2010; Garud et al., 2007; Lawrence, 1999).

This step in the analysis enriched the understanding and provided alternative explanations for the patterns of institutional change (Bruton et al., 2010; Koning, 2016). An important question posed during this study concerns why DHIS was not implemented in the setting during Phases 1 and 2, yet was implemented years later, despite the presence of similar institutional contradictions. One potential answer is that the institutional contexts evolved across the phases, increasingly influenced by external developments, thereby becoming more receptive to the system. Alternatively, the changes in DHIS itself, driven by internal advancements, might have enhanced its suitability and created more favourable conditions for adoption within the setting.

1.5 Expected contributions: theoretical and practical

My thesis aims to contribute to IS research within the domains of Information and Communication Technology for Development and Health Information Systems. The following theoretical and practical contributions have been developed:

1.5.1 Theoretical contributions

The foremost contribution of this thesis is the development of a historical narrative detailing the implementation of HMIS in an LMIC context and a methodology for conducting such historical analyses. This was achieved by creating a historical narrative that interprets the evolution of Mozambique's HMIS over two decades. Thus, while enhancing the understanding of information technology implementation processes within the public health sector and addressing the central research questions of my study. Drawing on empirical data and insights from diverse participants, it traces a comprehensive journey of long-term implementation,

essential for examining the institutional dynamics at play in the HMIS context. By documenting the National HMIS's history, I not only help forge a shared identity but also lay a foundation for ongoing learning. This applies equally to DHIS, where the narrative captures both its local evolution and international developments, contributing to a deeper appreciation of its identity.

As part of this contribution lies the process of historical analysis itself, whereby I have formulated a methodological approach for examining the institutional forces shaping digital health systems in an LMIC setting. The study's context, encompassing its spatial and temporal aspects, has been examined through a retrospective lens. This analysis, which unfolded alongside data collection, employed a three-step process and an analytical framework that integrates institutional and historical lenses. I conducted a longitudinal historical analysis spanning two decades, which diverges from previous studies that have typically concentrated on brief periods, providing only transient glimpses of the process cycles. This approach afforded the opportunity for an in-depth examination of the implementation and change processes. A temporal bracketing strategy was utilised, segmenting the 20-year period into distinct phases demarcated by three pivotal events concerning the technology in question. This method facilitated the handling of extensive datasets. A multi-level analysis was employed, focusing on institutions, organisations, and individuals. Additionally, a multi-site approach was indispensable for capturing diverse perceptions of the technological artefact across different environments. The methodologies selected and their integration address the call (Bryant et al., 2013b; Porra et al., 2014; Soden et al., 2021; Williams & Pollock, 2012) for innovative research techniques within the fields of IS and ICT4D. Based on institutional theory and change processes, the study offers insights into how institutional contradictions, institutional entrepreneurship, and institutionalisation are intrinsically linked and evolve over time. By extending Seo and Creed's (2002) framework to fit my analytical needs, the adapted model emphasises the interconnectedness of these concepts and their evolution as processes, which in turn enriches the analysis and enhances our comprehension of institutional change dynamics. Furthermore, it allows for the generation of alternative interpretations of how these dynamics influence the trajectory and results of implementation efforts across various contexts and timeframes.

Another theoretical contribution includes the formulation of arguments that counter the failure narrative in IS research, elucidating the mutual shaping process between technological artefacts and their implementation contexts. My research builds upon and complements and extends earlier studies on HMIS implementations in Mozambique and other LMICs. Investigations

conducted in Mozambique from 1999 to 2014 concentrated on various facets of HMIS development, including technology transfer and adaptation, system integration, standardisation, opposing networks, scaling, and the advancement of geospatial information systems (Chilundo, 2004; Mavimbe, 2008; Mosse, 2005; Muquingue, 2009; Nhampossa, 2006; Saugene, 2014). My study enriches this body of work by offering a cohesive synthesis of these previous inquiries, thereby significantly contributing to the accumulation of knowledge in the field. My research also delineates the evolutionary process of the technology under examination, weaving together the accumulated knowledge regarding its development over time. The trajectory of DHIS has been extensively documented in a series of episodic studies, typically focusing on specific implementations within countries or organisations (Adu-Gyamfi et al., 2019; J. Braa et al., 2023; Nicholson et al., 2022; Roland & Sanner, 2017). What these segmented studies often overlook are the institutional forces that drive modifications in the technology itself. My work seeks to fill this gap by fostering an understanding of both how and why these technological changes occur. Thus, while highlighting unforeseen positive influences shaping both the technological artefact and the setting.

An important theoretical contribution lies in the establishment and exploration of the interlinkages between three institutional concepts, thereby enhancing understanding of the emergence and development of institutional entrepreneurs, taking into account relevant institutional, socio-political, and technological dynamics. Through this it was possible to explore the emergence and development of agents of change across different phases over time, in a 'becoming process'. Exploring the interventions of these actors was pivotal to identify a set of entrepreneurial actions that characterise the mediation of enduring institutional contradictions and support gradual institutionalisation of technological artefacts in LMICs.

1.5.2 Practical contributions

As a practical contribution this thesis provides a deeper insight into the entrepreneurial actions accompanying HMIS implementation processes and their practical implications. The thesis offers empirical evidence that underscores the significance of developing training programs that enhance digital and data management competencies, extending beyond the traditional scope of healthcare functions to include fields like health informatics. Moreover, the research underscores the value of engaging health professionals in research, capacity-building measures, and HMIS development projects. These experiences are viewed as crucial for augmenting their social acumen and expanding their professional interests. Consequently, this can position them advantageously, enabling them to cultivate influential relationships and potentially challenge existing norms, thus driving transformation within their domains. Moreover, while those

interventions reveal to be beneficial supporting the HMIS implementation processes they concur to gradually develop technological sustainability, self-reliance and ownership within the setting.

1.6 Structure of the thesis

Following the introductory overview, this thesis is organised and discusses various topics in subsequent chapters as detailed below. Chapter 2 presents a thorough examination of the literature that informed the research direction. In Chapter 3, the research design, approach, and methodologies used for gathering and analysing data to underpin the discussions in the thesis are delineated.

Chapters 4 through 7 focus on the historical narrative. Chapter 4 offers an in-depth look at Mozambique, including its history and the particularities of the post-conflict era, segmented into two distinct periods: 1975-1992 and 1992-2023. These insights are essential to understanding the socio-political and technological milieu of the country and the consequent impact on its health sector.

Chapters 5, 6, and 7 each address one of the three phases that mark the project's chronology. Within each phase, I provide a succinct overview of the socio-political and technological landscape within the health sector, the evolution of the Health Management Information System (HMIS), and a detailed narrative of the implementation of the District Health Information Software (DHIS) [12] in Mozambique. Chapter 5 details the pioneering stage of introducing digital health systems in Mozambique, especially during DHIS's pilot phase, underscoring the challenges posed by the existing socio-political and technological contexts. Chapter 6 shifts focus to the intermediary stage, examining the efforts to revamp the HMIS with the re-introduction of DHIS2 to bolster the new information system. Lastly, Chapter 7 recounts the successful adoption and operationalisation of DHIS2, which occurred 16 years subsequent to the initial pilot phase.

Informed by various concepts derived from institutional theory and considering the contextual conditions, each chapter (4-7) concludes with a concise analysis of the events surrounding the implementation of DHIS for that specific period. The depth of these analyses is further expanded in Chapter 8, where I conduct a comprehensive investigation into the patterns,

[12] The acronym DHIS refers to the first version of the artefact developed in 1994, which evolved until its version 1.4, and DHIS2 refers to the second version released in 2006 and the subsequent versions developed until today. In this thesis, I use DHIS to refer to the technological artefact itself. The acronyms DHIS and DHIS2 will be used interchangeably along the document related to the period in analysis.

strategies adopted, and outcomes that shaped the changes in the processes leading to the development of the HMIS.

Chapter 9 delves into a comprehensive discussion of the theoretical and empirical contributions of the study, setting the stage for the concluding insights. Chapter 10 encapsulates the study's limitations and identifies potential areas of interest that surfaced during the research, highlighting opportunities for further inquiry.

The thesis concludes with the References and Appendices. The References section enumerates all the scholarly works and sources that underpin the arguments and findings of the study. Lastly, the Appendices feature the instruments used for data collection, along with a compilation of documents I created, which draw upon an array of information amassed from diverse and disparate sources.

Chapter 2 : Relevant literature

My study analyses the institutional dynamics that shape the implementation processes of historically grounded Health Management Information Systems (HMIS) in the context of Low- and Middle-Income Countries (LMICs). In this chapter, I provide a theoretical overview encompassing three primary focus areas of my research: implementation studies, historical research, and institutional change. The chapter is structured as follows. I describe the implementation studies landscape within the ICT4D domain in section 2.1. In section 2.2, I position the central approach adopted for the study, the historical perspective, and how this has been adopted in IS research. Further, I discuss the historical perspective's connections with institutional theory, adopted as the theoretical lens in the study. Section 2.3 introduces the theoretical framework and describes the institutional concepts selected to support it. Then, I introduce my analytical framework and describe how it guides my study in section 2.4. The last section, 2.5, summarises the chapter, highlighting the main topics discussed.

2.1 Information systems implementation studies within the ICT4D domain

Information Systems domain, initially known as Management Information System (MIS), emerged from the interplay "of computer science, management and organization theory, operations research, and accounting" towards understanding the "application of computers within" organisations (Hirschheim & Klein, 2012, p. 193). The field has evolved over the past six decades, expanding its research scope, communities, methodologies, and approaches. IS research generally focuses on the broader conditions that enable or constrain organisational settings, highlighting technological, managerial, and economic aspects. These influences have been studied concerning improving "profitability" and organisational "performance", and at the individual level, related to achieving "efficient and effective interactive processes or working routines" (Dwivedi et al., 2015, p. 143). Research on IS implementations is among the oldest topics within the discipline, underscoring the significance of context (Cecez-Kecmanovic et al., 2020). This aspect is particularly pertinent to ICT4D research (Dwivedi et al., 2015). My research builds upon the stream of implementation studies, specifically relating to a HMIS application in Mozambique, a LMIC. Given the LMIC setting of my research, my study also falls with the scope of ICT4D research, which represents "an academic field concerned with the use of ICTs for international development", and its "research and practice" contexts are focused on "developing countries" (Walsham, 2017, p. 18). My focus on implementation in a LMIC context also relates to similar types of research in mainstream IS,

with the potential of both learning from this body of work and also contributing to it through the insights I gain.

Reviews from 2000 to 2013 highlight ICT4D's emphasis on global and local societal challenges, technology-centered issues, and prevalent social theories and methodologies (Gomez, 2013; Naudé, 2016; Vessey et al., 2002; Walsham & Sahay, 2006). A significant area of ICT4D research and practice has been public health systems, recognised as vital for social development (Fraser & Blaya, 2010; Romanow et al., 2012). The Health Information Systems Program (HISP) network, based at the University of Oslo, stands out in this field (Avgerou, 2008; UiO, 2023). Among the diverse themes explored, two have been particularly relevant in resource-limited settings: technological transfer and adoption, and technological sustainability with local adaptations. These themes have attracted strong research attention from the HISP research network, including in Mozambique (Aanestad et al., 2005; Braa et al., 2004; Lungo, 2003; Nhampossa, 2006).

Research on north-south technological transfer processes underscores implementation challenges due to cultural, economic, and digital development disparities between donor and recipient settings (Heeks, 2002). Similarly, studies on south-south technology transfer indicate the need for local adaptations to enhance adoption (Kaasbøll & Nhampossa, 2002). Furthermore, other research highlights the potential of technological transfer processes associated with institutional and organisational transformations (J. Braa & Muquingue, 2007; Kaasbøll et al., 2018; Kaasbøll & Macome, 2002).

Technological sustainability refers to “the challenge” involved in making “an information system work, in practice, over time, in a local setting” (Braa et al., 2004, p. 338). This concept involves mutual adaptations between the system introduced and the recipient environment. Local needs are translated into system requirements, necessitating adaptations within the setting, including capacity-building initiatives, technical infrastructure investments, and organisational transformations (Braa et al., 2004). Scoones (2007) highlights sustainability as a concept that intersects the domains of science and politics. Kimaro and Nhampossa’s studies (2005, 2007) in Tanzania and Mozambique illustrate the challenges and opportunities of technological sustainability, particularly those influenced by cultural and political factors. These studies suggest inadequate donor support, power asymmetries, and ineffective policies may impede HMIS implementations. They propose integrating HMIS initiatives with the

development and institutionalisation of new organisational practices and cultures to achieve technological sustainability.

Over the past decade, ICT4D research has shifted focus to emerging developments in the digital domain, such as mobile technology, the Internet of Things (IoT), cloud computing, digital platforms, Artificial Intelligence (AI), machine learning and many others (Ali, 2023; Nielsen & Sahay, 2022). These advancements introduce new complexities, including socio-technical implementation challenges, legal implications, global consequences, and increasing interdependencies (Khubone et al., 2020). In the health sector, complexities arise from national HMIS, often fragmented and composed of historical legacy systems from global and national actors (Avgerou, 2000; Sahay, Nielsen, & Latifov, 2018). In Low- and Middle-Income Countries (LMICs), these complexities are magnified due to political structures, global asymmetries, governance challenges, and diverse health challenges (Ahuja et al., 2016; Guenther et al., 2014; Stroetmann, 2018).

Recent ICT4D research has focused on data management, access, and usage (David et al., 2020; Nielsen & Sæbø, 2016; Onthoni et al., 2022), challenges of local relevance and global scale (Nicholson et al., 2022; Sahay et al., 2017), and information infrastructures (Aanestad et al., 2014, 2017; Constantinides et al., 2018). These themes align closely with the phenomena explored in the current research. For instance, David et al. (2020) underscored the role of mobile health solutions in extending healthcare reach and reducing mortality rates in armed conflict zones, constrained by infrastructure and health provision deficits. Onthoni et al. (2022) examined the potential of IoT and AI in monitoring diseases like the Covid-19 pandemic. Sahay et al. (2017) raised concerns about the association between cloud computing and HMIS implementations, particularly the security and privacy risks in managing personal data and the political implications of tensions between governments and software providers.

Scholars have called for more "systematic research" and "cross-disciplinary" learning while unpacking the digital "black boxes" and developing a greater focus on understanding the dynamics of implementation contexts (Nielsen & Sahay, 2022, pp. 1–2). Studies within the ICT4D domain have examined IS implementations from a socio-technical perspective, assessing their impact on societal development (Dey et al., 2016). As such, they provide valuable insights to address persistent challenges, particularly in highly resource-limited settings, and to mitigate concerns such as the increasing digital divide related to "access, usage, and outcomes" of ICTs (Lythreatis et al., 2022, p. 2). The concept of the digital divide has

evolved over time and is widely recognised (Van Dijk, 2020). It refers to the gap between individuals with adequate access to ICT and those with limited or no access (Lythreatis et al., 2022). The challenges associated with this divide are multifaceted, encompassing aspects like digital innovations, persistent inequalities in opportunities, choices and freedoms, and the implications of individual and social participation in digital initiatives (Van Dijk, 2020).

The COVID-19 pandemic underscored the significance of data and digital technologies, revealing how digital divides can hinder equitable access to and utilisation of health services (Lythreatis et al., 2022). Recent research has highlighted various factors influencing the digital divide, including sociodemographic and socioeconomic conditions, personal elements, social support, technology type, digital training, rights, infrastructure, and major events (Lythreatis et al., 2022, p. 6). These elements are garnering increasing attention in both IS and ICT4D research fields, increasingly considering a sociotechnical approach in their studies. This reveals essential for IS implementation studies, as noted by Volkow (2003, p. 29):

> "It aims to elucidate the nature of the social change process entailed in information systems implementation by recognizing the embedded institutional features within a context that enables and constrains the use of information technology… recognizes the social nature of technology and regards an information system as both a social system… and a political system configured by different groups of people with diverse, and even antagonistic, interests…"

ICT4D research has embraced a variety of approaches, methodologies, and perspectives to investigate the challenges and opportunities of IS implementation. In the nineties, positivist-based studies were prevalent (Vessey et al. 2002), subsequently giving way to an interpretive turn in the field (Walsham & Sahay, 2006). Currently, IS research appears to be shifting towards a more substantial positivist approach, driven by the growing interest in data science research (Agarwal & Dhar, 2014). There have been ongoing debates about these approaches, focusing on their conceptual underpinnings, the balance between rigor and relevance, and the methods of generalisation (Avgerou, 2019; Lee, 2020; Siponen & Tsohou, 2018, 2020). Despite these discussions, the coexistence of diverse approaches has continued, reinforcing the multidisciplinary essence of the discipline, as noted by Walsham (2017, p. 34):

> "Transdisciplinarity… for ICT4D research, it is clear that multiple methodologies are an intrinsic property of the field. It is inconceivable that the various disciplines

> contributing to the field, such as anthropology, computer science, geography, development studies, and IS, could be brought together under one methodological or theoretical umbrella. So we should welcome the various approaches…"

Research exploring HMIS implementation studies has contributed significantly to the increasing diversity of IS research. Thus, adopting different approaches to explore the potential and relevance of ICTs while addressing HMIS challenges in their research contexts (Gomez, 2013; Naudé, 2016; Walsham & Sahay, 2006). Examples of studies adopting an interpretive stance[13] include Mosse's (2005) use of social identity to explore counter networks, Nhampossa's (2006) study with Actor-Network Theory (ANT) exploring the interplay of human and technological factors, Muquingue's (2009) analysis of Structuration Theory to study human agency, and Mukherjee's (2017) discussing empowerment through a Capabilities lens. Studies exploring HMIS implementation through an institutional lens include Sheikh's (2015) study discussing the challenges of institutionalisation processes, Fossum's (2016) study exploring institutional change related to standardisation processes, and Manya's (2019) study of the institutional incentives for data quality and data use effectiveness.

Recent studies have increasingly emphasised the dynamic nature of digital systems, conceptualising their evolution as a continuous process of 'becoming' (Cloutier & Langley, 2020). This perspective acknowledges multiple stages over time, wherein initiatives are introduced, evolve or stagnate, and eventually may be terminated (Langley et al., 2013). There is a growing recognition of the importance of combining different disciplinary approaches for in-depth studies. Such integration is crucial for enhancing our understanding of socio-technical interventions and their impact on societal development (Walsham, 2017). The historical method, in particular, has proven invaluable for retrospectively analysing past developments to inform and guide future interventions more consciously (Dias et al., 2023; Hirschheim & Klein, 2012; Immergut, 1998; Nelson, 2008).

[13] Some IS researchers have incorporated social theories (structuration, institutional theory) and economic approaches (Capabilities) in their studies even though they recognise that "technology is not" their "central focus", unlike IS native theories such as ANT and Information Infrastructure (Walsham, 2017, p. 32). Thus, aiming to explore the social nature of technology, its interplay with the recipient contexts, and the implications of their related processes.

2.2 Positioning historical studies

2.2.1 Historical studies in IS research

Various disciplines have recognised the value of historical studies in supporting research, and the field of IS is no exception (Bryant et al., 2013b). Since the late 1990s, IS scholars have highlighted the underutilisation of historical studies in the field (Mason et al., 1997b) despite acknowledging its potential and importance in fostering a deeper understanding of "social actions" (Cecez-Kecmanovic et al., 2020, p. 249). Box 1 provides further insights into the arguments supporting the significance of studying history both for and within the IS domain.

"History helps one understand the sources of contemporary problems, how they arose and how their characteristics unfolded through time. It also identifies the solutions that worked in the past and those that did not… an understanding of history helps executives avoid their natural human tendency to view their present circumstances in idiosyncratic, traditional, narrow, or shallow ways because reading history stimulates the imagination and reveals new possibilities… In the final analysis, the principle product of historical research is context – an understanding of the organizational, individual, social, political, and economic circumstances in which MIS [Management Information System] phenomena occur… the historical researcher opts for richness of reality because it enhances the understanding of context." (Mason et al., 1997, p. 307)

"… a historical understanding makes us more appreciative of the situation in which we find ourselves today. And this insight – if applied to IS – could contribute to improving communication among diverse scholarly communities and to establishing a social identity for IS as a field… history is important for understanding the evolution of social collectivities… Such understandings empower us to examine how the past continues to influence (and constrain) the present…" (Hirschheim & Klein, 2012, p. 192)

"Histories are powerful because they both create and reinforce collective identities. Without a history, it is difficult to know who one is, where one comes from, or where one is headed. It is difficult to belong or have direction… Having a history is important because what is articulated as having happened in the past profoundly affects all aspects of our lives and will affect what happens in the future." (Bryant et al., 2013b, p. 4)

"Project managers need to closely examine past mistakes… understand which are more common than others, and search for patterns that might help them avoid repeating the same mistakes in the future… In addition to uncovering what went wrong on the projects studied, our retrospectives also captured what went right. We found dozens of distinct "best practices"... If leveraged properly, these… can help organizations avoid the classic mistakes from occurring in the first place" (Nelson, 2008, pp. 72–73).

Box 1. Arguments from various scholars towards the importance of historical studies.

Numerous researchers have highlighted the necessity of historical studies in solidifying the identity of Information Systems as a discipline (Bryant et al., 2013b; Porra et al., 2014; Soden et al., 2021; Williams & Pollock, 2012). In 2012, the Journal of the Association for Information Systems issued a special edition to deliberate on the history of IS (Hirschheim et al., 2012). Expanding this dialogue, the Journal of Information Technology devoted two issues to foster historically oriented research studies, broadening the scope "of what 'doing history'" entails (Bryant et al., 2013b, p. 1).

These research endeavours have explored IS developments and their influence on shaping future research agendas (Hirschheim & Klein, 2012; Walsham, 2017). More recently, Soden et al. (2021) have invited further historical engagement within Computer-supported cooperative work (CSCW) research. These concentrated efforts and special editions have diversified methodologies and theoretical approaches in the IS field (Bryant et al., 2013b, 2013a; Porra et al., 2014) and laid a foundational basis for future studies (Soden et al., 2021; Walsham, 2017). Despite these advancements, the IS field continues to grapple with questions surrounding "its identity and its legitimacy" (Hirschheim & Klein, 2012, p. 193; Walsham, 2017). Moreover, historical studies remain underutilised in IS research (Dias et al., 2023).

The historical method proves vital in ICT4D studies, foregrounding context and enhancing analytical depth. Historians, united by their curiosity about the drivers and nature of change, can examine phenomena from various theoretical perspectives or approaches (Porra et al., 2014). These aspects are especially significant in ICT4D, where enduring historical and colonial legacies impact current digital interventions and their societal implications. Walsham and Sahay (2006, p. 7) responded "*yes"* to "*whether"* ICTs could be "*beneficial"* and argued to shift the argument from "*whether"* to "*how ICTs can be"* made more *"beneficial".* This rephrasing was an essential argument to the question "*Are We Making a Better World with ICTs?"* (Walsham, 2012, p. 87), a question that remains pertinent amidst the grand challenges faced globally today, irrespective of economic status (Prince et al., 2023).

Historical studies not only fortify the identities of disciplines like IS and ICT4D but also illuminate their central subjects, such as technological artefacts or information systems. They offer valuable insights into the cycles and processes of evolution within specific spatial-temporal contexts, thereby enabling learnings from the past to shape present and future undertakings.

2.2.2 Historical studies and Institutional theory

Historical studies have utilised various theories to examine a wide range of topics, domains, contexts, and timelines. These theories include the Social Construction of Technology (SCOT) (Van Der Blonk, 2002), General Systems Theory (Porra et al., 2005), Institutional Theory (Rajão & Hayes, 2009; S. V. Scott & Zachariadis, 2012; Singh et al., 2010; Volkow, 2003), Imprinting Theory (Dias et al., 2023), and statistical models (Menkir et al., 2021). For instance, Van der Blonk (2002) employed SCOT theory to study changes in an information system at the Dutch Railways over a period of 12 years. Porra et al. (2005) analysed 40 years of Texaco's history, a petroleum company in Texas, using both mechanistic and organic systems metaphors, along with colonial systems metaphors, to analyse their case study. Menkir's (2021) study conducted a historical analysis of malaria notifications over 13 years to comprehend trends in reporting delays and develop predictive tools to enhance malaria surveillance. Dias et al. (2023) focused on how established organisations strategise their information systems, examining their historical conditions over a span of 60 years.

Institutional Theory has frequently been applied as a lens for historical analyses. Volkow (2003) investigated the modernisation processes within 'Petroleos Mexicanos,' a public organisation, over 59 years to gain insights into organisational change. Singh et al. (2010) used a Punctuated Equilibrium approach to study the implementation of telehealth in a rural Georgian public health sector over a decade. Scott and Zachariadis (2012) analysed the development of the Society for Worldwide Interbank Financial Telecommunication (SWIFT), using a path dependency approach derived from Institutional Theory to examine the evolution of standards and network effects globally. Rajão and Hayes (2009) employed a historical perspective to investigate a rainforest monitoring system in Brazil, conceptualising and studying the role of ‘control’ from an institutional perspective over 44 years.

2.3 Institutional Theory: developing the analytical framework

Institutional theory has a long-standing history of development and application (Alvesson & Spicer, 2019). Originally, old institutionalism emphasised the stability of institutions as taken for granted entities (Immergut, 1998). In contrast, new institutionalism has shifted focus to the paradox of institutional change, led by agents embedded within their institutional contexts (Hall & Taylor, 1996; Seo & Creed, 2002). Given my focus on developing a historical perspective on the institutional dynamics that have shaped implementation dynamics of the HMIS in Mozambique, I opted to use the Institutional Theory perspective to guide my analysis, for the

following reasons. One, what was constant over the period of my analysis was the MoH institution who were always responsible, in different forms and degrees, for the HMIS implementation. Holding that as a constant as my unit of analysis over the research period, provided a rich analytical focus to see the ongoing changes in institutional processes, and their implications on the implementation process. Two, institutional theory provides for a rich array of concepts, which lend itself to the analysis of different facets of the implementation process, including political processes, technological trajectories, human agency, change processes and more. Three, various Institutional Theory frameworks and lenses have been developed by researchers, over the years, and I could thus have a wide array of choices on selecting a framework and adapting it to suit my empirical context.

However, I did not start with an a-priori framework. Working with the broad lens of institutional theory, I started my empirical work, open to have conversations between the theoretical concepts in my mind and the data I started to see in the field settings. This conversation was supported by continuous reading of the literature.

During this journey, I encountered the Seo and Creed's (2002) framework, which resonated with these conversations. These scholars acknowledge the roles of particular actors distinguished among the others who, in the midst of contradictions, are motivated and willing to engage in transforming their status quo, relying on their abilities and networks to institutionalise novel and more accepted practices. Moreover, Seo and Creed's framework, designed to explain the paradox of embedded agency, examines institutional embeddedness and change linkages from an organisational perspective. It focuses on performance factors like technical efficiency, legitimacy, and resources, viewed through an economic and production lens. The framework identifies four sources of institutional contradictions: i) "legitimacy that undermines functional efficiency"; ii) "adaptation that undermines adaptability"; iii) "intrainstitutional conformity that creates interinstitutional incompatibilities"; and iv) "isomorphism that conflicts with divergent interests" (Seo & Creed, 2002, p. 226). Accumulating such institutional contradictions can provoke institutional entrepreneurial actions aimed at altering the status quo.

Along with the thematic analysis, I identified three concepts that I believed were essential to develop and operationalise my analytical framework and, to establish the linkages between them, I relied on Seo and Creed's (2002) framework. Therefore, I built upon their ideas to help analyse the relation between institutional contradictions, institutional entrepreneurship, and

institutionalisation. As my thesis matured, I continuously engaged in a process of adapting and extending this framework to my emerging theoretical understanding. This then led to the articulation of a modified form of this framework as a key contribution from my thesis. My framework included the three central concepts drawn from institutional theory, and adapted in this framework, to help me develop my historical analysis. These are first summarised in Table 3 below and then briefly described in the following subsections.

Table 3. Key concepts adopted from institutional theory to guide the historical analysis.

Concept	Definition
Institutional Contradiction	"…ruptures and inconsistencies both among and within the established social arrangements…" (Seo & Creed, 2002, p. 225) "…various ruptures and inconsistencies within and among institutionalized systems of meaning, forms of organization, and logics of action…" (Seo & Creed, 2002, p. 240) "…can incite tension or conflict and create the conditions for institutional change to occur…" (Burns & Nielsen, 2006, p. 451)
Institutional Entrepreneurship	"…represents the activities of actors [institutional entrepreneurs] who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones…" (Maguire et al., 2004)
Institutionalisation	"…represents institutional continuation rather than an exit – a change within an institutional form…" (Jepperson, 1991, p. 48) "…institutionalization best denotes a distinct social property or state…" (Jepperson, 1991, p. 38) "…the process by which an institution attains a stable and durable state or property…" (Currie, 2011, p. 3)

2.3.1 Institutional contradictions

The dynamics of social life can be delineated through four fundamental principles, including "social construction/production, totality, contradiction, praxis" (Benson, 1977, p. 3). Within this framework, an institutional context is often comprised of various institutions formed through social construction/production, following their creation and stabilisation. Collectively, these institutions represent a state of totality. However, they are loosely coupled and may evolve divergently, leading to contradictions. In complex institutional contexts, pressures can arise from multiple sources, such as resource scarcity, political changes in the environment, or a plurality of actors, all of which can contribute to these contradictions (Farjoun et al., 2018). Over time, these pressures may result in inconsistencies and conflicts, causing ruptures in institutional arrangements.

Institutional contradictions often manifest through multiple pathways, emphasising inconsistencies and tensions while potentially creating opportunities for institutional transformation (Burns & Nielsen, 2006; Seo & Creed, 2002). The accumulation of these

tensions and inconsistencies over time can culminate in scenarios that necessitate mediation. Given that these tensions can stem from varied sources, different mediating mechanisms may be required to address the diverse conflicts and strains. To explore these mediating mechanisms, my research considers the analytical approach of institutional entrepreneurship.

2.3.2 Institutional entrepreneurship

Institutional entrepreneurship focuses on institutional entrepreneurs (actors) to comprehend how their interests and agency are both influenced by and exert influence on their institutional contexts (Beckert, 1999; Bruton et al., 2010; Garud et al., 2007; Lawrence, 1999). Although institutions are often perceived as restrictive and taken for granted, researchers have posited that individuals can develop an awareness of their context (Engberg-Pedersen, 1997), which can enhance their agency to initiate change. This presents a paradox of embedded agency, raising questions about the actions of institutional entrepreneurs. How can these actors, deeply ingrained in an institutional environment and shaped by existing institutions, conceive novel ideas and challenge the status quo? History plays a crucial role in answering this. Institutional entrepreneurs don't emerge spontaneously in a vacuum; their actions are influenced by events, situations, conditions, or accumulated experiences over time.

Developing interests, social and intellectual skills, and strategies is a gradual process, influenced by a combination of factors and conditions (Lawrence, 1999). Institutional entrepreneurs form interests based on their understanding of the environment (Beckert, 1999; Lawrence, 1999) and cultivate social skills that extend beyond self-interest to encompass empathy for collective interests. This process also involves developing intellectual skills to broaden their perspectives and devise creative strategic actions (Fligstein, 1997; Garud et al., 2007). The amalgamation of these skills is crucial for garnering material resources and support from influential actors, thereby legitimising their intentions. Such actions contribute to challenging, reinforcing, or transforming existing institutional arrangements and reshaping their embedded institutional contexts (Bruton et al., 2010; Fligstein, 1997; Maguire et al., 2004).

Entrepreneurial actions vary depending on the development stage of the institutional context, whether it is emerging, forming, stable, or in crisis (Fligstein, 1997). Employing an institutional lens within a historical framework enables the construction of a comprehensive picture of the context, integrating insights from various perspectives. A strategic agency is a systematic

process aimed at achieving specific objectives through the deliberate and conscious utilisation of available means (Beckert, 1999). In pursuing their strategies, institutional entrepreneurs adapt their approaches based on the actions they desire to undertake. Additionally, they introduce or reinforce institutional arrangements to transform, maintain, discontinue, or establish new institutions (Lawrence & Suddaby, 2006; Maguire et al., 2004). Lawrence and Suddaby (2006) identify nine strategies for creating institutions, six for maintaining them, and three for disrupting institutions, as summarised in Table 4.

Table 4. Summary of the strategies suggested to create, maintain, or disrupt institutions.

Strategies to create institutions	**Strategies to maintain institutions**	**Strategies to disrupt institutions**
Advocacy, defining, vesting, constructing identities, constructing normative associations, changing normative networks, mimicry, theorising, and educating	Enabling work, policing, deterring, valorising and demonising, mythologising, embedding and routinising	Disconnection sanctions/rewards, disassociating moral foundations, and undermining assumptions and beliefs

Source: Lawrence and Suddaby (2006).

In the context of transforming specific Health Management Information Systems (HMIS) in Low- and Middle-Income Countries (LMICs), additional strategies may be necessary. These strategies can involve enhancing practices through training, developing effective working practices, supporting infrastructure, improving travel infrastructure to expand reach capacity, and strengthening continuity through advocacy (Sahay, Nielsen, & Aanestad, 2018). A crucial aspect of analysing the actions of institutional entrepreneurs is understanding how these actions are sustained and evolve over time. This leads to an examination of the processes of institutionalisation.

2.3.3 Institutionalisation

The transformation of institutions occurs over time in "subtle", "gradual", and multi-directional ways, encompassing both intentional and unintended changes (Mahoney & Thelen, 2010, p. 1; Wendt, 2017). Four critical stages characterise the process of change: generation/formation, institutionalisation, deinstitutionalisation, and reinstitutionalisation (Jepperson, 1991). Table 5 provides summaries and definitions of these processes.

Table 5. Key processes involved in institutional change.

Concept	Definition
Institutional generation/ formation	"…is an exit from social entropy, or from nonreproductive behavioral patterns, or from reproductive patterns based upon 'action'…" (Jepperson, 1991, p. 48)
Institutional development (or elaboration)/ Institutionalisation	"…represents institutional continuation rather than an exit – a change within an institutional form…" (Jepperson, 1991, p. 48) "…institutionalization best denotes a distinct social property or state…" (Jepperson, 1991, p. 38) "…the process by which an institution attains a stable and durable state or property…" (Currie, 2011, p. 3)
Deinstitutionalisation	"…the process by which the legitimacy of an established or institutionalized organizational practice erodes or discontinues…" (Oliver 1992, p. 564) "…represents an exit from institutionalization, toward reproduction through recurrent action, or nonreproductive patterns, or social entropy…" (Jepperson, 1991, p. 48)
Reinstitutionalisation	"…represents exit from one institutionalization, and entry into another institutional form, organized around different principles or rules…" (Jepperson, 1991, p. 49)

The stages of the institutionalisation process develop over time. Changes can be the result of intentional interventions or the unintended consequences of parallel processes (Jepperson, 1991), and are often influenced by the surrounding institutional contexts (Greenwood & Suddaby, 2006; Maguire et al., 2004). These changes invariably involve elements of unpredictability or undesired outcomes (Lawrence & Suddaby, 2006), the origins of which must be retrospectively analysed from a historical perspective.

In examining institutional changes, it is critical to identify the nature of their sources as either endogenous or exogenous (Koning, 2016, p. 643). This identification involves examining both the institutional context and the embedded institutional processes. Exogenous sources are linked to external events or environmental conditions, while endogenous sources pertain to the internal dynamics and structural design of the institutions in question (ibid). Variations in the behaviour of two institutions in response to an exogenous source may indicate one of two scenarios: (1) the institutional contexts of the institutions were different at a specific moment, or (2) the institutional context of one of the institutions has evolved over time (ibid). These scenarios are depicted in Figure 4.

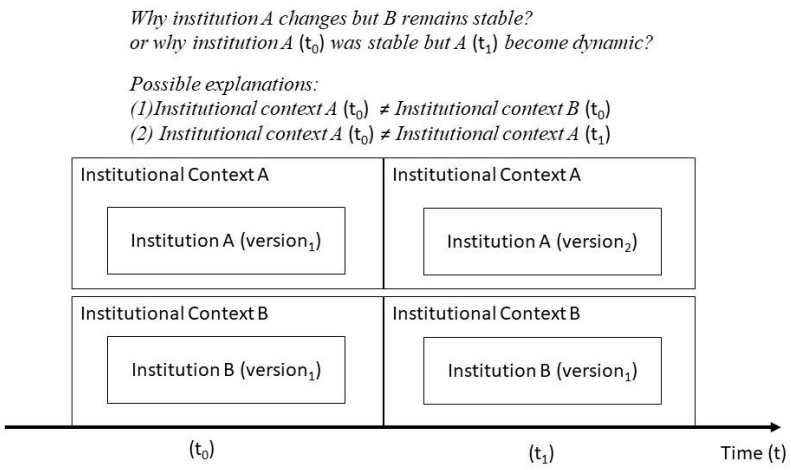


Figure 4. Possible explanations for exogenous changes. Source: Koning (2016)

The primary focus of this research is on the process of institutionalisation, a key concept underpinning my study. This process is examined in the context of its interlinkages with institutional contradictions and entrepreneurship. While institutional contradictions may create opportunities for institutional change, institutional entrepreneurs are considered the "driving force" of such processes (Siribaddana et al., 2019; Wahid & Sein, 2013, p. 76). Institutionalisation processes "may also differ from one context to another" (Wahid & Sein, 2013, p. 77), and as such, they may require sustained, incremental efforts to generate gradual achievements (Mahoney & Thelen, 2010). While external factors can influence these processes, entrepreneurial actions may also affect them "internally" (Wahid & Sein, 2013, p. 80). Scholars contend that for entrepreneurial initiatives to be successful, they must attain "legitimacy" (Garud et al., 2007, p. 960), which can help reduce resistance to change. This often involves bridging diverse groups that may not have direct connections or shared interests, while also facilitating access to a wide range of "disperse" resources (Maguire et al., 2004, p. 674). Furthermore, the existing organisational practices, policies, and norms can significantly impact the strategies used in entrepreneurial activities. These strategies may need to be harmonised and aligned with the "routines and values" of stakeholders to ensure effectiveness and coherence (Maguire et al., 2004, p. 658).

2.3.4 Developing the theoretical framework

The health sector, which is the analytical focus of my study, has evolved through historical developments in various domains, including socio-political, legal, economic, and technological areas. In my research, I utilise Institutional Theory as a guiding lens for historical analysis. This approach integrates a historical perspective with Institutional Theory, encompassing a

range of concepts. Institutional Theory's adaptability as a process-type theory is crucial for retrospectively analysing the Health Management Information Systems (HMIS) implementation processes. Given that contexts change over time and have their unique histories, my analysis includes retrospective examinations of both spatial and temporal aspects. This approach seeks to explain how and why specific events occurred, while providing contextual information about when and where they happened. From an institutional perspective, I explore the institutional context, which encompasses the environment and timeframe in which the institutions were established and transformed (Fligstein, 1997; Greenwood & Suddaby, 2006; Maguire et al., 2004). This environment includes both internal and external characteristics that define and are shaped by its elements, such as institutions, organisations, and individuals, all interconnected within a multilevel inter-institutional system (Thornton & Ocasio, 2008). These elements are influenced by temporal processes, and a historical perspective helps to understand the origins of institutions, organisations, and individuals. As individuals' social lives evolve, their experiences shape their personalities and other personal attributes, such as motivations and skills, enabling them to contribute to society and participate in various organisations influenced by the institutions in their social contexts.

The complexities surrounding the implementation of digital HMIS are rooted in institutional pressures from both internal and external sources and their interactions (Avgerou, 2000; Farjoun et al., 2018; Oliver, 1991). These interactions influence how individuals and organisations transition from passive to active roles, either conforming to or resisting the institutional pressures they encounter (Oliver, 1991; Seo & Creed, 2002). My aim is to gain a deeper understanding of the dynamics involving institutional arrangements and the actors (individuals and organisations) present in this context at multiple interconnected levels of interaction (Bruton et al., 2010; Currie, 2011, p. 19).

In conceptualising HMIS as an institution (Avgerou, 2000), I study them using the concepts of institutional contradictions, institutional entrepreneurship, and institutionalisation. Institutional contradictions illuminate how inconsistencies and tensions create opportunities for change and trigger developments (Seo & Creed, 2002). Institutional entrepreneurship integrates the roles of proactive actors who gather resources, legitimacy, and support to transform their institutional contexts (Bruton et al., 2010). Institutionalisation represents the core processes undertaken to establish and sustain institutions (Currie, 2011; Tolbert & Zucker, 1996) over

time and space. Collectively, these concepts and their interconnections offer a framework to explain changes in institutional processes from a historical perspective.

In my research, I considered multiple, diverse, and interconnected institutions, examining how they coexist, either harmoniously or discordantly, to create a composite whole. There can be incompatibilities in their foundations, such as differing norms, regulations, or cultural values, which may lead to contradictions. These contradictions often necessitate interventions by institutional entrepreneurs and their strategic actions. Since such occurrences may not be immediately evident, they can lead to an accumulation of inconsistencies over time, which is where a historical perspective becomes invaluable. It helps to analyse not only the emergence of institutional entrepreneurs but also how they accumulate resources and legitimacy over time. As institutional entrepreneurs develop their skills and become more attuned to the events within their institutional context, they progressively improve in planning and implementing strategic interventions. Achieving a state of institutionalisation requires consistent efforts and organisational engagement, and these are inherently tied to the processes of institutional change. A historical perspective thus plays a crucial role in understanding these dynamics, revealing how changes evolve and manifest in an institutional context.

In the next section, I present the synthesised analytical framework.

2.4 Synthesising the analytical framework

In this section, I introduce my analytical framework, illustrated in Figure 5 and described as follows.

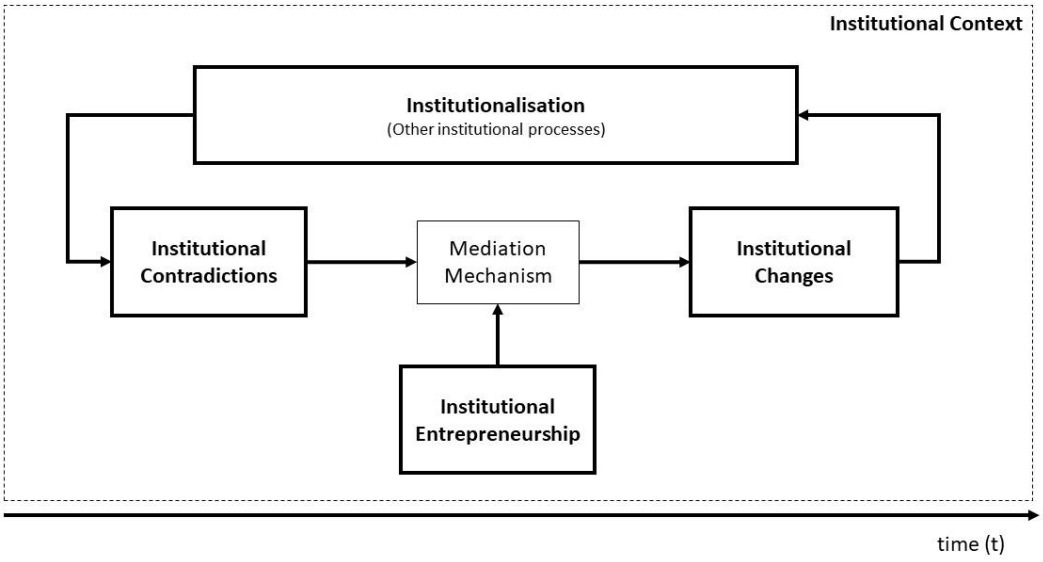


Figure 5. Analytical framework adapted from Seo and Creed (2002).

My study is situated within the public domain, where organisations are influenced by factors extending beyond their immediate domain, such as national policies, laws, and socio-economic and technological dependencies driven by donors. I have adapted and expanded Seo and Creed's framework to suit my study's context. This involves considering both internal and external factors that influence my study's subject. I emphasise the role of institutional entrepreneurs, highlighting their strategic actions as mediators of institutional contradictions and pivotal participants in institutional change. I replace the term 'praxis' with 'mediation mechanism', broadening the scope to include other mediating mechanisms, such as digital technologies.

The expanded analytical framework leads to certain premises based on existing literature, guiding its operationalisation and my analysis. I rely on two key premises for analysing the institutional context where institutional processes take place (Fligstein, 1997; Greenwood & Suddaby, 2006; Maguire et al., 2004): (i) processes unfold within an institutional context involving institutions, organisations, and individuals that mutually influence each other, and (ii) the institutional context can be characterised by its current attributes, indicating its developmental stage—emergence, formation, stability, or crisis. These premises guide my examination of the transformations observed during the study period. Additionally, I aim to characterise the institutional context in which the implementation processes unfolded throughout my project's study phases.

Secondly, to explore the emerging institutional contradictions over the years, I rely on three premises (Nawab et al., 2021; Seo & Creed, 2002): (i) institutional processes are comprised of institutional contradictions arising from varying interests of institutional actors within the organisational field, shaping the trajectory of implementation processes; (ii) institutional contradictions are not inherently harmful and can be potential catalysts for change, as actors negotiate and take action to resolve them; (iii) institutional contradictions can be triggered by multiple sources, including exogenous, endogenous, or a combination of both.

Thirdly, to identify the institutional entrepreneurs and how they develop their skills and act strategically, I rely on their motivations, roles, and positioning. This analysis is based on four premises (Garud et al., 2007; Seo & Creed, 2002): (i) organisations and individuals are not passive but possess 'embedded agency', enabling them to question their current situations and take actions attempting to change them; (ii) organisations and individuals may gather resources and support from powerful actors, both internal and external to the organisation, thereby

challenging the status quo of their institutional contexts. The model of institutional entrepreneurship may be internal, external, or hybrid; (iii) the institutional and historical context influences the behaviour and processes of the embedded organisational actors and the agency they can exert; (iv) institutional contexts vary over time as they go through different developmental stages of foundational norms, regulations, and cultural values, requiring varied entrepreneurial approaches and strategies.

Fourthly, I aim to understand the role of institutional entrepreneurship in enabling institutionalisation processes. Institutional entrepreneurs leverage their skills, roles, and positioning to support their intentions or to mobilise collective actions. I explore how they gather the necessary support, resources, and legitimacy to enact their strategic agency (entrepreneurial actions) and achieve the intended outcomes. The premise here suggests that institutional entrepreneurs act strategically (Lawrence, 1999; Lawrence & Suddaby, 2006; Sahay, Nielsen, & Aanestad, 2018). They adopt strategies according to their tasks while creating and attempting institutional adoption, institutionalising (maintaining/strengthening), reinstitutionalising (transforming), or deinstitutionalising (disrupting) institutions. Finally, I aim to identify patterns of actions and explain how the institutional dynamics contribute to the outcomes identified during the HMIS implementation. I follow these four steps to explore each concept in the three phases described in my study.

The final stage of my analytical process focuses on delineating probable explanations for why similar processes unfolded differently over time and their implications for the setting. Thus, considering the historical perspective, the processes unfold in different institutional contexts, involving various institutions and institutional entrepreneurs interplaying, some new and some established.

2.5 Conclusion

In this chapter, I have presented the literature related to my research. I outlined the landscape of implementation studies within the ICT4D domain, providing examples of themes discussed over the last twenty years related to the studied phenomena. These themes include technological transfer and adoption, technological sustainability and local adaptations, as well as challenges associated with data management, access, and use. These themes, both historically significant and currently relevant, are crucial to enhancing our understanding of the challenges and transformations involved in IS implementations, particularly in resource-

limited contexts. I also discussed how the historical perspective is increasingly recognised as relevant to IS research and how integrating it with an institutional theory lens is crucial for analysing essential phenomena within the ICT4D domain. I described how this relevant literature informed the development of my theoretical framework, guiding the construction of my analytical framework. This framework is built on the interlinkages of three concepts: institutional contradictions, institutional entrepreneurship, and institutionalisation. The rationale behind the chosen approach guiding the study, including the research strategy and methods adopted, is detailed in the following chapter.

Chapter 3 : Research strategy and methods

This chapter provides an overview of the research process used in this study. It begins by outlining my ontological and epistemological perspectives in Section 3.1. Building on these foundations, the subsequent sections elaborate on how these perspectives influenced the research design and the methodological choices made, as detailed in Section 3.2. Section 3.3 offers a more detailed explanation of the data collection process, considering the methos adopted. This is followed by an explanation of the historical reconstruction and analysis conducted in Section 3.4. Ethical considerations, along with a discussion of the constraints and limitations encountered during the study, are addressed in Section 3.5. Finally, Section 3.6 concludes the chapter with a summary that encapsulates the main points covered.

3.1 Research approach

3.1.1 Ontology

In distinguishing substances (things) from processes, their essence is emphasised. Where substances are defined by "what they are", processes are defined by "what they do" (Schatzki, 2019, p. 11). As such, processes exist constantly in flux and evolution (Langley et al., 2013)[14]. Furthermore, processes do not occur in isolation; they neither begin identically nor follow uniform patterns. Since processes are defined by their actions, this leads to logical questions like 'to whom or what', 'how', and 'why', as well as 'when' and 'where.' These questions underscore my efforts to explore implementation and evolution processes in my research. My understanding of events and processes is illustrated through an example in Box 2, where I draw from my personal experiences as a PhD candidate.

[14] Heraclitus's perspective of reality perceives it "not as a constellation of things, but" rather as a collection of ongoing "processes" (Langley et al., 2013, p. 5).

My journey in the last five years exemplifies a process of change. I was a different me in 2018. The process of my admission to the current PhD program was initiated in Mozambique in February 2018, with a meeting (an event) at Eduardo Mondlane University (UEM), my workplace. This provided me with the opportunity to participate in the NORPART research exchange program with the University of Oslo as a PhD candidate. This event changed the following months/years: I was registered as an exchange student, organised my travel to Norway. I was exposed to a different country with all that came along with it: I was introduced to the University of Oslo, met new people, learned, and shared my own experiences with them. All the academic experiences, courses, workshops, and proposal writing (parallel events and processes) enriched my experience as a PhD candidate at an early stage of this journey. In this process, my personal affairs, the events, and the conditionings at the time influenced the establishment of relations, interests, choices, decisions, and actions taken/adopted over time. By the end of the year, I was already a different version of myself. I submitted my application and returned to my country, and the admission process followed the next year. It was not straightforward (several events in between), and it was completed when I received an email in September 2019 with the admission letter (event). The termination of that process was simultaneous with the beginning of the unfolding events and processes that came after in the following years. This journey is not complete, and I acknowledge the transformations in becoming a new me as time goes by ... (the process of becoming).

Box 2. Examples of events and processes based on my own experience.

3.1.2 My role as a researcher

I recognise the potential for subjective positioning in my research, given my origins and previous academic and professional experiences. Firstly, I am a Mozambican citizen. Secondly, I played a role in a Master's program in Informatics at University Eduardo Mondlane (UEM), both as a student and subsequently as a lecturer. Thirdly, I am affiliated as a researcher at UEM and as a PhD candidate at UiO, both of which were directly engaged in the HMIS implementation processes in Mozambique from their inception.

Despite being a Mozambican researcher and part of the group involved in HMIS implementation in Mozambique, my direct contribution to shaping specific implementation processes has been minimal. This allowed me to assume a relatively more distanced position

compared to my colleagues while collecting data, examining existing descriptions of the process, and analysing them.

Another factor to be considered was my academic background. My studies have been in informatics and information systems, not in health or history. I do not claim to be a historian, not even an amateur one. Rigney (2013, p. 17) notes that many amateurs, with access to the Internet and resources to generate and disseminate content, may consider themselves historians. Conversely, Bryant et al. (2013b) commends those who engage with historical studies and suggest that individuals, regardless of their areas of expertise, should be acknowledged as historians. Growing up as a historian's daughter has made me more sympathetic to the historical method. Through my engagement with the rigor of the discipline, I have embraced the role of a historian in my work.

3.1.3 Epistemology

My research design evolved over time, leading to the realisation that I needed to broaden the scope of my analysis beyond the technical aspects of the technological artefact's evolution and implementation processes. As a result, my study took on a wider examination of the HMIS implementation processes, incorporating interconnected spatial, temporal, socio-political, and technological dimensions. Consequently, I viewed the object of my study as a sociotechnical phenomenon within an institutional context shaped by complex interrelations among its components: institutions, organisations, and individuals (Thornton & Ocasio, 2008). In my research, I considered their mutual influences and interactions over time, along with the transformations of their embedded contexts (Fligstein, 1997). In line with this perspective, I also drew upon Van der Blonk's (2002, p. 29) argument that "institutions always have a history, and they have to be understood within the historical process in which they were produced". These considerations provided important insights that influenced the research design, theory selection, methodological choices, and the definition of the analysis perspectives.

To conduct this study, I adopted a qualitative interpretive and retrospective approach. This allowed for the development of an in-depth and long-term historical description and supported a multi-level historical analysis (Mills et al., 2010a) guided by an institutional theory lens. I believe this approach is well-suited for the study, recognising the potential of historical research to investigate the evolution of institutional processes. I used history as the primary method guiding my research, specifically adopting an explanatory analytical approach for the development of the narrative and its analysis. Despite lacking a background in history, I

actively engaged with the method and its suggested techniques, allowing me to assume the role of a 'practical' historian. This involved zooming in and out as needed throughout the research process, taking advantage of the rich picture that the historical perspective provides to support my interpretation of the phenomena.

3.2 Research design and empirical setting

In this section, I present and justify the decisions that have shaped the overall research project, including the choice of empirical setting (framed both geographically and temporally) and the selection of approaches (strategies and methods) guiding the research.

Considering the temporal aspect and the need to explore the phenomena over time, I adopted the temporal bracketing strategy. This approach involves dividing the project timeline "into distinct phases", recognising "continuity" within each temporal phase and "discontinuity" at their boundaries (Mills et al., 2010b, p. 2). Three analytical and interconnected phases were interpretively reconstructed, aligned with the initiation and culmination of three HMIS implementation processes related to the introduction of the District Health Information Software (DHIS) in Mozambique. The historical reconstruction and analysis approach evolved concurrently, with each element supporting and informing the other. A three-step analytical process guided this: a preliminary analysis, a thematic analysis, and a theoretical historical analysis employing institutional lenses.

I employed mixed techniques[15] for the data collection, exploring primary and secondary sources. My research combined techniques recommended for historical studies with those used in other research methods, such as Case Studies, Archival Analysis, and Surveys (Yin, 2018). These include conducting interviews, examining archival documentation, and administering surveys. Given my lack of direct participation in the described implementation processes throughout the study period, non-structured on-site observations were also made during field visits. I identified the study's participants as my primary data source, selecting them based on a snowballing strategy (Parker et al., 2019). For secondary data sources, I utilised existing documentation in forms of reports and meeting minutes, research studies and archival information related to the context and the HMIS implementation processes from 1975 to 2022.

[15] I had the opportunity to participate in two informal discussions with a historian from the Mozambican Historic Archive Directorate. I considered this very important since he conferred legitimacy to the methods and techniques selected.

A thematic analysis (Braun & Clarke, 2006) guided and supported the development of the historical narrative, detailing the socio-political and technological contexts pertinent to the different temporal periods in question. This approach was instrumental in presenting the events and processes in a logical sequence, while also mitigating any instances of presentism in my analysis (Soden et al., 2021). By maintaining a clear focus on the historical context, my goal was to provide a comprehensive and coherent account of the phenomena under study.

3.2.1 Research setting: navigating in time and space

My empirical setting encompasses two dimensions: temporal and geographical. The geographical dimension was defined by selecting the sites for data collection, while the temporal dimension determined the study period.

When I began the admission process for my PhD program, my initial interest lay in contributing to ongoing strengthening of interventions in Mozambique's HMIS. My goal was to understand the processes surrounding the implementation of technological artefacts at the community level, particularly concerning the District Health Information Software (DHIS). A review of the literature on HMIS implementation processes in Mozambique revealed a research gap. Although extensive research which had been conducted between 1999 and 2014 described the digital context of HMIS and the processes associated with introducing DHIS in the country, limited information was available on the processes following DHIS's reintroduction in 2012 and its nationwide implementation in 2016. This gap piqued my interest. Additionally, the timespan from DHIS's initial introduction in 2000 to its effective implementation in 2016 captured my attention. I was curious about why Mozambique, one of the first countries to receive this technological artefact after its successful implementation in South Africa, did not adopt it earlier, why it first 'failed' and then subsequently reintroduced and became the national system. I sought to understand the factors that may have hindered the implementation process at the time and how these processes evolved, along with transformations in the setting itslef. These inquiries spurred my curiosity and motivated my research pursuit. I also viewed my planned analysis as an opportunity to contribute to the field of ICT4D and Health IT in LMICs. For example, I observed that the main influential factors are rooted in the socio-political and technological historical developments within the implementation setting. Additionally, donor support and investment in capacity-building initiatives emerged as crucial pillars shaping the implementation process.

For the current project, a 20-year time span was selected for investigation. This period was temporally bracketed into three phases, categorised based on key events and processes associated with the introduction of the District Health Information Software (DHIS) in Mozambique. These phases were: Strengthening the HMIS (2000-2007), Restructuring the HMIS (2008-2014), and Establishing the New HMIS and Continuity (2015-ongoing).

I chose Mozambique as the research setting, also considering the advantage of living and working there, which has bred my familiarity with the language and culture. The focus was on the technological artefact, the DHIS software, initially introduced in the country in the early 2000s, subsequently discontinued, and later nationally reintroduced in its second version, DHIS2. For data collection, specific sites were selected in four provinces of Mozambique: Gaza, Inhambane, Niassa, and the national capital, Maputo City. Figure 6 illustrates the location of these sites on the map of Mozambique.

Figure 6. Location of the empirical sites. Source: Google Maps.

These sites were selected based on the early DHIS pilot implementations, the first of which was conducted in 2000 in Gaza, Inhambane, and Niassa, and the second in 2014 in Maputo City. This strategic decision was made to revisit the same locations where the phenomena under study originated. The aim was to engage participants who might have been involved in the initial processes and subsequent developments over the years. At the beginning of my project, I had the opportunity to visit two districts in Maputo Province, namely Moamba and Matola. This was crucial, as it allowed me to familiarise myself with the context (health sector) and to test the interview guide and survey I intended to use during subsequent fieldwork visits. The fieldwork included visits to health directorate offices, hospitals, and health units at both the provincial and district levels.

3.2.2 Research design: delineating strategies and methods

As I aimed to anchor the case study in the introduction of DHIS in Mozambique, my starting point was identifying those involved and reviewing existing publications on the subject. Early in 2018, while designing the project, I identified a few key participants involved in the projects that introduced DHIS in Mozambique (the seeds for the snowball process) and reviewed some published studies on the topic. This was instrumental in identifying sources of information, dividing the longitudinal historical study into different phases, and outlining the overall data collection and analysis processes.

I prepared the research protocol, which included the chronogram of activities and instruments to guide data collection using appropriate techniques. This protocol was submitted as part of my application for the doctoral program at UiO and to UEM, and after obtaining approval from both organisations, I requested approval from the local Bioethics Committee before initiating data collection. I submitted my protocol to the Institutional Committee on Bioethics in Health at the Faculty of Medicine/Central Hospital of Maputo and received their approval in April 2021. I also sought and obtained clearance from local health institutions, including the Ministry of Health (MoH) through the Directorate of Planning and Cooperation (DPC), and from Health Services at the Provincial level. Additionally, the protocol was assessed by the Norwegian Center for Research Data (NSD), from whom I received clearance. These documents are included in Appendix 2.

The historical reconstruction and analysis were conducted concurrently. The data collection process involved gathering primary data (obtained directly through interviews, surveys, archival and documentation consultations, and observations) and secondary data (previously produced and available in physical and online sources). The historical analysis approach adopted was a three-step process: preliminary analysis, thematic analysis, and theoretical analysis.

The initial data collection phase entailed consulting available documentation from various sources, including official websites, libraries, research databases, physical repositories, and online resources. The information collected during this phase underwent a preliminary analysis, which was crucial for reviewing the research conducted over the 20-year period. This review examined the HMIS implementation processes and the context of implementation, allowing me to gain an overview of available information sources and identify any gaps that required further exploration through participant inputs. Implementing temporal bracketing and the

snowballing strategies was essential to identify key actors involved in the initial processes and significant events and to familiarise myself with the overall research context.

The subsequent data collection process focused on primary data obtained through interactions with participants and the setting during fieldwork. Gathering secondary data was also crucial as it provided insights to support and assess the facts described. While interacting with participants, I concentrated on gathering information about their past experiences. To facilitate this, I engaged in conversations that helped participants mentally transport themselves to the past. At times, I provided references from the specific period under exploration, enabling them to recall and provide more detailed information. I actively encouraged them to share additional insights to support their descriptions and expand the evidence pool for my analysis.

To organise all the data collected within the overall project, I adopted a thematic analysis approach (Braun & Clarke, 2006). I engaged with the terminology described by these authors, as illustrated in Table 6, and followed the six steps proposed by this method. A thorough description of how I conducted this process is included in Section 3.4.

Table 6. Thematic analysis terminology and its use in the study.

Term	Definition	Application in the study
Data corpus	refers to "all data collected for a particular research project"	All data gathered during the preliminary analysis, fieldwork, and other data collected during the project. The content of this data was related to the setting (Mozambique), the health sector, and HMIS implementation processes in the setting and abroad.
Data set	refers to "all the data from the corpus that are being used for a particular analysis"	Correspond to my single interviews (notes and transcripts), surveys, notes from the observations in the field, reports, documents, theses, articles, websites, and photographs captured on the sites.
Data item	refer to "each individual piece of data collected, which together make up the data set or corpus"	Composed of Data Item extracts collated according to the three phases temporally bracketed covering the project timeline.

Source: Braun and Clarke (2006, p. 79).

The third step of the historical analysis was guided by an institutional lens, adopting the analytical framework described in Chapter 2. This framework integrated three sets of concepts: institutional contradictions, institutional entrepreneurship, and institutionalisation.

3.3 Data collection: methodology, techniques and process

In this section, I describe the methodology, the techniques and the processes included in my journey during the doctoral program. An overview of the process is synthesised in Figure 7.

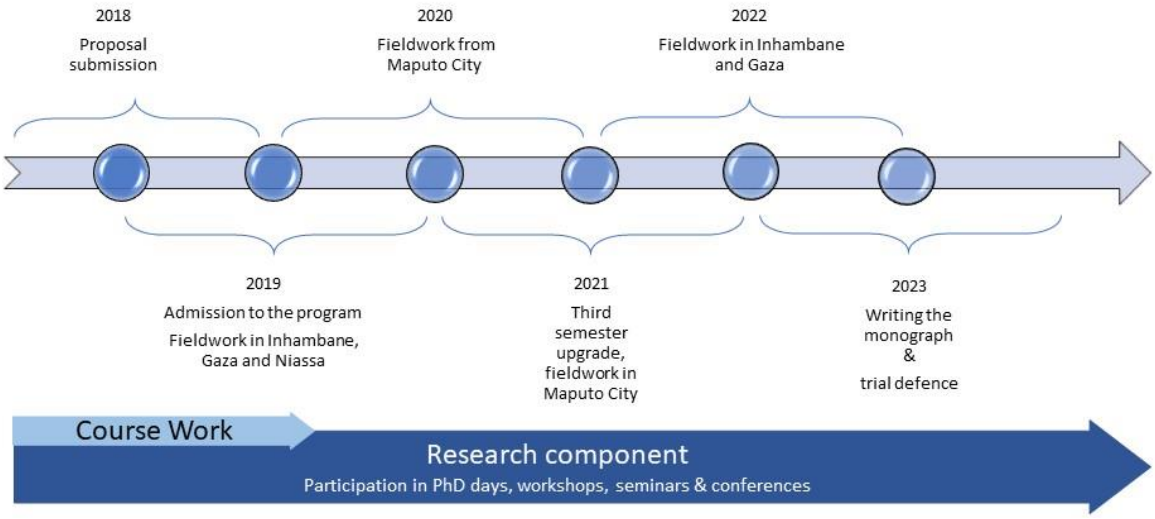


Figure 7. Overview of my PhD journey.

3.3.1 Gathering data with mixed techniques

I conducted the data collection process from 2018 to 2022. Initially, I consulted with researchers from Eduardo Mondlane University (UEM) who were involved in introducing the District Health Information Software (DHIS) in Mozambique in the early 2000s, which helped me develop an overview of the initial processes and the various entities involved. By employing different techniques and corresponding instruments, I collected crucial information on the implementation processes from diverse perspectives.

Archival Documentation

I identified and analysed relevant archival materials to gain insights into the political-institutional and digital contexts in which each phase unfolded. This step, part of the preliminary analysis, involved examining research studies on the HMIS, policy documents, statistical reports, and other relevant literature. This process was vital in establishing the context for my analysis and understanding the conditions during each period.

For instance, regarding the first phase, I developed an understanding of the historically existing post-conflict political context and its present-day implications. I explored how the civil war had devastated the health and ICT infrastructure nationwide, as well as the repercussions of the Portuguese exodus and its impact on the available capacity in the health sector. Such

information, categorised as secondary data, was incorporated into my three historical phases to provide contextualisation that formed the foundation for the processes described in each phase.

Interviews

I approached the identified researchers from UEM to conduct the initial interviews. Their deep knowledge of the process was invaluable, as they had been involved in designing and developing the projects that introduced DHIS in the setting as part of their enrolment in a Doctoral program at the University of Oslo (UiO). Starting with these initial participants, I utilised a snowballing technique to connect with other key individuals who played crucial roles in various stages of the HMIS evolution process.

The interviews were conducted from August 2020 to June 2022. I engaged with a diverse group of individuals, including local and international students involved in the DHIS pilot, project coordinators, researchers, consultants, executives, data officers at various levels of the health sector, internal and external support teams, and medical doctors who participated at specific points during the 20-year period. The COVID-19 pandemic and the geographic locations of the participants influenced the dynamics of these interactions. While some participants preferred virtual meetings only, others were located in different provinces of Mozambique or even abroad. Whenever feasible, I conducted interviews in person. However, when in-person meetings were not possible, electronic means such as Zoom, WhatsApp, Skype, Google Meet, and telephone (for instances without internet access) were used, depending on the participants' preferences and availability.

First Round of Interviews

The initial round of interviews began in 2020 with a group of former PhD students who were part of the project that introduced DHIS in Mozambique. Box 3 details my personal experiences during this phase of the interview process.

With the COVID-19 restrictions still in place, people were very cautious about avoiding several in-person contacts. I needed to reshape the overall design of the data collection. I opted to proceed in a hybrid mode as well. The invitations were emailed to the first group of interviewees, with the option to participate according to their preference – in person or virtually. Another option was to select the preferred virtual platform to establish the contact (Skype, Zoom, Google Meet, or another). Only one interviewee accepted an interview in

person, and the others opted to do it using a virtual tool (with some selecting Skype while others opted for Zoom). In all the interviews, the terms of consent were presented. Another important option was whether the interviewees accepted me recording the interview. Some accepted, but others were not comfortable and rejected this option.

Box 3. My experiences from interactions with the participants during the interview process.

Second round of interviews

I obtained recommendations for contacts to interview in subsequent rounds at the Ministry, Provincial, and District levels. It's important to note, however, that some of the referred individuals had left their positions, were no longer affiliated with the Ministry, or were based outside of Mozambique. Additionally, some had transitioned to other organisations within the sector. These interviews were conducted remotely from Maputo City via platforms like Skype and Zoom between August and October 2020.

In 2021, after receiving clearance from the Minister through the Directorate of Cooperation and Planning, I initiated another round of interviews. Directed to engage with the Department of Information for Health, I visited the site in person. There, I interacted with executive staff and officers who provided contacts of individuals involved in the process. Invitations were sent out, resulting in some positive responses. However, there were instances where I received no immediate or any response, despite multiple follow-up visits and email reminders. Nevertheless, I managed to conduct several interviews from Maputo City using platforms like Zoom, Google Meet, WhatsApp, and mobile phones between May and October 2021.

Due to delays associated with the COVID-19 outbreak, including visa renewal and international border restrictions, my travel to Oslo was only possible in October 2021. Once in Oslo, the data collection process was adjusted to include analysis of existing data and the preparation of narratives describing the first phase. Between October and November 2021, I conducted a few interviews from Oslo, including in-person meetings and using platforms such as Zoom, Google Meet, and WhatsApp.

In February 2022, after concluding my four-month stay in Oslo, I returned to Maputo City. Back in Maputo, I reached out to potential interviewees both in person and through virtual channels, including those outside the Maputo City province. Some previous interviewees were also recontacted for additional information. The goal was to conduct another round of data

collection to complete the data gathered for Phases 2 and 3. These interviews were carried out from Maputo City using the same digital platforms as before, as well as through in-person meetings, from February to May 2022.

In May 2022, I returned to Oslo for a two-month period to concentrate on advancing the writing component of the project. During my stay in Oslo, I conducted the final round of interviews between June and July. Some of these interviews were conducted in person with participants who were also in Oslo, while others were conducted via Zoom with participants in Mozambique.

Overall, I successfully interviewed a total of 41 participants through semi-structured individual and group interviews, and reached an additional 36 participants through surveys. The details of these interviews and surveys are summarised in Table 7.

Table 7. Data collection sources for the entire project (all three phases).

Research method and techniques	**Data sources**
Review of Secondary data	Research articles, PhD, and Master thesis
	Documentation from the MoH website and government archives
Field visit (4 sites)	4 Piloted sites: Gaza, Inhambane, Niassa, and Maputo City (Mozambican Provinces)
Observations (On-site observations)	1 Headquarters of the MoH (DPC)
	3 Provincial Directorate of Health
	1 Health facility at the Provincial level
	6 Health facilities at the district level (near and distant from district headquarters)
	1 Program Officers Meeting at the Province level
	1 Validation and 1 Statistical, Meetings at the District level
41 Interviews	6 Project Managers (from 3 universities and three organisations involved)
	7 PhD Students (UEM)
	5 International Master Students (UiO and UEM)
	3 Consultants (MoH)
	2 Executive staff (MoH)
	2 Data Officers (MoH)
	4 External HMIS support teams
	4 Executive staff at the Provincial level
	2 Data Officers at the Provincial level
	2 Data Officers at the District level
	2 Data Officers at the Hospital level
	2 Medical Doctors from the setting
2 Surveys (36 participants)	21 Data Officers from the Nucleus of Statistics at the Provincial, District and Hospital level
	15 Data Officers from the Nucleus of Statistics at the Provincial, District and Hospital level

Surveys

The two surveys were distributed electronically in 2019 and 2022 across the provinces visited, each targeting different participants. The questions from these surveys are included in Appendix 1. The aim was to reach districts that I was unable to visit and officers I couldn't meet during my stay. The first survey received responses from 21 officers across 16 districts, while the second garnered 15 responses from 12 districts. These surveys comprised questions designed to understand the profiles of individuals involved in the HMIS, their working conditions, and their level of involvement in the system. The insights from these surveys were instrumental in identifying officers involved in each phase of the ongoing implementation, and they were subsequently included in the interview plan for further engagement. This approach enabled me to gather insights directly from the officers, complementing the perspectives obtained from health workers at the micro-level.

Non-structured on-site observations

During my visits, I observed the implementation sites of the HMIS, participated in discussions and meetings, interacted with participants, and documented physical artefacts mentioned by some interviewees through photographs. Immersing myself in this environment allowed me to observe the current conditions of the facilities, the surrounding infrastructure, the working conditions, and ongoing activities.

These observations offered valuable insights, enabling me to draw connections with historical descriptions and understand the evolution over time. For instance, I noted that while HMIS-related activities are now digitally supported (e.g., graphs, presentations, WhatsApp groups), many tasks still rely on manual tools (such as maps, registry books, and reports). The on-site observations also helped me establish a personal connection with the staff and the locations where they were based.

3.3.2 Fieldwork: experiences gathered from the sites

The fieldwork visits were conducted in two stages. The initial stage occurred in 2019, when I visited the empirical sites accompanied by my principal supervisor. This period involved collaboration with a team of local researchers from the UEM, staff and students from UiO, officials from the MoH and provincial authorities. The second stage of fieldwork, in 2022, involved solo visits to the sites. These visits were delayed due to Covid-19 pandemic restrictions. The fieldwork covered four provinces: Gaza, Inhambane, Niassa, and Maputo

City, where the MoH headquarters is situated. Additionally, I made a preparatory visit to Moamba and Matola districts in Maputo Province, but did not collect data there as they were not part of the selected research sites, but served instead as pilot sites.

During the 2019 fieldwork, I visited the following provinces and districts: Inhambane Province (Inhambane, Jangamo, Cumbana, Maxixe districts), Gaza Province (Xai-Xai, Chibuto, Bilene districts), and Niassa Province (Cuamba, Caronga, Metarica, Lichinga districts). This visit spanned from May 20th to May 29th. My principal supervisor was present for the visits to Gaza and Niassa, and my third supervisor joined us in Gaza. Additionally, I made several visits to the MoH in Maputo City. I share examples of my personal experiences from 2020 in Box 4.

A second period for the fieldwork was planned to start in the first semester of 2020. The outbreak of Covid-19 disturbed this plan. The government declared a state of emergency, and all activities were interrupted. We were confined and needed to stay at home and work from there. First, I was caught in the middle of the emergency to shift the in-person lecturing to a virtual mode. My role as the head of the department of technologies, communication and libraries at the Faculty of Sciences at Eduardo Mondlane University was essential during this process. I integrated a team led by the Informatics Center from the university to develop a platform based on Moodle (vula.uem.mz), create the structure, and incorporate the courses, lectures, and students. Furthermore, this team was called to provide support and training. During this process, I was designated as a focal point for prevention and action, representing the faculty. I also needed to coordinate a local team to implement the measures defined by the health sector, promote training to several teams and produce informative and support the preparation of academic reports regularly. When the government released some of the restrictions, only after a few months, the university also decided to reopen its activities. At the time, we were working in a hybrid mode. Although I was still providing the needed support, it was only during this period that I could refocus my attention on the PhD program.

Box 4. Some of my personal experiences during COVID-19 in 2020.

In 2021, my fieldwork primarily centred on Maputo City, with plans for visiting other provinces materialising in 2022. However, obtaining clearance from the Ministry for provincial travel was delayed. Despite this, I successfully conducted a second round of fieldwork visits to Inhambane Province (Inhambane and Maxixe Districts) and Gaza Province (Xai-Xai and Chokwe Districts) from May 2nd to May 6th. This visit aimed to include two districts —

Maxixe in Inhambane and Chokwe in Gaza — that I had missed during my 2019 fieldwork. These districts were of particular significance as they were part of the pilot implementation of the District Health Information System (DHIS) in 2000.

The fieldwork visits were instrumental in gaining an in-depth understanding of the sites, facilitating interactions with interviewees, and clarifying the objectives of my project. I carried out in-person interviews and arranged meetings with those who were unavailable on-site during my visit. Figure 8 in the document captures two moments from these fieldwork visits, showcasing my introduction to some of the participants.

(a)  (b) 

Figure 8. (a) Photo taken in Inhambane with one of the participants, who was involved in the DHIS pilot in 2000. (b) Photo taken with two participants, involved with the HMIS, in Xai-Xai, at the Gaza Provincial Directorate of Health.

While conducting historical reconstruction, my primary focus was on collecting information regarding the ‘what’, ‘who’, and ‘when’ aspects. The questions directed at participants were designed to elicit details about the events during the pilot implementation of the District Health Information System (DHIS) and other systems within the HMIS. I encouraged them to recount their experiences, including references to the people and entities involved, and to establish a timeline of events. This approach was crucial for filling information gaps, cross-verifying data, and enhancing my understanding of the complexities involved in these processes. While I also endeavoured to uncover the ‘how’ and ‘why’ behind these developments, responses in these areas were notably fewer. This could be attributed to the participants' perception of the study's topic as being controversial and sensitive. Alternatively, it might indicate that the respondents lacked the necessary information to provide comprehensive answers.

3.3.3 Interacting and sharing preliminary results with the academic community

During the research process, I engaged in valuable discussions and idea exchanges with fellow PhD candidates, faculty members, and other members of the academic community, especially from UiO and UEM. I also had the privilege of participating in two informal discussions with a historian from the Mozambican Historic Archive Directorate. My involvement extended to scientific writing, and I actively participated in four conferences, presenting preliminary results as outlined in Table 8.

Table 8. Preliminary results were discussed with the community, participation in conferences, and feedback received from journals.

Community: feedback from From guest researchers, faculties, supervisors, colleagues
35th, 39th– 44th PhD days, workshops, seminars
Conferences: feedback from reviewers, editors, co-authors, participants
2019 – IFIP WG 9.4 Conference in Dar es Salam, Tanzania (spring), PhD Days at Faculty of Mathematics and Natural Sciences (autumn), Nokobit Conference 2019, rejected (autumn)
2020 – IFIP WG 9.4 European Conference in Salford, UK, virtual (spring), DHIS2 Annual Conference, virtual (spring), Joint Conference of IFIP WG in Hyderabad, India, virtual (autumn)
2021 – IFIP 9.4 Virtual Conference (spring), European Conference on Information Systems, Timisoara, Romania, rejected (autumn)
2022 – IFIP 9.4 Lima, Peru, virtual (spring)
2023 – ICIS 2023, Hyderabad, India, paper was rejected (spring)
Journals: feedback from reviewers, editors, co-authors
2023 – ITD Journal, EJISDC Journal

Additionally, I successfully submitted two journal papers. The first was published in July 2023, while the second is currently undergoing the review process. In May 2023, I submitted a research-in-progress paper to a conference. Although it was not accepted, the feedback I received was instrumental for further improvements. These academic interactions were invaluable, offering opportunities to discuss preliminary findings, gain insights, and enhance my analysis and results, which are summarised in Table 9.

Table 9. Some publications submitted for conferences and journals.

Learnings from the context
Paper 1: Tracing over time the Institutional dynamics around the implementation of DHIS2 for HMIS strengthening in Mozambique (Collinson, N., 2019) as Poster and (Collinson, N., Sahay, S., 2020) as RIP paper
Paper 2: Introducing Digital Health in Post Conflict Mozambique: A Historical Perspective (Collinson, N., Sahay, S., 2022)
Paper 3: Introducing Digital Health Information Systems in Post-Conflict Mozambique: A Historical Perspective (Collinson, N., Sahay, S., 2023)
Paper 4: Institutional Dynamics Shaping Historical Digital Health Implementation Processes (Collinson, N., Sahay, S., rejected)

Learnings from DHIS2 Community
Paper 5: Different Approaches to Complementing Software Platforms: A Case Study of Digital Innovation across 10 Developing Countries (Collinson, N., Mahundi, M., Nielsen, P., 2020)
Paper 6: The roles of complementors in digital health platforms (Mahundi, M., Collinson, N., Nielsen, P., under review)
Learnings from the field
Paper 7: Reflections, learnings and proposed interventions on data validation and data use for action in health: A case of Mozambique (Collinson, N., Saugene, Z., Braa, J., Sahay, S., Mosse, E., 2021)

Furthermore, I actively engaged in the PhD days sessions at UiO, which provided a platform for discussing progress, challenges, and ongoing work with peers and faculty members. These sessions, organised by the Information Systems research group at the UiO, enabled me to present two of my historical narratives to faculty members who had participated in the implementation process. The feedback I received was both highly encouraging and constructive. Additionally, I shared these narratives with three other researchers directly involved in the implementation process across its three phases. Their positive and insightful feedback further enriched my research.

3.4 Historical reconstruction and data analysis in practice: the three-step process

The historical reconstruction and data analysis were carried out simultaneously, following a three-step analytical process. The first step involved initial data collection and a preliminary analysis, which were vital in defining the research context in terms of time and space. The second step consisted of a more comprehensive data collection and a thematic analysis, crucial for crafting the historical narrative. The final step entailed a theoretical historical analysis using concepts from institutional theory. In this section, I detail how these steps were executed to develop their outcomes and describe how each step informs the next. It is important to note that, while the historical reconstruction and analysis process are outlined linearly, they involved multiple instances of reflexivity, unfolding in a recursive pattern throughout the study.

Step 1 – Preliminary analysis supporting temporal bracketing

The process began with a preliminary analysis, searching for studies and documentation detailing the Mozambican HMIS, related policies, processes, and strategic documents in the sector, spanning from 1975 to the present. This search identified key actors, entities, events, and documents, providing insights into the interventions within the setting and the HMIS. This phase was instrumental in strengthening the research design and guiding further data collection. It facilitated the selection and implementation of the temporal bracketing method, defined

participant profiles, and prepared fieldwork instruments. The data from this preliminary analysis informed the subsequent data collection round.

During this stage, various techniques suited for a historical study were chosen, including interviews, surveys, archival data studies, and observations, planned as in-person activities following a predetermined schedule outlined in the research protocol. The outcomes of this stage included the definition of three interconnected analytical phases (temporally bracketed), a map of potential participants, and relevant information sources. This groundwork laid the foundation for the ensuing data collection and historical reconstruction processes in the next analytical step.

Step 2 – Thematic analysis enabling historical reconstruction

The extensive data collection and fieldwork yielded a significant amount of data. Thematic analysis (TA) was crucial to organise, interpret, and prepare a rich and detailed description of all the information gathered. I employed TA as outlined by Braun & Clarke (2006), following their six-step procedure, which I refer to as ‘stages’ to avoid confusion with the analytical steps of the study.

In TA Stage 1, I organised the collected data into a data corpus, as per TA terminology detailed on page 8. The data, gathered in both English and Portuguese, was based on an interview guide included in the Appendices. It was transcribed, compiled, and translated from Portuguese to English where necessary. This data corpus encompassed all compiled information from the preliminary analysis, fieldwork, and additional data collected throughout the project. The content related to Mozambique's setting, the health sector, and HMIS implementation processes. The data items in this collection included individual interviews (notes and transcripts), surveys, field observation notes, reports, documents, theses, articles, websites, and photographs from the sites. I organised these data items and familiarised myself with their content. For example, the Ministry of Health's website provided policy information and documentation; the UiO's site offered access to dissertations and theses related to DHIS; and photographs from the field sites gave insights related to the various manuals and devices used in the process.

During TA Stage 2, I screened the data corpus to identify pertinent codes, aiding in the organisation of each data item into corresponding time periods. These periods included pre-2000, the three phases from 2000-2020, and post-2020. I meticulously reviewed the transcripts

to manually identify initial codes, such as ‘DHIS pilot’, ‘capacity building and training’, ‘digital health initiatives and systems implemented’, ‘DHIS adoption and institutionalisation’, and ‘participants or stakeholders’.

In TA Stage 3, I created data sets corresponding to each of the three phases within the project timeline, as well as the periods before and after. I organised five data sets, collating extracts from each data item relevant to these five distinct periods:

- Data set 1 included information from before DHIS was introduced in Mozambique, before 2000.
- Data set 2 – Period (Phase 1, 2000 – 2007) - Information related to DHIS pilot implementation from 2000 to 2007.
- Data set 3 - Information related to DHIS2 reintroduction from 2008 to 2014.
- Data set 4 - Information related to DHIS2 adoption and institutionalisation from 2015 to 2020.
- Data set 5 - Information related to DHIS2 implementation and further HMIS developments after 2020.

For each data set, I established initial themes to structure the information, taking into account the chronological order of events and the similarity of topics described. These themes were then discussed with my main supervisor to deepen my understanding of their significance and the meanings they conveyed. TA Stage 4 involved revising these initial themes to ensure they accurately reflected the information compiled for each data set.

TA Stage 5 focused on drafting initial narrative descriptions. This stage entailed defining the final themes and subthemes and selecting supporting data items and coded extracts. I also began constructing the overall historical narrative, integrating some of the insights gleaned from data sets 1 and 5. This approach enabled me to depict the evolution of the research setting over time, taking into account various themes:

- Country socio-political context: location, territory, borders, geography, and climate; population, languages, culture, and religion; economics, industry, and living standards; political landscape.

- The health sector socio-political and technological context in three periods: historical background of Mozambique post-conflict; the rise of the new country (1975-1992); restoring hope with peace (1992-2023).

Data Set 2 focused on describing the processes within Phase 1, which corresponded to the period (2000 – 2007) when the country first introduced the District Health Information System (DHIS) to strengthen its HMIS. Data Set 3 covered Phase 2 (2008 – 2014), a period marked by the country's reassessment and initiation of HMIS restructuring. Data Set 4 detailed the processes within Phase 3 (2015 – 2020), when the HMIS underwent effective restructuring.

In TA Stage 6, I developed the historical narrative, integrating key themes from each project phase. This allowed me to identify a primary concept, informed by my institutional perspective. While describing these processes, I focused on the selected themes, delved into specific moments of the implementation, and included participant quotes to bring their perspectives into the narrative. Additionally, I considered both macro and micro contextual elements, particularly highlighting their interconnections. For example, in Phase 2, I explored how the ministry's decision against adopting a specific platform contrasted with its adoption by other health program partners in the setting. This discrepancy led to an increased workload at the lower levels, where health workers supported both the Ministry and health program partners.

Throughout this process, I adhered to the rigour expected in historical studies. Historians, when crafting narratives, often prioritise different aspects than other scholars studying the same subject. Their primary concern is with the production of historical knowledge and the process's rigour, as opposed to merely focusing on narrative representations and analyses (Doran, 2013) (Doran, 2013, p.4). Another key factor is the content of the narrative. Doran (2013, p. 12) highlighting the permeability of a historian's interpretations in creating historical narratives and the concepts of historical truth, knowledge, or reality. Historians may sometimes present interpretations that defy empirical validation or portray events in morally contentious terms, yet remain within the accepted norms and protocols of historical research (ibid). In writing my historical narrative, I relied on cross-checking information from various sources to align my interpretation as closely as possible with the actual sequence of events.

The thematic analysis played a pivotal role in the historical reconstruction process. It was instrumental in crafting the historical narrative and pinpointing key concepts that underpinned the analytical framework used in the theoretical historical analysis. For each of the three phases,

I scrutinised the descriptions to identify themes that most accurately represented the respective phase.

This approach was integral to discerning the theoretical concepts and constructing the theoretical analytical framework employed in the third analytical step. Each of the identified key themes mirrored certain dynamics that influenced the HMIS implementation process during the corresponding period. These themes were subsequently renamed to align with the selected concepts from institutional theory:

- *Institutional contradictions* shaping the implementation processes: considering the concept of institutional contradiction.
- *Institutional entrepreneurs* challenging their institutional context: considering the concept of institutional entrepreneurship.
- Strategic actions towards *institutionalisation*: considering the concept of institutionalisation.

The historical narrative, a key outcome of the historical reconstruction process, was vital for facilitating the historical analysis. It aided in identifying key concepts that formed the foundation of the theoretical analytical framework guiding the subsequent stage. Figure 9 below resumes the overall process followed to interpret the three concepts from the themes of

the historical narrative, namely institutional contradictions, institutional entrepreneurship, and institutionalisation.

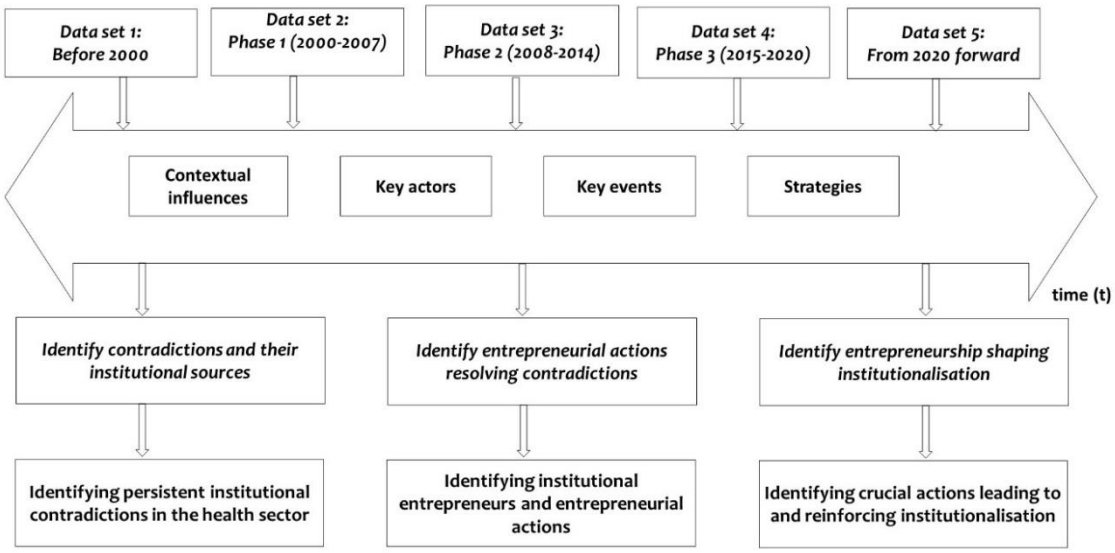


Figure 9. Analysis process in step 2 resumed and identification of the institutional concepts supporting step 3.

Step 3 – Theoretical historical analysis

In the third step, I applied institutional lenses to analyse the case. Developing an analytical framework informed by institutional theory, I focused on three key concepts: institutional contradictions, institutional entrepreneurship, and institutionalisation. I delved into the historical narrative to understand how and why the implementation processes evolved in specific ways, drawing on Langley (1999). This analysis offered insights into both visible and latent elements of the evolving processes.

The concept of institutional contradictions was instrumental in identifying challenges and opportunities for change. For instance, a contradiction observed in two phases involved 'discrepancy between governance demands and the constraints of financial resources and infrastructure'. During Phase 1, this contradiction posed a challenge to the DHIS implementation, whereas in Phase 2, it was seen as an opportunity to guide developments towards the adoption of DHIS2. Institutional entrepreneurship allowed me to track the emergence and evolution of change agents across different phases. A notable institutional entrepreneur participated in all three phases, assuming various roles: initially a medical doctor and researcher at Eduardo Mondlane University (UEM), then a PhD candidate at the University

of Oslo (UiO) involved in the DHIS pilot in Mozambique, and later a decision-making manager in the Ministry of Health during Phases 2 and 3. His unique position, bridging the inside of the Ministry of Health and the outside through his affiliation with UEM, brought novel legitimacy and resources crucial for initiating and institutionalising change.

Institutionalisation aided in examining the patterns of actions related to the unfolding institutional processes, particularly in the adoption and institutionalisation of the technological artefact supporting the HMIS. A dominant pattern identified throughout the three phases was the development of capacity-building through education. This involved a blend of conventional formats (formal courses at universities, schools, or institutes) and innovative approaches like regional training and in-service training. These multifaceted modes of education and training complemented each other, playing a significant role in the institutionalisation process.

Phase 1 themes underscored the complexities encountered during the HMIS implementations. I took into account various exogenous factors—historical, political, economic, social, technological, environmental, and legal developments—shaping the health sector (Avgerou, 2000; Farjoun et al., 2018). These factors often resulted in institutional contradictions that remained over time. A notable contradiction from this phase concerned the 'Readiness of the setting'—including human, technical, infrastructural, regulatory, and financial aspects—versus the Ministry of Health's (MoH) pressing need to implement a consistent digital HMIS. Originating in the early nineties with initial digital health solution efforts, this contradiction persisted throughout the review period, spawning various opportunities, actions, and outcomes. It catalysed the introduction of the District Health Information System (DHIS) and the development of capacity-building programs to support its pilot implementation. Figure 10 provide data from the data sets and outcomes from this analytical process related to Phase 1.

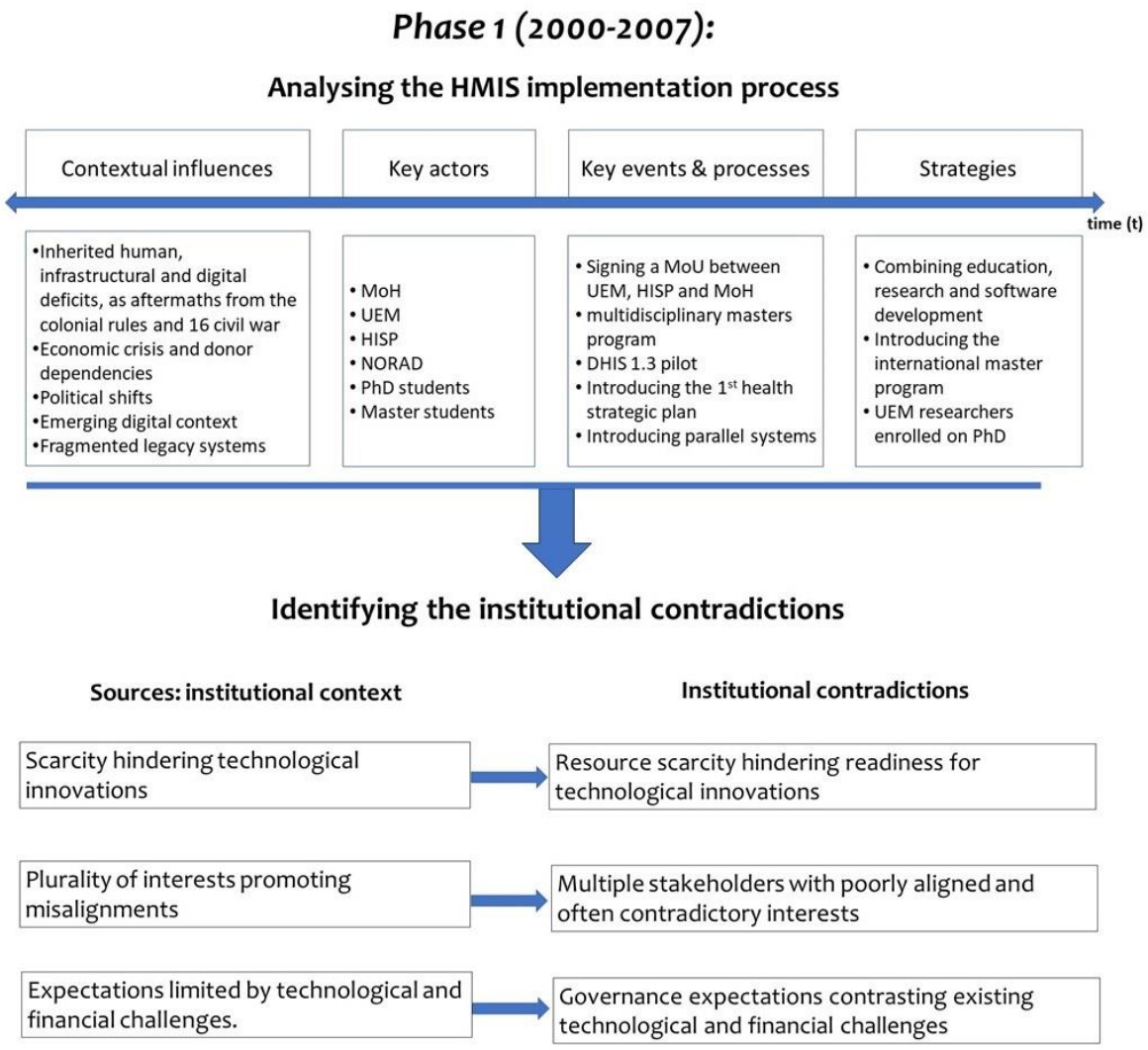
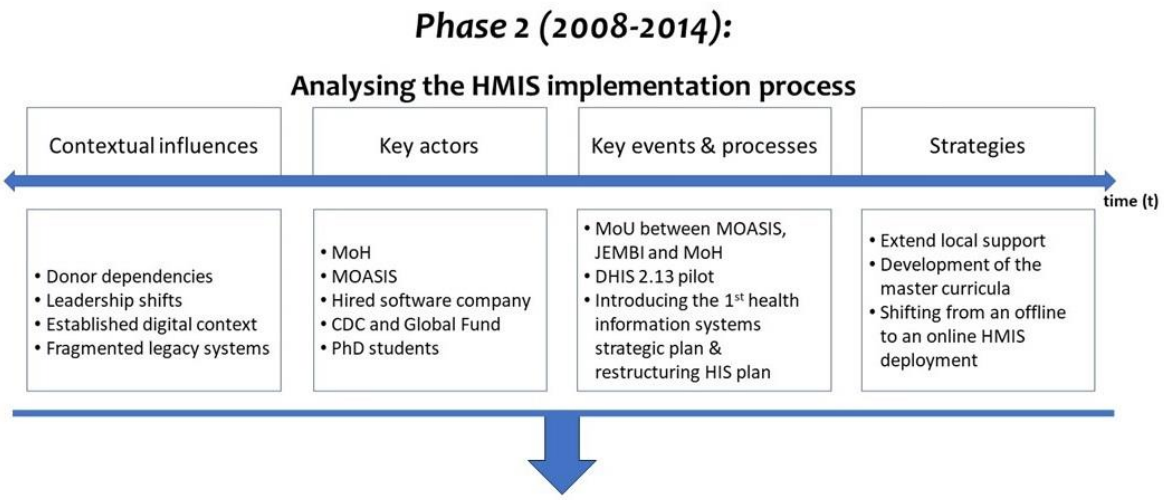


Figure 10. Analysis of the HMIS implementation process during Phase 1.

In Phase 2, I observed that the dynamics were substantially influenced by the actors involved in HMIS implementation, drawing focus to themes of institutional entrepreneurship. By considering the institutional entrepreneurs and their actions, I recognised several individuals who played pivotal roles in the HMIS implementation over the two decades analysed. Scrutinising their roles revealed key entrepreneurial actions, such as those facilitated by the synergies of 'research, education, and practice.' For example, an institutional entrepreneur identified in Phase 2 was a local UEM researcher, previously involved in Phase 1, who was appointed to a significant role by the MoH. His involvement was essential in orchestrating collective efforts and navigating institutional contradictions during ongoing developments (Engberg-Pedersen, 1997; Seo & Creed, 2002). Figure 11 provide data from the data sets and outcomes from the analytical process related to Phase 2.



Analysing the becoming of institutional entrepreneurs and identifying entrepreneurial actions

Process	Institutional entrepreneurs	Entrepreneurial Actions	Examples
Phase 1	• Internal consultant	• Integrating research, education, and practice, as combined efforts introduced by HISP Norway+ HISP Mz	• Introducing a master course which combines education, research and software development • Introducing in-service courses at province and district levels
Phase 2	• Deputy Director (former PhD student)	• Tailored technological innovations for extended support, as combined efforts from Former PhD students with MOASIS and Saudigitus	• Reinforcing relations between UEM and MoH • Introducing new master courses
Phase 3	• Deputy Director (former PhD student)	• Diversifying to strengthen capacity • Building networks of support, resources and legitimacy • Embracing platform coexistence while bridging interests • Tailored technological innovations for extended support	• Reinforcing capacity building • Extending Networks of support (DIS, MOASIS & Saudigitus) • Connecting internal and external systems (Health & Justice) • Developing local applications for DHIS2

Figure 11. Analysis of the HMIS implementation process during Phase 2.

For Phase 3, my research pivoted to the processes of institutionalisation, aiming to discern the conditions under which institutional dynamics could lead to successful HMIS implementations. Although some institutional contradictions identified in earlier phases persisted, their relevance evolved over time, with the country's investments increasingly mitigating the impact of limited resources. For example, while DHIS was not adopted in Phase 1, it was embraced and institutionalised in Phase 3 with its second iteration. One reason for this could be tied to the institutional context within which the artefact was implemented. I examined the digital context, which in Phase 1 was nascent and by Phase 3 had relatively stabilised (Fligstein, 1997; Greenwood & Suddaby, 2006; Maguire et al., 2004). Another contributing factor could be the technological artefact itself, which underwent transformative changes, thereby creating new possibilities within the environment. Figure 12 provide data from the data sets and the outcomes from this analytical process related to Phase 3.

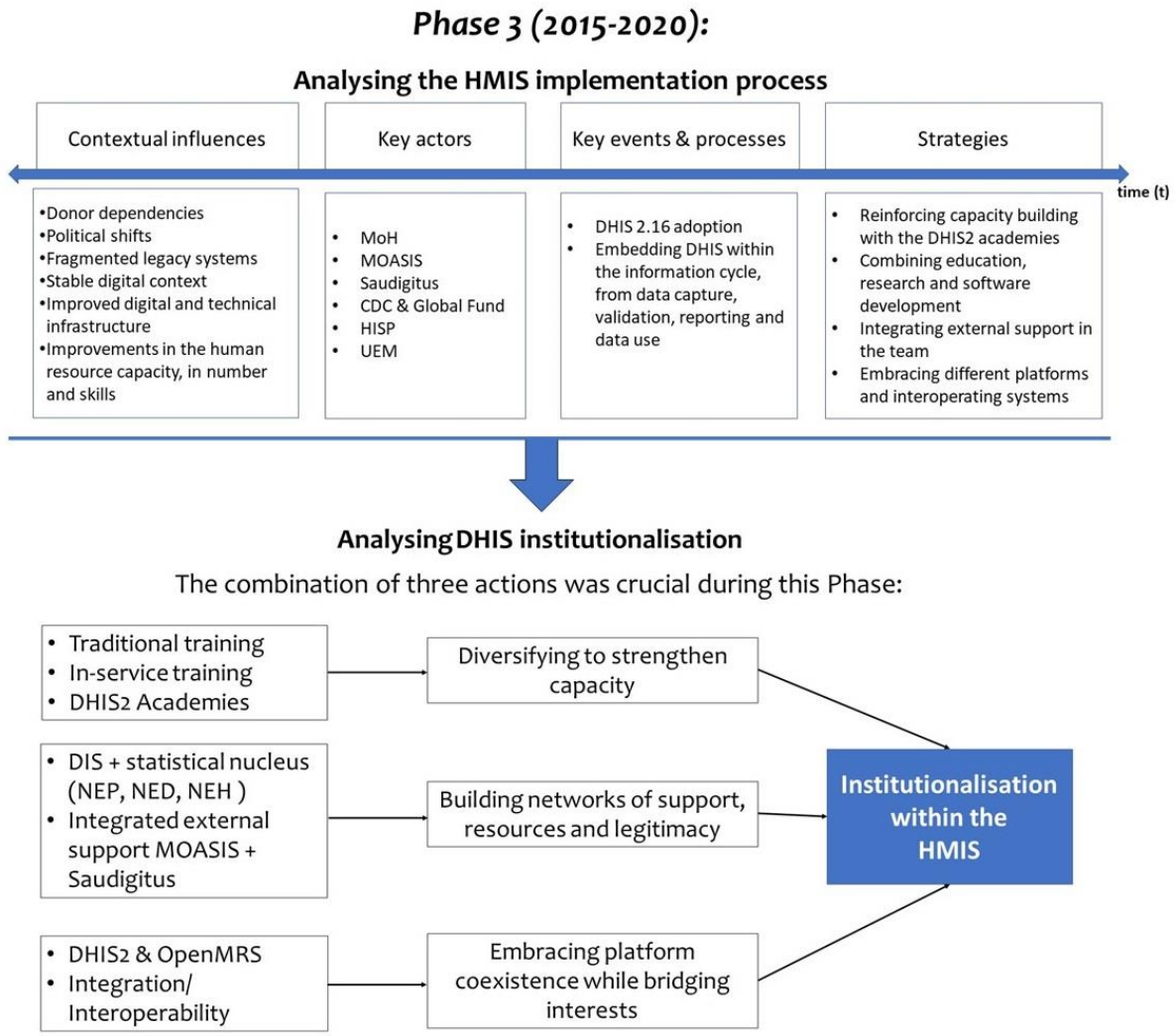


Figure 12. Analysis of the HMIS implementation process during Phase 3.

The analytical framework, adapted from Seo and Creed (2002), facilitated an examination of the interplay among three key concepts: institutional contradictions, institutional entrepreneurship, and institutionalisation, and how their dynamics influenced the HMIS implementation processes. The extended analytical framework intertwines the three key concepts with the institutional context where they emerge, evolve and ultimately exert their influences. It not only allows for a deep analysis of the developments of these concepts as historical processes but also illuminates how they are influenced by internal and external institutional dynamics, thereby shaping the trajectory of HMIS implementation.

First, it considers the constraints and opportunities characterising the post-conflict context over the years and the sites where the HMIS implementation unfolded; it also acknowledges the existing internal factors within the health sector influencing this process. The institutional dynamics, a crucial component of the institutional context, are perceived as potential sources

of institutional contradictions. For instance, during phase 1, the setting was recovering from an economic crisis and implementing reforms across sectors, including the health sector. In turn, the shortages in technical infrastructure and skilled human resources in technological domains were evident within the health sector. Despite the opportunities created with the introduction of DHIS to replace existing legacy systems and strengthen the HMIS, this process was significantly affected by the institutional dynamics in place.

Secondly, my analytical framework explores how institutional contradictions emerge, evolve, and are mediated over time leading to institutional changes or resistance to it. For example, in addressing the persistence of 'Multiple stakeholders with poorly aligned and often contradictory interests' as an institutional contradiction, I was able to consider the potential for change. This exploration included the emergence, evolution, and interventions of an institutional entrepreneur who held various roles throughout the process. The strategic actions undertaken by this entrepreneur were pivotal in rallying the disparate stakeholders toward a unified objective—the adoption and institutionalisation of the HMIS in the environment (Bruton et al., 2010; Garud et al., 2007; Lawrence, 1999).

Thirdly, the framework serves as a platform to explore the emergence of institutional entrepreneurs and the development of entrepreneurial actions fostered by the level of development of the institutional context. This framework provides a stage to analyse how some participants stand out to become potential agents of change in the presence of institutional contradictions. For instance, in phases 2 and 3, a former PhD student who participated in the DHIS pilot (phase 1) assumed a significant role in reintroducing and adopting DHIS2. The historical perspective supporting the framework enables the analysis and understanding of how this participant engaged with collective actions to transform their status quo. This study underscores the potential for human agency to drive change in complex institutional contexts. Moreover, it acknowledges the role of technology in mediating institutional contradictions. For example, this is the case when DHIS2 is reintroduced in the setting with the potential to respond simultaneously and provide data access for different stakeholders with different interests and needs. While managers at the MoH could obtain a broader overview ideal for strategic planning, managers at the District level become entitled to plan and intervene more closely in the health facilities.

Fourthly, my analytical framework ties institutional entrepreneurship roles with the institutionalisation process. This is possible since human and technological interventions are

considered relevant and strategic in reinforcing adoption, institutionalising (maintaining/strengthening), reinstitutionalising (transforming), or deinstitutionalising (disrupting) institutions. Considering these linkages and the historical perspective, my analytical framework enabled me to delineate probable explanations for the questions regarding 'why' the HMIS unfolded in various formats along the study period and its implications to the recipient setting.

The insights gained from this analytical phase contributed to a deeper understanding and offered alternative explanations for the patterns of institutional change (Bruton et al., 2010; Koning, 2016). A crucial inquiry of this study was why the DHIS was not implemented during Phases 1 and 2, yet was successfully launched in the same environment years later, despite the presence of similar institutional contradictions. One plausible explanation is the variation in institutional contexts across the phases, shaped by external influences, which gradually became more receptive to the new system. Alternatively, the DHIS itself had functionally evolved due to internal transformations, enhancing its capabilities and creating more conducive conditions for its adoption within the setting.

3.5 Ethical considerations

3.5.1 Ethical aspects related to the research field

Ethical considerations in Information Systems research align closely with those in the Social Sciences, especially concerning potential impacts on research participants (Mingers & Walsham, 2010). In the context of Information and Communication Technology for Development, I adhered to the 'Ethical standards for the ICTD/ICT4D community' as recommended by Dearden and Kleine (2018, p. 2).

Literature offers various models to apply ethical principles across different research contexts. In this study, I embraced four widely recognised ethical principles in Information Systems research, as outlined by Mingers and Walsham (2010): non-maleficence (avoidance of harm), beneficence (provision of benefits), autonomy (respect for individual autonomy through informed consent, confidentiality, and avoidance of deception), and justice (ensuring fairness, especially towards minorities). The research aimed to impartially understand a phenomenon and contribute knowledge, aligning with the principles of non-maleficence and beneficence. Autonomy and justice were integral to the consent process, which detailed participant anonymity, confidentiality, freedom, rights, protections, and data use.

Participants were provided with a consent form to sign, ensuring they were informed about the terms of their participation and consented to the publication of their contributions. Both physical and digital materials—articles, reports, regulations, photographs, and news items—were sourced from various providers, with usage rights obtained as required. Participant confidentiality was prioritised, with names and visited facilities remaining anonymous. With participant consent, recordings were used to facilitate note-taking during open-ended responses, which were often lengthy and detailed, enhancing the comfort level during the sessions.

My foremost goal was to make a meaningful contribution to the implementations underway in the study's setting. Equally important was the emphasis on reciprocity to the organisations and individuals participating in the study. To honour these ethical commitments, I initiated dialogues with some participants from the Ministry of Health, provincial entities, and the academic community, involving them in the research and publication efforts. A key objective of this collaboration is to devise strategies, guidelines, and frameworks that resonate with their goals, integrate established best practices, and reflect insights from academic experts. I intend to craft policy briefs encapsulating my recommendations.

Throughout the research journey, I regularly engaged with my supervisors in substantive dialogues about the ongoing study. These interactions took place face-to-face when feasible, with virtual meetings bridging the gap during times of geographical separation or mandatory isolation prompted by the COVID-19 pandemic. Collaboratively writing papers with my supervisors was a significant aspect of the process, enhancing my research competencies.

My research substantially contributes to the characterisation of the technological artefact as being central to my study. Crafting a historical narrative that chronicles a segment of this artefact's history stands as a testament to this effort. This narrative, I believe, is an invaluable addition to the broader understanding and identity of the technological artefact.

3.5.2 Constraints and limitations around the research process

Constraints related to reaching and interacting with the participants

Throughout my research, I endeavoured to connect with individuals directly involved with the phenomena being studied. Utilising the snowball sampling technique, I built upon references from initial contacts to compile a list of potential participants. These individuals, previously

unfamiliar with me, required a respectful and concise introduction to myself and the context of my project. Given their varied geographic locations, email served as the primary mode of communication. After securing most of their email addresses, I compiled a content package (including the documents from Appendixes 1, 2 and 3) and dispatched the invitations. Those without accessible contact information were, regrettably, omitted from the list. The response rate from participants was appropriate; however, not all were able to contribute. Some did not reply, one declined participation, and others, despite accepting, were unavailable for interviews. While disappointing, these instances did not severely impact the research, as I received referrals to other similarly qualified participants from those unable to engage. Attempts to contact three entities – NGOs and private organisations using DHIS2 in Mozambique – remained unanswered. To address this, I turned to secondary data, demonstrating DHIS2's utilisation by comparable organisations in the health sector. An outline of this recruitment process is presented in Table 10. A notable limitation was my inability to establish communication with any donor organisations involved in the processes, precluding me from incorporating their valuable perspectives into the historical narrative.

Table 10. Overview of the process to reach the participants.

References & Potential Participants	Invitation not sent (without contact)	Invitations sent	Accepted & participated	Accepted & and could not participate	Rejected	No response
Individuals	8	67	41	13	1	12
Entities	-	4	1	-	-	3

One non-critical challenge I faced pertained to language. The majority of participants spoke Portuguese, my native language, which facilitated seamless communication and data collection. However, translating the interview content from Portuguese to English was necessary to streamline the analysis process. I recognise that some nuances may have been lost in translation.

Constraints related to the sources of information

The study also faced constraints concerning information sources. Despite the official online presence and physical archives of the organisations involved, accessing certain documents, such as formal directives in working letters, proved challenging. Some information was either inaccessible, lost, or could not be located. The shift toward digital data management systems affected the preservation of physical documentation. In instances where information existed solely in digital form without physical backups, there is a risk of data loss, particularly if robust

backup measures are absent or if key individuals leave the organisation. Where information could not be retrieved in any form, archival departments suggested oral histories as an alternative evidence source, recorded according to specific guidelines. Nevertheless, valuable insights may have been missed if they remained unrecorded, as observed in Phase 1. While the study was not fully compromised—thanks to alternative sources—adding these lost pieces would have enriched the historical narrative and benefited organisational records.

Additionally, I appreciate the significance of paper archives alongside digital repositories. Where written records were lacking, oral accounts from those involved were deemed vital and relevant for the research. In Mozambique, archival materials include an array of documents, images, and audio recordings, with the oral tradition playing a crucial role in historical transmission.

In compiling varied information from diverse sources, I leveraged on my training as a qualitative researcher. This involved interpreting and making sense of the data, allowing me to construct arguments grounded in my own analytical perspective.

3.6 Conclusion

In this chapter, I have outlined the perspectives that guide the exploration of the phenomena under study, which are rooted in the historically evolving processes. This involves recognising the HMIS as an ever-evolving process within which the implementation unfolds over time. The research design details the methodological choices made from the project's inception through its subsequent stages. I have employed a qualitative, interpretive approach for this longitudinal retrospective historical study. The methodology incorporates two fundamental, concurrent tasks: firstly, reconstructing the history of the District Health Information System (DHIS) implementation, and secondly, conducting a multi-level historical analysis. History serves as the primary method, underpinning the mixed techniques utilised in data collection and analysis, which include archival research, documentation analysis, interviews, surveys, and non-structured observations.

Ethical considerations were addressed from the outset, with approvals sought and obtained from the local Bioethics Committee, the Ministry of Health, provincial authorities, and the Norwegian Center for Research Data, following a thorough evaluation.

The subsequent chapters present the results of this comprehensive process. Chapter 4 sets the stage by introducing the Implementation Context, the backdrop against which the implementation processes occurred. Chapters 5 through 7 delve into the three phases that mark the HMIS implementation in the studied environment. Each of these four chapters includes a succinct analysis, applying institutional theory perspectives and drawing on themes illuminated by the historical narrative.

Chapter 4 : Introducing the research setting

4.1 Location, territory, borders, geography, and climate

Mozambique is situated on the southeast coast of Africa. Its extremities are defined by the coordinates: North latitude at 10° 27´ 12´´ S and South latitude at 26° 52´ 45´´ S, along with East longitude at 41° 52´ 57´´ E and West longitude at 30º 12´ 14´´ E (INE, 2022). The nation is bordered by Tanzania to the north; Malawi, Zambia, and Zimbabwe to the west; South Africa and Eswatini to the southwest; and the Indian Ocean to the east. Off its eastern coast, across the Mozambique Channel, lie Madagascar and Comoros (INAGE, 2015). Mozambique occupies a total land area of 799,380 km², with its borders extending 9,150 km, of which 4,838 km are inland and 4,312 km run along the coastline (INE, 2022). The country's landmass, including interior waters, encompasses 786,380 km² and 13,000 km², respectively. Within this expanse, 112,296 km² are dedicated to conservation areas, encompassing parks, reserves, and other protected zones (ibid). Figure 13 illustrates Mozambique's position on the global map.

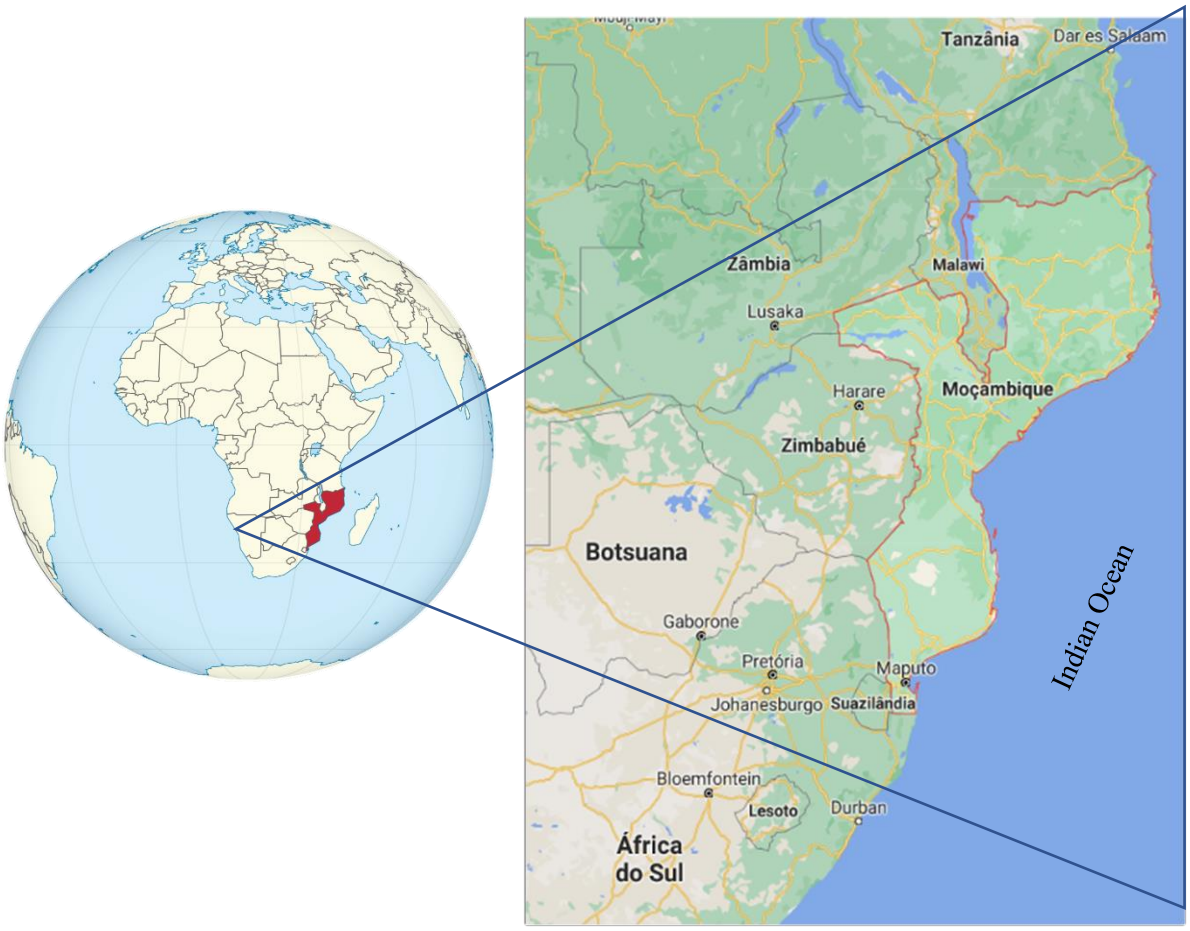


Figure 13. Map of Mozambique. Source: Google Maps.

Mozambique is administratively divided into eleven provinces, traditionally categorised into three regions: north, central, and south. The northern region includes Niassa, Cabo Delgado, and Nampula provinces. The central region is composed of Tete, Zambézia, Manica, and Sofala, while the southern region consists of Gaza, Inhambane, Maputo Province, and Maputo City, the nation's capital (INAGE, 2015).

Geographically, Mozambique exhibits notable variation. The central and northern provinces are situated on higher terrain, reaching altitudes of up to 2,436 meters, whereas the southern region features lower altitudes and plains (INE, 2021a). Major rivers include the Zambeze (820 km), Rovuma (650 km), Lúrio (605 km), Limpopo (600 km), Messalo (530 km), Licungo (336 km), Save (330 km), Búzi (320 km), and Maputo (150 km).

The climate in Mozambique is defined by two primary seasons: dry (winter) and rainy (summer). Temperature fluctuations range between 7 and 45 degrees Centigrade depending on the season. The average temperature is around 26.5 degrees Centigrade in January and 21.1 degrees in June (INE, 2021a). Precipitation peaks at an average of 247.4 mm in January, during the rainy season, and falls to about 4.7 mm in June.

Mozambique's geographical and climatic conditions render it vulnerable to natural phenomena such as tropical storms and cyclones. These natural elements, combined with the socio-economic context, amplify the country's susceptibility to disasters. This vulnerability has led to the prevalence of diseases like malaria, the spread of airborne illnesses including tuberculosis (TB), and epidemics such as cholera, placing a substantial burden on the health sector.

As an African nation, Mozambique is a member of the African Union (AU), established in July 2002, encompassing all members of the former Organisation of African Unity (OAU), which was founded in May 1963. Mozambique became a member of the OAU on July 15, 1975 (AU, 2003). Its strategic location also promotes collaboration in developmental activities with regional countries. This collaboration laid the groundwork for the Southern African Development Coordination Conference, founded in 1980, which later evolved into the Southern African Development Community (SADC) in 1992 (SADC, 2022). Participation in these regional forums aligns with Mozambique's broader and sectoral development strategies, including health, fostering cooperation and dialogue with neighbouring countries.

4.2 Population, languages, culture, and religion

In 2021 Mozambique had 30,832 million inhabitants, with only 34,2% living in urban areas (INE, 2022). Table 11 summarises four population indicators for the country from 2019 to 2021.

Table 11. Recent Mozambican social indicators.

Year	*Illiteracy rate (%)*	*Life expectancy at birth (years)*	*Birth rate (per 1 000)*	*Mortality rate (per 1 000)*	*Infant mortality rate (per 1 000)*
2021	39%	55,3	37,2	12,1	*66,2*
2020	39%	54,9	37,6	12,3	67,4
2019	39%	54,5	37,9	12,4	68,6

Sources: (INE, 2020, 2021a, 2022).

Mozambique boasts a diverse tapestry of languages, ethnicities, and cultures, reflecting its rich heritage and historical background (De Paula & Duarte, 2016; Lopes, 2013). Despite the presence of multiple indigenous and foreign languages, Portuguese has been designated as the official language (INE, 2022). This decision, rooted in strategic and political considerations, aimed to foster unity during the liberation movements and subsequent to colonial independence (Lopes, 2013). As Lopes (2013) notes, a comprehensive study to accurately ascertain the number of Bantu languages spoken in Mozambique is yet to be conducted. Nonetheless, it is recognised that these languages predominantly constitute the mother tongues of the local populace. During the 1980 census conducted by the Central Census Office (*Gabinete Central de Recenseamento*), at least 24 local languages[16] were recognised. De Paula and Duarte (2016) note that various studies have resulted in divergent views on the number of Bantu languages, but they refer to the official data provided by the National Statistics Institute in 2010, which identifies at least 21 Bantu languages. These languages are associated with existing ethnic groups inhabiting the country, including the Yaos, Makondes, Makuas, Nyanjas, Senas, Ndaus, Changanas, and Rongas, among others[17]. Over the years, Mozambique has experienced a fusion of its values and lifestyles with foreign cultures and religious influences. Presently, it is considered a secular state, characterised by a tapestry of strong indigenous traditions and diverse religious communities. According to the 2018 International Religious Freedom Report, the major religious groups include Roman Catholics (28%), Muslims (18%), Zionist Christians

[16] These local languages included: Bitonga, Chope, Chuabo, Koti, Kunda, Lomwe, Maconde, Macua, Marendje, Mwani, Ngulu, Nsenga, Nyanja, Nyungwe, Phimbi, Ronga, Sena, Shona, Swahili, Swazi, Tsonga, Tswa, Yao, Zulu.

[17] Mondlane, E. (1967) Tribos ou grupos étnicos moçambicanos (seu significado na luta de libertação nacional). In J. Reis e A. Muiuane (eds) (73-9).

(15%), and Protestant Christians (12%). This report also mentions smaller religious groups such as the Baha'i Faith, Judaism, and Hinduism, which collectively represent 7% of the population, with the rest not affiliated with any specific religion (US Embassy, 2019).

While local languages are commonly used for communication along Mozambique's borders with neighbouring countries, interactions with the global community are predominantly conducted in Portuguese and English (Lopes, 2013). These languages have facilitated Mozambique's integration into two significant international communities: the Community of Portuguese Language Countries (CPLP) in 1996 (GB, 2021) and the Commonwealth in 1995 (CS, 2023).

In the education sector, Portuguese is the primary language of instruction, with English and French introduced at more advanced educational levels. Efforts to implement bilingual education and incorporate native languages into the curriculum have been initiated, but widespread implementation across the country remains incomplete. In healthcare services, Portuguese is the standard language, but there is an ongoing effort to communicate with patients in their local languages, enhancing empathy and trust between patients and healthcare providers. The process of integrating bilingual services in Mozambique faces numerous challenges, compounded by population movements due to historical conflicts that have created diverse and heterogeneous communities.

The health sector, recognising the need to distribute doctors across the country, implemented a mobility system requiring health workers to shift locations as needed to address personnel shortages. The introduction of digital health systems in Mozambique brings additional challenges, including language adaptation and customisation for local use. Despite these hurdles, all parties involved must continually adapt their communication strategies to effectively navigate these complex processes.

4.3 Economics, industry, and living standards

The Mozambican currency has been designated as the New Metical since January 1st, 2006, after the introduction of the new family of the local currency, formerly designated as Metical[18]. The Mozambican economy and industry have undergone significant transformations over the

[18] On June 16th, 1980, Mozambique adopted its own currency, designated as Metical, replacing the former currency in use (Portuguese "*escudo*"). Since then, this currency has been subjected to two major transformations introducing coins and notes with new features, constituting different "families" of the Metical. The actual currency, belonging to the third family of the Metical, introduces new features to enhance security and recognition by touch and sight (INAGE, 2015).

past fifty years, with notable developments contributing to the country's progress. During the 1970s, the cashew nuts industry played a pivotal role in boosting Mozambique's economy, establishing it as a world leader in the production of both raw and processed cashew nuts (Penvenne, 2015). In the 1990s, efforts to recover from the political and economic turmoil of the 1980s focused primarily on investing in agriculture and fisheries. This trend persisted and gained momentum with the implementation of a strategy for rural development at the century's turn. The discovery of substantial mineral resources attracted international investment, invigorating the extractive industry (Besharati, 2012).

Currently, Mozambique's leading exports include mineral coal, aluminium bars and rods, electricity, heavy sands, natural gas, tobacco, wood, cashew nuts, cotton, prawns, bananas, cane or beet sugar, and lobsters (INE, 2022). Simultaneously, efforts are underway to gradually re-establish the transformative industry. The primary imports consist of machinery, diesel, cereals, automobiles, petrol, medicines, food oil, electricity, hydraulic cement, beer, and sugar (INE, 2022).

Despite the significant economic contribution of natural resource exploitation, data from the Household Budget Survey (*Inquérito Sobre Orçamento Familiar* - IOF) for the period 2019/20 revealed that 73.6% of the employed population is engaged in agriculture, forestry, and fishing, with 88.6% of these individuals residing in rural areas (INE, 2021b). Table 12 provides a comparative overview of Mozambican development indicators alongside its neighbouring countries.

Table 12. Comparative analysis of the development indicators, between Mozambique and its neighbouring countries.

	Human Development Index (HDI)	**Average HDI annual Growth**	**Life expectancy at birth**	**Population in Multidimensional Poverty**	**GDP (current)**
	Value	**%**	**Years**	**%**	**US$**
Country	**2021**	**1990-2021**	**2021**	**2019**	**2021**
Mozambique	0.446	2.05	59.3	73.1	15.78 billion
Tanzania	0.549	1.27	66.2	57.1	64.84 billion
Malawi	0.512	1.71	62.9	54.2	12.63 billion
Zambia	0.565	1.02	61.2	47.9	22.15 billion
Zimbabwe	0.593	0.49	59.3	25.8	28.37 billion
Eswatini	0.597	0.29	57.1	19.2	4.74 billion
South Africa	0.713	0.39	62.3	6.3	419.02 billion

Sources: UNDP (2022) *and World Bank* (2023).

The transport and communication infrastructure in Mozambique comprises a network of roads and railways, a telecommunication network providing landline and mobile services, and various communication services, including television and radio (MTC, 2021). The country's railway corridors extend from west to east, linking inland nations bordering Mozambique to its three primary ports: the Port of Nacala in the north, the Port of Beira in the center, and the Port of Maputo in the south. The national road, known as the N1, traverses the country from north to south and is a key thoroughfare, intersecting and connecting these three railway corridors (Dominguez-Torres & Briceño-Garmendia, 2011).

4.4 Political landscape

Mozambique was established as a "People's Republic" through the country's first constitution on 25 June 1975, which assumed a popular democracy and affirmed the state as sovereign, independent, and democratic, governed by FRELIMO[19].

The constitution of Mozambique, revised in 1990, established the country as a 'Republic', grounded in the fundamental principles of independence, sovereignty, unitary democracy, and social justice. This revision marked the introduction of a multi-party political system (INM, 1990). Since this change, three main political parties, FRELIMO, RENAMO[20], and MDM[21], along with others with lesser representation, have participated in the electoral processes. While FRELIMO holds a significant portion of the governance power, RENAMO and MDM have also shared in governance, controlling several municipalities across the country.

The evolution of the health sector in Mozambique is closely linked to the nation's political landscape. Table 13 summarises the progression of two critical, concurrent processes related to governance (G) and policies (P). These processes have significant implications for the health sector, particularly its HMIS.

[19] FRELIMO is an acronym for *Frente de Libertação de Moçambique* (meaning in English: Movement for the Liberation of Mozambique). It is used by the party governing the country since its Independence in 1975, and after the five elections conducted within the country.
[20] RENAMO is an acronym for *Resistência Nacional Moçambicana* (meaning in English Mozambican National Resistance). This acronym is used by the main party representing the opposition.
[21] MDM is an acronym for *Movimento Democrático de Moçambique* (meaning in English: Democratic Movement from Mozambique*)*.

Table 13. Two concurrent processes in the political-institutional context.

G	Presidential Elections	1994 – 1999	1999 – 2004	2004 – 2009	2009 – 2014	2014 – 2019
	Presidents of Mozambique	Second president		Third president		Fourth president
	Ministers of Health	4th MoH (1995-2000)	5th MoH (2000-2005)	6th MoH (2005-2010)	7th MoH (2010-2015)	8th MoH (2015-2020)
P	Action Plan for the Reduction of Absolute Poverty (PARPAs)	Interim PRSP (Poverty Reduction Strategy Paper) (1999-2000)	PARPA I (2001 – 2005)	PARPA II (2006 – 2009	(Integrated into the 5-year Government Plan)	
	Health Sector Policy & Recovery Plan	1995 – 2000				
	Health Strategic Plans (PESS)		2000 – 2005	2007 – 2012		2014 – 2019
	Health Information System Development Program[22]		2003-2005			
	Restructuring and reorientation of the Health Information System Plan[23]			2006-2008		
	Health Information System Strategic Plan (PESIS)				2009-2014	

The current profile of the country has been shaped by various ongoing socio-political processes and digital interventions, including those within the health sector. The next two sections provide an overview of Mozambique's historical background.

4.5 Historical background of Mozambique post-conflict

Mozambique's recent history has been shaped by struggles and conflicts, significantly impacting its social and political evolution. The post-conflict era can be divided into two pivotal periods: the phase following independence in 1975 (The Rise of the New Country) and the post-1992 peace agreement era (Restoring Hope with Peace), marking the end of the civil war. In both periods, concerted efforts were made to improve various sectors, especially education and health, although numerous setbacks often hindered these advancements.

4.5.1 The rise of the new country (1975-1992)

Upon gaining independence from Portuguese colonial rule, Mozambique faced a plethora of challenges, necessitating critical decisions. Starting anew with fresh personnel and structures, despite retaining the same physical infrastructure, the country prioritised unity, ownership values, patriotism, and inclusive development. However, a civil war erupted before these goals could fully materialise (Garrido, 2020).

[22] Information extracted from (DIS, 2009)
[23] Information extracted from (Almeida, 2007)

Before independence, health services in Mozambique were highly fragmented and largely inaccessible to the local populace, with over half of the health workers based in the capital. In 1974, the country had 550 doctors, equating to a doctor-to-population ratio of 1 to 17,349 (Bouene, 2005; Muquingue, 2009). Post-independence, the health sector faced two major personnel shortages.

The first shortage emerged immediately after independence, as Mozambicans grappled with the choice of staying or moving to Portugal. This led to a substantial exodus of skilled professionals, including health workers, decreasing the number of health personnel by 85% in 1975. The country was left with just a handful of doctors and approximately a hundred nurses and health technicians (Gilio & Freitas, 2008; Muquingue, 2009).

The second personnel crisis occurred during the sixteen-year Civil War, resulting in the murder of over a hundred health workers nationwide (Garrido, 2020). To combat this, the government formed agreements with foreign countries for healthcare professionals and initiated training programs (Muquingue, 2009). Table 14 provides a summary of significant events impacting the health sector in Mozambique before 1992.

Table 14. Local, regional, and international events shaping the health sector in Mozambique before 1992.

Year	Local, regional, and international events shaping the health sector in Mozambique
1898[a]	Around this time, the colonial power organised the health services, establishing the first health infrastructures and respective operation rules, comprised of civil and military hospitals distributed in 11 health districts, "prioritising curative medicine" within a "racist structure".
1975	The Mozambican government abolished the practices of private medicine on 24 July.
1975[a]	The Decree-Law nr. 1/1975, of 29 July, Article 37 establishes and defines the principles guiding the health policy for Mozambique after the independence, preconising a "unified national health service", integrating preventive and curative actions, although with emphasis on prevention.
1977[b]	The Law nr. 2/77, of 27 September, approved the Free Medicine Act, establishing "free healthcare to disease prevention campaigns" and paid curative services at a low cost.
1978	World Health Organisation Alma-Ata Conference Declaration [d]
	Creation of the Military Health Service under the Ministry of National Defence, the Paramilitary Health Service under the Ministry of the Interior, and establishing that the health units inside the prisons would be managed by the Ministry of Justice (Garrido, 2020, pp. 3-4).
1985	Ministerial Diploma nr. 35/85, from 14 August, approves the Statute of the Mozambican Ministry of Health by the Minister of Health Pascoal Manuel Mocumbi.
1987[c]	The World Bank and the International Monetary Fund economic policies imposed on the Mozambican government "led to a drastic reduction in public spending, including the provision of free healthcare to most citizens".
1989	MoH conducts the first revision and reformulation of the HIS created in 1982.
1989-90	Updates to the registration process and data collection principles, including creating the Nucleus of Statistics operating at District, Provincial and Central levels. Two documents to serve as a reference are introduced: the Manual of Procedures for HIS at the district and provincial level and the HIS Instruments Manual [e]

Sources: [a] Garrido (2020, p. 2), [b] Garrido (2020, p. 3), [c] Garrido (2020, p. 4), [d] WHO (2004), [e] Almeida (2007).

The Nucleus of Statistics was established to coordinate “with various local programs to analyse, interpret data, and produce relevant reports" (Almeida, 2007, p. 3). At that time, the Health Information System (HIS) in Mozambique predominantly relied on paper-based processes.

The civil war, which erupted in the late 70s and lasted 16 years, profoundly impacted Mozambique. Initially one of the poorest countries in the world, it descended to being the world's poorest by 1992 due to the armed conflict (Garrido, 2020). The war caused widespread damage to the existing infrastructure, leading to vandalism or abandonment. For example, the health sector had 113 hospitals in 1975, but this number dwindled to 39 by 1977. Despite recovery efforts, there were only 43 functional hospitals by 1997 (INE, 2011).

The extensive loss of life and infrastructure had a domino effect on service delivery, contributing to economic instability, increased reliance on donor aid, and a subsequent loss of sovereignty (Funada-Classen, 2013; Newitt, 1995). This situation attracted greater attention from the International Monetary Fund (IMF) and the World Bank, leading to increased external assistance (Funada-Classen, 2013; Garrido, 2020), particularly in the health and education sectors—a trend that continues today.

Mozambique's digital landscape has been significantly shaped by the conflicts it has endured. The country's first computers were introduced in the 1960s, but their expansion was sluggish post-independence, with broader adoption beginning only in the early 1990s (Kluzer, 1993).

The exodus of skilled professionals post-independence also impacted Informatics training. For instance, a course offered by the University of Lourenço Marques (now Eduardo Mondlane University) was suspended in 1976 due to a lack of lecturers, with subsequent years seeing the involvement of foreign instructors (ibid).

During this period, several initiatives supported the further development of Mozambique's digital framework. Notable among these was the establishment of Telecommunication of Mozambique (TDM) in 1981 and the early efforts to develop informatics capacity-building through the Data Processing Centre (CPD), created in 1977 (ibid).

4.5.2 Restoring hope with peace (1992-2023)

Mozambique's political-institutional landscape has undergone significant changes in the thirty-one years following the end of its conflict (1992-2023). The 1990 constitution, which heralded

the multi-party political system, paved the way for the first democratic elections in 1994 (INM, 1990). A constitutional revision in 2004 further solidified the country's democratic principles (RM, 2004). The recovery plans and sectoral reforms initiated in the 1990s aimed to address the dire consequences of the conflicts, creating opportunities for cross-sector interventions and the development of long-term strategies and action plans from 2000 onwards (CC, 2003; RM, 2001, 2006a; Zimba, 2010).

Since 2010, these action plans have become integral to the Government's Five-Year Plan. While the reduction of poverty remained a key focus, particular attention was directed towards the education and health sectors. Key initiatives in these areas included policy development, infrastructure restoration, enhancement of essential services, and human resources development (Muquingue, 2009; Garrido, 2020). These efforts have forged connections between national policies and international directives, such as the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs). Notably, these measures contributed to a significant decrease in the poverty index from 69.7% in 1997 to 54.7% in 2009 (DNEAP, 2010), and further to 46.1% in 2015 (DEEF, 2016). Additionally, gradual progress has been observed in other development indicators, as detailed in Table 15 below.

Table 15. Evolution of two development indicators from Mozambique.

Indicator per Year	**1997**	**2010[a]**	**2011**	**2012**	**2013**	**2014**	**2015[b]**	**2020**
Life expectancy (years)	42,3	52,1				53,5	53,8	54,4
HDI [c]	0,281	0,363	0,367	0,403	0,408	0,415	0,417	0,431

Source: [a] INE (2015); [b,c] INE (2016).

In Mozambique's health sector, significant strides have been made in increasing the number of trained health professionals across various levels, as evidenced in Table 16. These efforts led to a notable improvement in the health personnel ratios (per 100,000 inhabitants), which climbed from 123.3 in 2006 to 189.4 in 2016 (DRH, 2017). Concurrently, the number of national doctors rose from 501 to 1,604 during this period, significantly reducing the doctor-to-citizen ratio from one doctor per 38,763 citizens to one per 17,213 citizens (ibid). This trend of improvement persisted in subsequent years, with the count of national doctors increasing to 2,198 in 2020 (INE, 2021a) and further to 2,332 in 2021 (INE, 2022).

Table 16. Evolution of human resources in the health sector.

Human Resources Evolution per Year	**2006**	**2016**	**2021[a]**
Local Health Personnel [b]	16983	53 670	63 982
Local Medical Doctors [c]	501	1604	2332

Sources: [a] INE (2022); [b,c] DRH (2017).

Structural transformations within the health sector (1992-2023)

In 1997, Mozambique's national health sector underwent a significant restructuring to align with the decentralisation processes outlined in the public sector reform directives (BR, 1997). This structure was reassessed in 2009 to reorganise two key sectors involved in the information cycle. As part of this reorganisation, the Informatics Sector was placed under the jurisdiction of the Ministry's Cabinet, and the Department for Information for Health (DIS) became part of the Directorate of Planning and Cooperation, where it remains (BR, 2009a; BR, 2009b). A further revision in 2017 updated the structure to reflect changes in some directorates and to include new institutions under its management (BR, 2017). Table 17 summarises the significant events that have impacted the health sector in Mozambique from 1992 to 2020.

Table 17. Local, regional, and international events shaping the health sector in Mozambique between 1992 and 2020.

Year	Events
1995	Health Sector Policy (1995-1999), Health Sector Recovery Program (HSRP)
1997	Ministerial Diploma nr. 94/97, from 22 October, revokes the previous and approves the new Statute of the Mozambican Ministry of Health, from the need to restructure the MoH, making it more operational and able to respond to the decentralisation process, issued by Minister Aurélio Amândio Zilhão
2003	The Higher Institute of Health Sciences[a] was created through Decree 47/103, approved by the Council of Ministers, commencing its activities in the following academic year of 2004.
2008	Resolution nr. 16/2008, from 19 December, Mozambique adopted the International Health Regulations, issued by Prime Minister Luisa Dias Diogo
2009	Ministerial Diploma nr. 43/2009, from 18 March, the Informatics Repartition from the MoH becomes subordinate directly to the Cabinet of the Minister of Health – to the Permanent Secretary, as part of the MoH restructuration process, issued by Minister of Health Paulo Ivo Garrido
2009	Ministerial Diploma nr. 44/2009, from 18 March, the Department for Information for Health becomes subordinate directly to the Directorate of Planning and Cooperation, issued by Minister of Health Paulo Ivo Garrido
2009	Ministerial Diploma nr. 45/2009, from 18 March, approves the general statute of hospitals to clarify the organisation and functioning of the Hospitals, where these classify as Central, Provincial, District, General and Rural, issued by Minister of Health Paulo Ivo Garrido
2010	3rd Supplement, 23 March, Dispatch, appoints the joint national postgraduate commission to boost the number of national specialists in various areas within the health sector
2010	Ministerial Diploma nr. 64/2010, from 24 March, creates the Medium Polytechnic Institute of Health (IMEPS) to train professional health technicians, aiming to enable improvements and expansion of the healthcare services provided to the population, issued by Minister of Health Paulo Ivo Garrido and the Minister of Education and Culture Aires Bonifacio Baptista Aly
2017	Resolution nr. 04/2017, from 26 May, revokes the previous Statute of the Mozambican Ministry of Health and approves a new one issued by the President of the inter-ministerial commission on public administration reform, Carlos Agostinho do Rosário
2020	The Covid-19 outbreak

Source: [a] ISCISA (2023);MISAU (2012).

The health sector in Mozambique is organised into three primary levels: central, provincial, and district (Chilundo, 2004). Each of these levels comprises various entities that provide specific services, aligning with vertical health programs that extend across these tiers. The HMIS operates across four administrative levels: central, provincial, district, and community (Mosse, 2005).

At the primary level are health posts and health centers, while district (rural or general) hospitals constitute the secondary level. Provincial hospitals form the tertiary level, and the quaternary level includes central (specialised) hospitals and the National Reference Hospital in Maputo (Chilundo, 2004; Nhampossa, 2006).

The Evolution of the Digital Context in Mozambique (1992-2023)

While initial digital developments began in the late 1960s, with continued progress post-independence, regulatory focus in this area became more pronounced in the late 1990s with the widespread adoption of computers (Kluzer, 1993). The government's regulatory and normative actions encompassed a variety of laws, policies, and strategies. Additional initiatives aimed to broaden the reach and accessibility of telecommunication services, including landlines, mobile telephony, and the Internet (Brouwer & Brito, 2012). Table 18 below provides a summary of key interventions that laid the groundwork for the country's digital foundations for the Information, Communication, and Technology (ICT) domains.

Table 18. Critical interventions to the digital context of Mozambique with implications to the health sector.

Year	Policy
1991	First National Informatics Conference is organised on May 8-10, with around a hundred participants, including government representatives, entities from the field involved in different extracts of the Mozambican society, aid agencies, and regional and other foreign guests (Kluzer, 1993)
1997	Policy for Information (RM, 1997)
1997	Creation of MCel, as a branch of the public Telecommunication Company of Mozambique (TDM)
1998	Establishment of the Commission for the Development of the National ICT Policy [a]
1999	First Telecommunications Law (RM, 2002b)
1999	Policy for the Diffusion of Statistical Information (RM, 2000)
2000	Approval of the National ICT Policy (CPINFO, 2000)
2000	Introduction of the Public Servants Information System (SIP) and the State Financing Information System (SISTAFE) (Nhampossa, 2006)
2002	Updates to the Telecommunications Law (RM, 2002b; Mabila, 2013)
2002	Informatics Policy implementation strategy (RM, 2002)
2003	Policy for Sciences and Technology (RM, 2003)
2003	MCel is split up from TDM to enable competitive services with the entrance of a new private company later in the same year, designated Vodacom (Brouwer & Brito, 2012)
2004	New Telecommunications Law, nr. 8/2004, from 21 June (RM, 2002b)
2002	The International Conference of Electronic Governance for Development, Palermo, Italy, influences the acceptance and introduction of the eGovernance concept in Mozambique and abroad
2006	Approval of the e-Governance strategy [b]
	Approval of the eGovernment Interoperability Framework for Mozambique (eGIF4M)
2011	A new mobile company was introduced to the setting, designated Movitel (Mabila, 2013).
2016	New Telecommunications Law, nr. 4/2016, 3 June [c]
2018	Telecomunicações de Moçambique, SA (TDM) and mcel- Moçambique Celular, SA (mcel) merge into Mozambique Telecom, SA [d]
2018	The Policy for the Information Society of Mozambique replaces the Policy for Informatics (RM, 2018b)

Sources: [a] RM (n.d.); [b] RM (2006b)*; [c] INCM (2023); [d] CoM (2019) and Tmcel (n.d.)*

The initial ICT initiatives in Mozambique were predominantly centered in the capital, and extending these to rural areas presented significant challenges. These included limited infrastructure, such as inadequate electricity and equipment supply, and a scarcity of skilled human resources to provide necessary support (Mosse, 2005).

In 2018, the Policy for Informatics was superseded by the Policy for the Information Society of Mozambique. This new policy is organised around seven axes that intersect with the

government's priority sectors, focusing particularly on education, human development, and health (RM, 2018b).

4.6 Conclusion: brief analysis of the institutional context

In this chapter, I have outlined the implementation setting and detailed the key transformations in the socio-political and digital landscapes of Mozambique. This includes historical events, occurrences, and processes that have evolved over the years. Following this, I examined how these transformations have significantly influenced the health sector and the implementation of digital health initiatives in Mozambique.

My thesis builds on the analytical framework introduced in Chapter 2. The first premise of this framework posits that processes unfold within an institutional context involving institutions, organisations, and individuals that mutually influence each other. A second premise holds that an institutional context can be characterised by its current attributes, indicating its developmental stage – emergence, formation, stability, or crisis.

My analysis aims to identify the characteristics of the institutional context as it relates to the evolving process of HMIS (Health Management Information System) implementation over time and space.

The contextual analysis underscores two processes that have indubitably shaped the relationship between the context and HMIS implementation processes. Post-independence in 1975, crucial decisions steered the nation's direction, aiming to liberate Mozambique from colonial impositions. While some decisions were pivotal for national unity, such as choosing the official language, others, like the option to stay or leave the country, led to significant disruption. This resulted in a mass exodus of skilled individuals to Portugal, severely impacting various sectors, including health and education. The subsequent sixteen-year civil war further intensified these challenges, leading to considerable human and material losses and plunging the country into political and economic crises. The 1980s saw interventions to alleviate these crises, largely supported by external aid and international agencies from the North. Following the peace agreement in 1992, the country's efforts to restore hope encompassed capacity-building investments, collaboration agreements with different nations, and recovery programs. These political decisions during these periods profoundly influenced Mozambique's socio-political and digital context.

The adoption of the new constitution and the peace agreement facilitated steady progress across various domains, particularly from the 1990s onwards. During this period, the digital landscape in Mozambique began to emerge. In the health sector, organisational practices that had developed over the years were relatively well-established, albeit predominantly paper-based. The global promotion of digital technologies by international organisations created opportunities for the adoption of new technologies. There was a prevailing expectation and somewhat of a myth that technology would be a panacea for organisational challenges.

Early ad-hoc digital initiatives in the health sector date back to the 1980s, with the introduction of the first digital system occurring in 1992. However, these initiatives struggled to gain traction within the existing organisational framework, lacking support from institutionalised practices, and thus found it challenging to integrate into the organisational setting.

The 1990s saw a wider availability of computers and the introduction of Internet services in Mozambique. Concurrently, new legislation was enacted to facilitate these technological advancements and regulate the dissemination of information.

The sector had limited internal human resources with technical skills to support the diffusion of computers and expand the development of SIS-Prog[24] and users constrained with limited digital skills. Investments in legal, human resources, and infrastructure were recognised as essential to support the transformative processes in Mozambique. A notable disconnect between existing organisational practices and technological advancements highlighted the fragile conditions for the needed transformations. Consequently, capacity building became a priority to develop, enhance, and scale digital and technical skills within the country. However, during this phase, the reliance on expert consultants, often expatriates hired by donors and partners, was prevalent for the development and implementation of digital initiatives.

Following reforms and recovery plans, notable advancements were observed in various domains, including telecommunications and the digital sector. Between 2000 and 2007, the digital context entered a formation stage, significantly influenced by the engagement of international development agencies. Their support facilitated the involvement of expert consultants, providing timely and necessary assistance. Acknowledging the local human

[24] SIS-Prog was the first digital system introduced in the setting in 1992, as part of the MoH's digital initiatives to support the health sector through its HMIS. It consisted of a Dbase application, supporting two health programs: (1) Immunizations (EPI) and (2) Mother and Child Health (MCH), which was developed and supported by external personnel to the organisation (Aanestad et al., 2005).

resources' limited technical skills for developing in-house digital solutions, various initiatives were introduced through technology transfer schemes, importing successful digital models from abroad.

Over time, there was a growing recognition of the role of digital systems within organisations, which led to an increased implementation and adoption of digital solutions. However, the extent of acceptance varied. Certain technological solutions required extensive adaptations for the local context, hindering their adoption. Continuous investments in capacity building were crucial for raising awareness about the importance of digital solutions, with a focus on developing infrastructure and legal frameworks to support more complex digital systems.

Between 2008 and 2014, the digital context transitioned from formation to stability. During this period, digital initiatives benefited from improvements in human resources, infrastructure, and legal and strategic frameworks. The number of professionals with digital skills saw a significant increase, leading local organisations to recognise the potential of employing more technically skilled local staff. Despite the influx of new professionals, the reliance on external technical support continued, perpetuating donor dependencies.

Various digital support initiatives were introduced over the years, initiated by a mix of local, external, private, and state entities. However, many of these initiatives were not sustainable or scalable, resulting in a proliferation of independent digital systems. This situation underscored the need for greater cohesion and local capacity development, aiming to reduce dependency on external support.

The digital context in Mozambique from 2015 to 2023 entered a relatively stable stage, largely due to investments in technical infrastructure and capacity building. Significant advancements in technical infrastructure were marked by the introduction and expansion of mobile networks and the Internet. This progress was facilitated by a growing market for computers and mobile phones. Capacity-building investments played a crucial role, offering a variety of options and increasing exposure to computer and Internet usage. There was also a noticeable embedding of technology within organisational practices. Prior experiences with earlier systems, coupled with the evolving conditions of the digital context, enabled the Ministry of Health (MoH) to better understand the necessary changes and make more consistent improvements within the HMIS. The MoH was better positioned to integrate technology with organisational practices in cost-effective ways, reflecting an enhanced understanding of the dynamics between technological advancement and organisational adaptation.

Chapter 5 : Phase 1 – Introducing digital health in Mozambique (2000 – 2007)

5.1 Defying the odds to partake in global developments

In the 1990s, Mozambique demonstrated a keen interest in overcoming existing limitations by developing sectoral reforms and new developmental agendas, with the health sector being a primary focus. The Ministry of Health engaged in various initiatives and strategies to strengthen and eliminate inconsistencies within the HMIS. This reform process was guided by three key policy documents from 1995: the Government Program, the Health Sector Policy (1995-1999), and the Health Sector Recovery Program (HSRP) (Muquingue, 2009).

Accompanying these structural changes in the government, new policies, and strategic shifts, there was a need for novel and adapted supportive systems. Since Mozambique's independence in 1975, the HMIS had primarily relied on manual instruments such as paper-based forms, registry books, and report files. The HMIS interventions evolved alongside developments within the health sector. Notable ad-hoc digital interventions date back to the 1980s, before the introduction of the first computerised system. These early initiatives are detailed in Table 19. In September 1990, the MoH undertook a significant exercise titled 'Organisation and Operationalisation of the HIS in Mozambique,' which set the stage for the development of the first computerised system, SIS-Prog (DIS, 2009). Implemented in 1992 at both the central and provincial levels, SIS-Prog was utilised for approximately a decade (Almeida, 2007). However, its limited scope, which did not encompass all health programs, along with its inherent limitations and inconsistencies, led to the gradual introduction of other parallel systems.

Table 19. Main achievements of the MoH in terms of Health Information Systems from 1976-1992.

Year	HMIS key events in Mozambique
1976	1st formal system to register preventive, promoter, and curative activities
1979	Mechanism to collect data based on forms
1982	1st System organised, structured, and uniformed to collect data systematically, designated HMIS (SIS)
1989	HMIS (SIS) was revised to simplify and integrate various programs such as STD, Mother & Child, EPI, Nutrition, and Notifiable Diseases. Drugs, TB and Finances are not incorporated.
1992	The first computerised system is installed at the National level, nominated SIS-Prog, reporting data from some health programs.

Source: Adapted from Almeida (2007).

As computers gained prevalence in the late 1990s (Kluzer, 1993), a variety of digital solutions began to surface within Mozambique's health sector. This era saw the sector actively engaging in digital health initiatives across different levels, with a focus on specific areas and diseases. Many initiatives

arose from collaborative projects aimed at strengthening efforts, marked by partnerships, consultancies, and contractual agreements. In 1997, the Information System for Epidemiological Surveillance (*Sistema de Informação para Vigilância Epidemiológica*, SIS-VE) was developed, marking a significant advancement in health information systems (Ladd et al., 2010). Additionally, partners supporting national health programs for diseases such as malaria, tuberculosis, and HIV (Human Immunodeficiency Virus) were instrumental in introducing other specialised systems to aid in disease control and surveillance (Nhampossa, 2006).

By the late 1990s, the HMIS had become highly fragmented as legacy systems continued, with new systems being introduced over time. The MoH was keen to reverse this situation. Two assessments were carried out during this period: (1) by the MoH with UEM and an international partner[25] in 1998 (Chilundo, 2004; Mosse, 2005; Nhampossa, 2006), and (2) a joint evaluation conducted by the MoH and the World Health Organisation (WHO) in 1999 (DIS, 2009). Each assessment highlighted the need for a new strategy to address identified issues, including limitations in local technical support and the enabling digital infrastructure. Several instruments played an essential role in guiding changes in the digital context within the health sector, as summarised in Table 20.

Table 20. Key instruments guiding the evolution of the digital context within the health sector from 2000-2007.

Year	Key Instruments
2002	Evaluation of the SIS and project for the health sector Computerisation Master Plan, a proposal prepared by the company EUROSIS, between August-November [a]
2003	Introduction of the Health Information System Development Program (2003-2005) - *Programa de Desenvolvimento do Sistema de Informação para Saúde* (PRODESI), in August [a, b]
2004	A Report organised by the MoH, mapping the ongoing digital health initiatives, under the consultancy of the Institute for Global Health from the University of California and the Faculty of Medicine from University Eduardo Mondlane, in June [a]
2004	Introduction of the Statistics Sector Master Plan for the Ministry of Health for the period 2005-2007 [c]
2006	Restructuring and reorientation of the Health Information System Plan (2006-2008)
2007	Elaboration of the TOR and the requirements for the bidding of Hospital Information System for Maputo Central Hospital (HCM), under a WHO consultancy [b]

Source: [a] DIS (2009)*; [b] De Faria Leão* (2007)*; [c] Almeida* (2007).

Aid and partner organisations continued to provide essential support for further advancements. In addition to financial assistance, some partners collaborated directly, while others hired personnel to form internal teams, taking on distinct roles such as consultants and assessors. Some of the key systems introduced between 1992 and 2007 are shown in Table 21.

[25] The Health Information Systems Programme (HISP)

Table 21. Key systems introduced into the HMIS to support routine reporting and specific functions associated with different sectors and health programs between 1992-2007.

Year	Key systems
1992	The first computerised system is installed at the National level, nominated SIS-Prog, reporting data from some health programs.
1997	System for Epidemiological Surveillance (SIS-VE)[26], implemented gradually, reaching a national scale by 2010
2000	DHIS Pilot [a] in Mozambique, SIS.D (form based data entry screen) with DHIS 1.3, installed in some districts from Gaza, Inhambane and Niassa provinces
2002	SIMP [b], Integration tool (IS for Monitoring and Planning) to manage finances, resources, and infrastructures; Implemented at the Central and Provincial Level
2004	Módulo Básico (MB-SIS) [c], the aggregated data is sent by the lower to central levels, and it is used at provincial and National levels
2005	MISAU website [c], as part of the country's eGovernance strategy implementation
2006	The Human Resources Management system introduced include the State Employees Registry (*Cadastro eletronico de Agentes e Funcionários do Estado* – eCAF), and the Personnel Information System (SIP in Portuguese)[27]

Sources: [a] Mosse (2005); [b]Nhampossa (2006); [c]Almeida (2007)

The following section describes in more detail the introduction of digital health within the HMIS during the period between 2000 and 2007.

5.2 Introducing DHIS in the setting

In the early 2000s, Mozambique saw the introduction of a technological artefact known as the District Health Information System (DHIS) software through different projects. These initiatives were part of the Health Information Systems Programme (HISP) research and development program from the Department of Informatics at the University of Oslo (UiO), with funding support from the Norwegian Agency for Development Cooperation (NORAD) (Nhampossa, 2006). HISP-UiO originated in the mid-1990s, empirically based in South Africa, to create and maintain sustainable health information systems in low- and middle-income countries. According to Sahay et al. (2017), the initiative began in South Africa in 1994, following the fall of the apartheid government, to develop DHIS software to support the decentralisation and unification of health information systems.

[27] Developed under the *Mozambique Health Information Network (*MHIN) project aiming to support health data collection and reporting through a two–way communications system using Personal Digital Assistants or PDAs. The project was implemented by the Academy for Education Development - SATELLIFE Center for Health Information and Technology (*AED-SATELLIFE*), with the Ministries of Health (MISAU) and Science and Technology (MCT). The funds for this project were granted by the Canadian International Development Research Centre (IDRC) and the Canadian International Development Agency (CIDA) (Ladd et al., 2010)

[27] eCAF is an online Oracle Database managed by the Ministry of Economy and Finance (MEF), used for payrolls, financial and budgetary; SIP was an access-based system administrated by the Ministry of State Administration and Public Function (MAEFP), used to gather personal information, employment status and other HR life-cycle elements (Waters et al., 2016).

Leveraging the success of the District Health Information System (DHIS) in South Africa, which became the official national reporting system in the late 1990s (Sahay et al., 2017), the Health Information Systems Programme at the University of Oslo (HISP-UiO) initiated efforts to introduce DHIS in Mozambique in 1998. Collaborative discussions began with key stakeholders at Eduardo Mondlane University (UEM) and the Ministry of Health (MoH). Initial meetings included representatives from UEM's Faculties of Medicine (FM-UEM) and Sciences (FC-UEM). Two FM-UEM researchers and a FC-UEM coordinator joined the network, bringing established connections with the MoH to the table. This team engaged with the MoH, which showed openness to innovations that supported health sector reforms, including the Health Management Information Systems (HMIS). A Memorandum of Understanding (MoU) among HISP-UiO, UEM, and the MoH was signed in 1998, laying the groundwork for. pilot implementations of DHIS in selected locations within three provinces: Gaza, Inhambane, and Niassa (Nhampossa, 2006).

The network of the MoH partners related to the project that introduced DHIS in the country is illustrated in Figure 14.

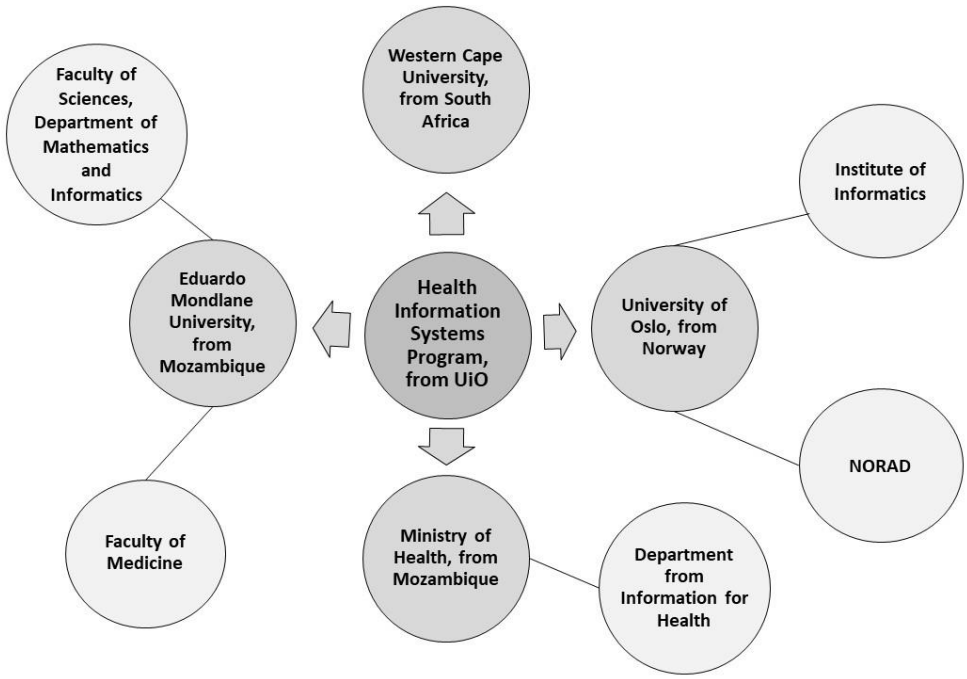
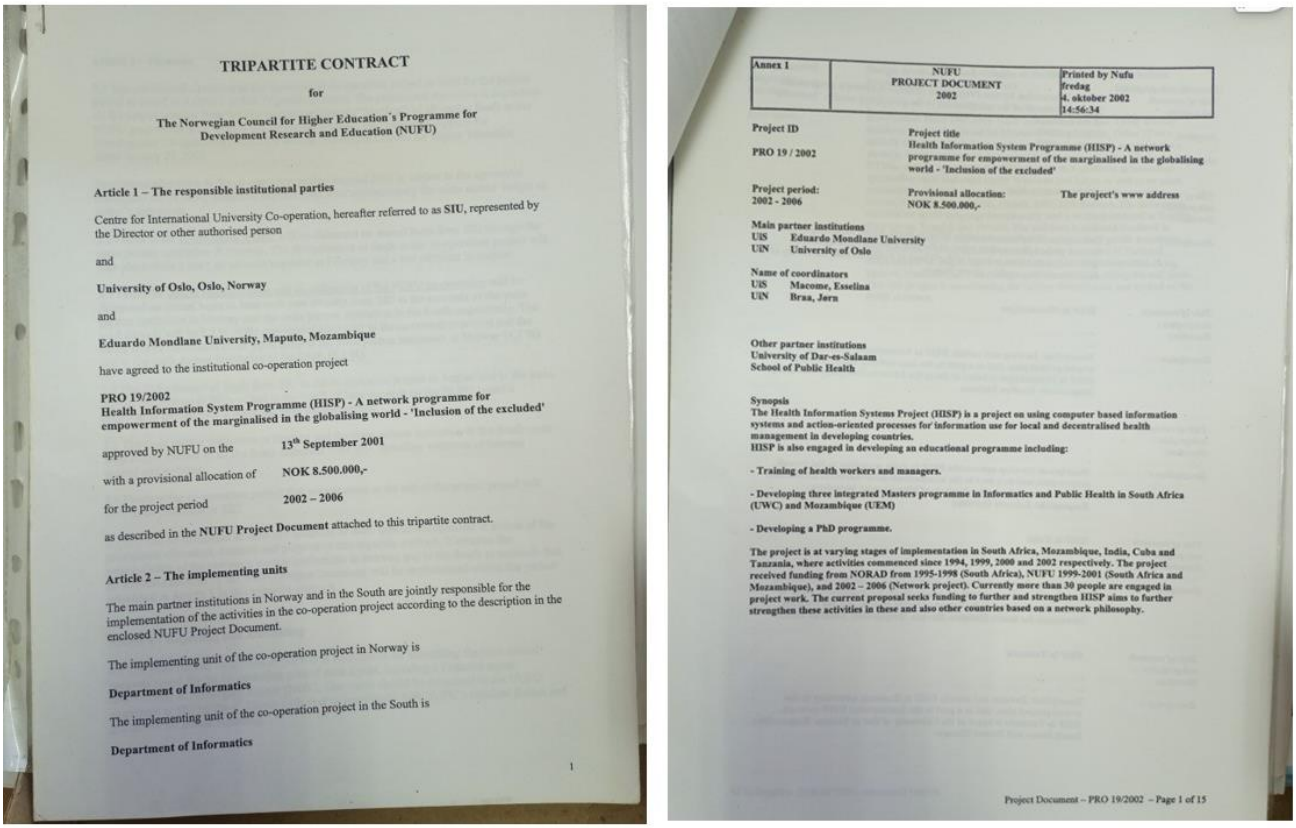


Figure 14. Organisations involved in the first phase of DHIS implementation in Mozambique (Collinson & Sahay, 2022).

As part of the initial efforts related to the DHIS pilot implementation process, other researchers from UEM and members of the Department of Information for Health (DIS) at the MoH were involved. Funding was provided by the Norwegian Government[28] (Braa et al., 2001), as illustrated in Figure 15.



TRIPARTITE CONTRACT

for

The Norwegian Council for Higher Education's Programme for Development Research and Education (NUFU)

Article 1 – The responsible institutional parties

Centre for International University Co-operation, hereafter referred to as SIU, represented by the Director or other authorised person

and

University of Oslo, Oslo, Norway

and

Eduardo Mondlane University, Maputo, Mozambique

have agreed to the institutional co-operation project

PRO 19/2002
Health Information System Programme (HISP) - A network programme for empowerment of the marginalised in the globalising world - 'Inclusion of the excluded'

approved by NUFU on the 13th September 2001

with a provisional allocation of NOK 8.500.000,-

for the project period 2002 – 2006

as described in the NUFU Project Document attached to this tripartite contract.

Article 2 – The implementing units

The main partner institutions in Norway and in the South are jointly responsible for the implementation of the activities in the co-operation project according to the description in the enclosed NUFU Project Document.

The implementing unit of the co-operation project in Norway is

Department of Informatics

The implementing unit of the co-operation project in the South is

Department of Informatics

1

Annex I | NUFU PROJECT DOCUMENT 2002 | Printed by Nufu fredag 4. oktober 2002 14:56:34

Project ID
PRO 19 / 2002

Project title
Health Information System Programme (HISP) - A network programme for empowerment of the marginalised in the globalising world - 'Inclusion of the excluded'

Project period:
2002 - 2006

Provisional allocation:
NOK 8.500.000,-

The project's www address

Main partner institutions
UiS Eduardo Mondlane University
UiN University of Oslo

Name of coordinators
UiS Macome, Esselina
UiN Braa, Jørn

Other partner institutions
University of Dar-es-Salaam
School of Public Health

Synopsis
The Health Information Systems Project (HISP) is a project on using computer based information systems and action-oriented processes for information use for local and decentralised health management in developing countries.
HISP is also engaged in developing an educational programme including:

- Training of health workers and managers.

- Developing three integrated Masters programme in Informatics and Public Health in South Africa (UWC) and Mozambique (UEM)

- Developing a PhD programme.

The project is at varying stages of implementation in South Africa, Mozambique, India, Cuba and Tanzania, where activities commenced since 1994, 1999, 2000 and 2002 respectively. The project received funding from NORAD from 1995-1998 (South Africa), NUFU 1999-2001 (South Africa and Mozambique), and 2002 – 2006 (Network project). Currently more than 30 people are engaged in project work. The current proposal seeks funding to further and strengthen HISP aims to further strengthen these activities in these and also other countries based on a network philosophy.

Project Document – PRO 19/2002 – Page 1 of 15

Figure 15. Extract from the tripartite contract between NUFU, UiO and UEM supporting the HISP project in Mozambique.

In collaboration with the Ministry of Health (MoH), the team carried out an initial assessment of the existing situation, focusing on districts within the three previously mentioned provinces where Eduardo Mondlane University (UEM) operated medical student training sites (Chilundo, 2004). The findings of this assessment were initially shared as ongoing research at a conference in Zimbabwe in 1999 and subsequently published as a comprehensive research paper in 2001. These valuable insights informed the MoH's inaugural strategic plan and facilitated the development of a more customised operational plan by the Health Information Systems Programme at the University of Oslo (HISP-UiO) for the pilot rollout of the District Health Information System (DHIS).

[28] Attachment 4 includes an exemplar of the funding agreement between the Norwegian Council for Higher Education's Programme for Development Research and Education (NUFU), UiO and UEM, signed on 13th September 2001, for the period 2002-2006. This was the second agreement following a previous agreement for 1999-2001.

"We embarked on this assessment… It was important… the country was coming out of the post-war and emergency phase… entering a much more planned phase… which was expressed in the year 2000 with the elaboration of the first strategic plan for the health sector… which came out the following year…" (a participant from the central level)

The pilot project entailed the customisation and adaptation of the existing District Health Information System (DHIS) application, originally developed in South Africa, with the assistance of the researchers from Eduardo Mondlane University (UEM). This approach was a form of 'technology transfer' from South Africa to Mozambique and was influenced by the principles of Scandinavian action research tradition (Braa et al., 2001).

"We did not have trained and specialised personnel; the base was the health workers themselves… doctorates, masters, licentiates, they were a drop of water." (a participant from the central level)

"The first step was the introduction of a master course in Mozambique… and enrol PhD students…" (a participant from the academy side)

To bolster Health Management Information Systems (HMIS) capabilities, six researchers from Eduardo Mondlane University (UEM) — three from the Faculty of Science and three from the Faculty of Medicine — embarked on Ph.D. studies at the University of Oslo (UiO), with collaborative supervision from both the Informatics and Medicine faculties. Concurrently, a multidisciplinary International Master's program in Health Informatics was launched as a joint effort between UiO and UEM, featuring coursework at both institutions. In its initial phase, the program welcomed students from a range of countries, including Mozambique, Ethiopia, Malawi, Tanzania, and India, drawing from fields such as informatics and community health.

5.3 Building on Digital Awareness while Enhancing Digital Capacity

5.3.1 Enrolment in doctoral programs

In the year 2000, three faculty members from the Faculty of Medicine and another three from the Faculty of Informatics at Eduardo Mondlane University (UEM) enrolled in a doctoral program at the University of Oslo (UiO), with five members eventually completing their degrees. These researchers undertook the task of customising the District Health Information Software (DHIS) to fit Mozambique's unique needs, employing an action research framework. They received specialised software training in South Africa. During their time in Oslo, they were also expected to provide

practical support for implementing projects back in Mozambique. This dual responsibility, however, proved to be a complex challenge, with one of the UEM doctoral candidates highlighting the inherent contradictions of this arrangement.

> *"…we were supposed to do the PhD program in a sandwich mode… but it was not doable… The same people had so many responsibilities as lecturers, students, and implementers… And then, we disappeared, and when we came back with our PhD we were seen as strangers…" (a participant from the academy side)*

By 2000, Mozambique did not have any PhD programs in informatics. Thus, the successful completion of five PhDs through the program at UiO represented a significant achievement in building tertiary education capacity in the country.

5.3.2 Engaging support through the master programs

In the year 2000, in tandem with ongoing projects, an initiative was launched to enhance the capacity of the HMIS by introducing an International Master's program at Eduardo Mondlane University (UEM). Faculty from the Health Information Systems Programme at the University of Oslo (HISP-UiO), the University of Western Cape (UWC), and local academics from UEM formed a multidisciplinary task force to design and implement the Master's program. The curriculum comprised two primary components: (1) academic coursework focused on health information systems, and (2) a compulsory fieldwork and thesis research component. These efforts marked the inception of embedding robust action research elements within the master's curriculum. The program attracted many students, both local and international, and by 2007, approximately 37 students had graduated from the three cohorts that commenced in 2001, 2003, and 2005. Figure 16 depicts the fieldwork undertaken in Mozambique by students from the Master's and Ph.D. programs, highlighting the involvement of some HISP-UiO researchers in these endeavours.

(a)

3.4.2. Field work in Mozambique

Figure 3.8: Inhambane district, Photograph of HISP team member installing automated reports in DPS

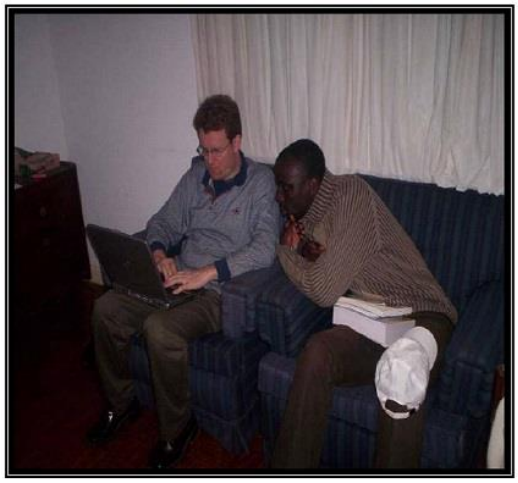
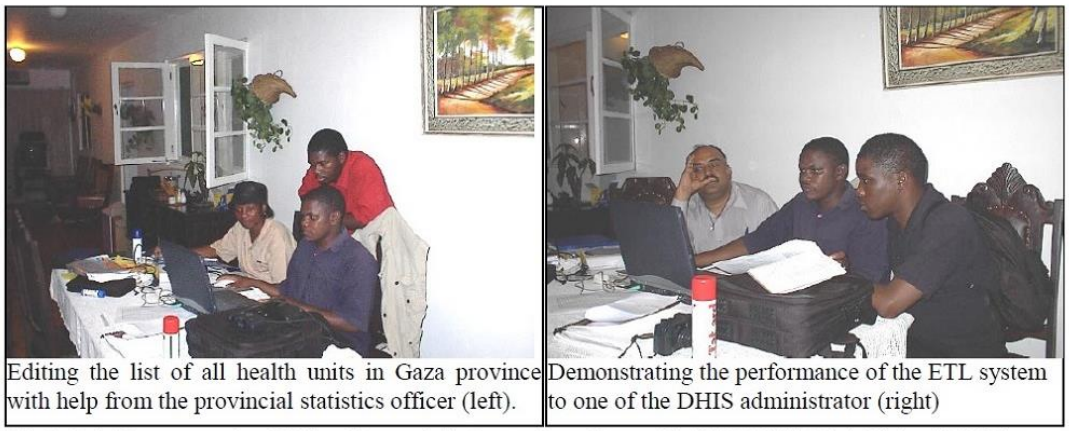


Figure 3.9: Maputo city, Informal discussion with master student and HISP researcher

(b)



Editing the list of all health units in Gaza province with help from the provincial statistics officer (left).

Demonstrating the performance of the ETL system to one of the DHIS administrator (right)

Photo 3.1: Programming ETL software (photographer: Fumo, T, Xai Xai district, 26 April 2002)

Figure 16. Extracts from two theses presented by two International Master students enrolled in the program, illustrating moments of their fieldwork in three Mozambican provinces (Inhambane, Maputo City and Gaza), during the DHIS pilot and alongside researchers from UEM and HISP-UiO.(a) Extracted from Lewis (2005, p. 53) and (b) Extracted from Lungo (2003, p. 49).

The introduction of practical courses at the Master's level at UiO, such as the 'Open-Source Software Development' course, also benefited the ongoing developments in Mozambique, South Africa, and Norway (Staring & Titlestad, 2008). One of these initiatives is described by a Master student enrolled in the International Master, as shown in the excerpt from Lewis (2005, p. 40):

> *"In June 2004, I had the opportunity to attend an international workshop of developers of HISP, which was conducted in Cape Town, South Africa. Two master and one previous master student from Mozambique, one master student from Norway, the project coordinator for DHIS*

development, the developer of DHIS, who supervised the workshop, two software programmers from "Soft Craft" Software Company, and myself were part of this workshop. During this period, I received valuable suggestions on the design of the DHIS spatial GIS application and how it could be globalised. The aim of the workshop was to spread the technology and knowledge on DHIS which was till now mainly concentrated in South Africa, to a more global setting and also to bring the expertise, knowledge from different countries. In addition to becoming part of the team involved in the development of DHIS 1.4 database structure, we also looked at various other software related to health sector in South Africa. The integration of SIS.D form based data entry screen with DHIS software for Mozambique was also prepared during this period."

At an assembly of researchers and students dedicated to the innovation of digital health solutions, pivotal contributions were made that furthered the evolution of the District Health Information Software (DHIS). Progress included the enhancement of the existing DHIS 1.3 in Mozambique with new integrative features, the advancement of DHIS 1.4 in South Africa and Zanzibar, and the foundational work for the emergence of DHIS2 (Staring & Titlestad, 2008).

In 2006, Mozambique's international Master's program was replaced by specialised Master's degrees in Informatics and Public Health (DMI, 2011; Kaasbøll et al., 2018). These programs persist in various forms to the present day and are recognised for their efficacy. The Informatics program, currently in its ninth iteration, now offers two specialisations: software engineering and information systems (DMI, 2011). The Public Health program has been updated to include tracks in Health Promotion, Disease Prevention and Control, and Health Planning, among other areas (UEM, 2023). Over time, curricular revisions have broadened the scope for engagement by professionals from multiple fields beyond the health sector.

5.3.3 Introducing In-service training

Deliberate efforts were made to integrate educational and fieldwork components, essential for both Master's and Doctoral students' curricula. The Ministry of Health (MoH) undertook capacity-building initiatives aimed at empowering health personnel within the Nucleus of Statistics and Planification and at the provincial and district health staff levels. These personnel were instrumental in managing data-related functions both administratively and in the field. Despite their initial limited expertise, they not only managed their routine duties but were also trained to educate their peers.

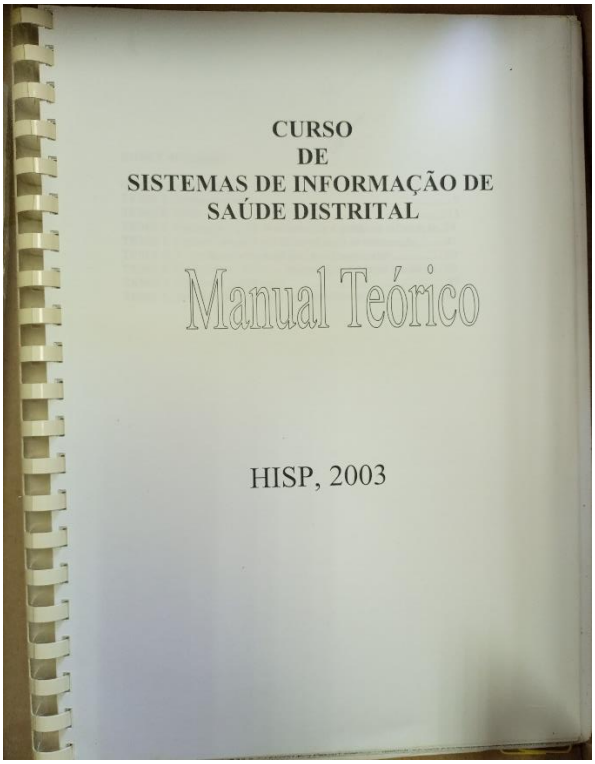
In 2001, the MoH, in collaboration with Health Information Systems Programme teams from the University of Oslo (HISP-UiO) and HISP-Mozambique, orchestrated a comprehensive 10-day course addressing the technical facets of the District Health Information Software (DHIS). The curriculum included key subjects such as the significance of digital data, data quality issues, and the cultivation of political endorsement for digital health information systems (HIS). Initiated in Gaza province, this course welcomed 20 attendees from the three provinces involved in the pilot program. These instructional sessions, conducted in tandem with the DHIS deployment, were pivotal in enhancing political recognition of digital HIS and emphasising its strategic significance. Figure 17 below presents excerpts from two instructional manuals developed at that time.

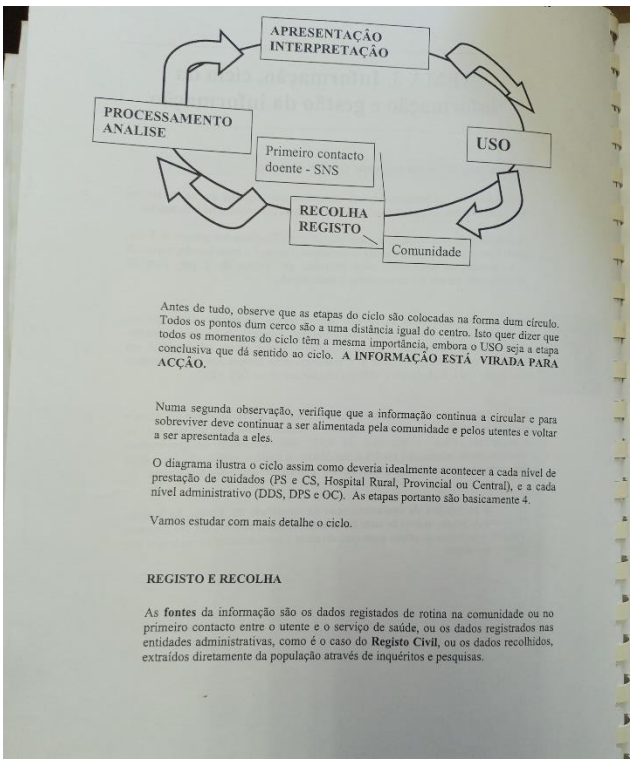
However, the effectiveness of the training was limited due to the trainers' relative lack of experience, especially in recognising the varied information requirements of medical doctors, nurses, and other technicians. The training often emphasised technical aspects, which was viewed as inadequate for fostering a comprehensive understanding of the social system challenges related to Health Information Systems (HIS).

> *"After the initial training, the training to use data entry and analysis began. That is where we began to face difficulties…" (a participant from the academy side)*

Despite facing numerous challenges, a conducive environment was established in Mozambique to launch the initiative. This endeavour aimed to assist the Ministry of Health in carrying out health sector reforms and to aid the Universidade Eduardo Mondlane (UEM) in bolstering its research and educational capacities.

(a)





(b)

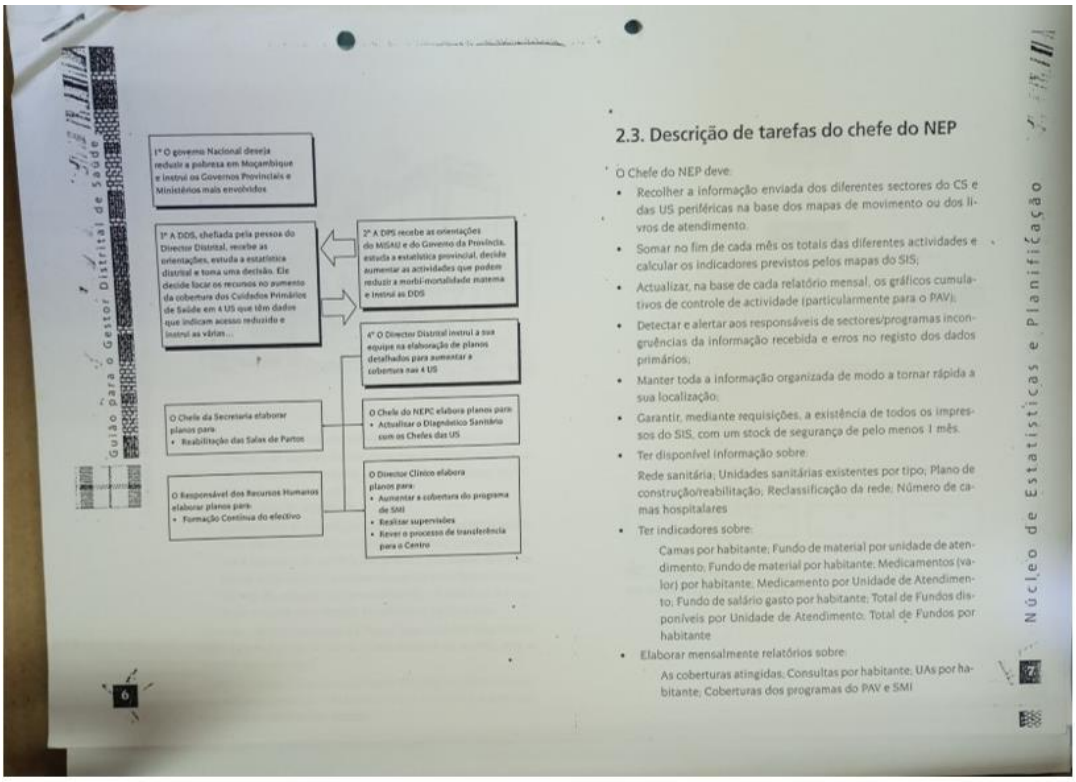


Figure 17. Extracts from two manuals produced for the training conducted by the MoH and the HISP project. (a) A manual for the training in District Health Information Systems. (b) A manual produced specifically for the Nucleus of Statistics and Planification (NEP). Pictures collected during the fieldwork.

5.4 Controversies alongside DHIS pilot implementation process: 2000-2007

5.4.1 Technological contradictions in the process of DHIS "Technology Transfer"

The foundational DHIS software implemented in Mozambique was originally developed using Microsoft Access, based on requirements from South Africa. Initially, the software's code and interfaces were in English, necessitating extensive translation into Portuguese. This task was undertaken by a local team comprising Portuguese-speaking PhD and Master's students from Universidade Eduardo Mondlane (UEM). However, the translation process proved to be cumbersome and fraught with difficulties. While the team was proficient in Portuguese, they lacked specialised expertise in translation and a technical grasp of the specific terms and concepts used in the software. This often led them to seek explanations from their South African counterparts. Further complications arose from the structural variances between English and Portuguese, which sometimes resulted in the loss or misinterpretation of certain concepts during the translation process.

> *"Terms like backup, zoom and data mart do not have a direct translation in Portuguese… the team was forced to perform a partial or intermediate translation, mixing English and Portuguese text. This hybridization of terms often created problems of interpretation for the users." (Nhampossa, 2004, p. 9)*

> *Else… "in order to keep the 'correct' translation, the buttons… had to be enlarged and located in different positions. Or the long strings had to be simplified to keep a reasonable layout and distributions of the buttons" … e.g., "…the translation of 'backup' will be 'Cópia de segurança,' which did not fit in the original user interface button. In this case, the button had to be expanded with knock down implications on the design of the Menu." (Nhampossa, 2004, p. 10)*

Nhampossa (2006) explains that the initial database design was based on specific requirements in South Africa, which were not suitable for Mozambique. Further contradictions arose when the MoH demanded integration between DHIS and SIS-Prog.

> *(1) "ambiguous data elements" in SIS-Prog … e.g., "categories of Children 0-11 months and also 0-4 years, which created an overlap" … (2) "organizational structure" … "South African health structure… consisted of five levels, while we had four" … (3) "fundamental differences between English and Portuguese languages" … e.g., "longer words to express concepts" in Portuguese… "which had implications on the user interface design and the use of icons" (Nhampossa & Sahay, 2005, pp. 342–343)*

"… Many of the functions of DHIS were not yet in Portuguese language. Some of the screens and some functions, for example, when some indicators appeared were already translated into Portuguese. But the programming process was still entirely in English and when data were introduced, in most cases, the person had to adapt based on the English words, which caused disturbances" (a participant from the central level)

The challenges associated with customisations and adaptations, compounded by the limited part-time participation of PhD and Master's students, led to substantial delays in the pilot implementations. Consequently, the initial enthusiasm and expectations for the HISP/DHIS initiative waned. This decline in momentum resulted in the Ministry of Health (MoH) and HISP teams each attributing the delays to the other party.

"…DHIS was gaining experience as a package… in other countries like South Africa, Tanzania, Kenya, India, but in Mozambique it was not developing... the HISP and its active members were at the same time doctoral students who did not have enough dedication to adapt the DHIS to the country." (a participant from the central level)

While these technical challenges and resource limitations primarily impacted health workers responsible for data collection, district-level managers were generally satisfied with the reporting outcomes. Their reports, featuring well-organised data presented in tables and graphs, were more comprehensible in their meetings. However, in the absence of a formal decision to consolidate into a single system, data continued to be entered into parallel systems simultaneously. This resulted in a substantial increase in the workload for health workers, leading to significant dissatisfaction (Mosse, 2005) and a decreased commitment to the new system.

5.4.2 Inadequate infrastructure and capacity to support digital health

The deployment of the Health Information System (HIS) faced obstacles due to poor infrastructural conditions, including power restrictions, electricity outages, communication barriers, inadequate transportation, and underdeveloped road networks, as observed by Mosse (2005) and Nhampossa (2006). Furthermore, constrained government budgets forced the Ministry of Health (MoH) to seek support from external donors. While this provided additional resources, it also contributed to the fragmentation of data, systems, and governance.

"The available resources from the project were to pilot DHIS and not to implement it on a national scale… we did not have that time to pilot, improve and return with human and

financial resources. This also affected the success of an appreciated project." (a participant from the academy side)

"…In terms of technological support, there were Health Units that did not have the resources to buy toner and paper… we arrived, and the PC was there, with the system installed but not working because the computer broke down. It was a mixture of feelings… The support should be given by the Department of Informatics. But they said they went a long time without receiving visits from MISAU…" (a participant from the academy side)

The technical support capacity was limited and predominantly centred in Maputo, the capital city (Braa et al., 2001), which impeded assistance to rural facilities. Moreover, students from Universidade Eduardo Mondlane (UEM) showed little interest in traveling to remote districts.

5.4.3 Contradictory objectives of project "resource persons"

While the Ministry of Health (MoH) nominally agreed to the pilot, there were no explicit directives for transitioning from SIS-Prog to DHIS at the district levels. Compounding this issue, the HISP team could not commit their full time to implementation efforts due to conflicting academic responsibilities. These delays led to mutual blame between both teams and created openings for alternative HIS applications, such as the SIMP (*Sistema Integrado de Monitoria e Planificação*), developed by an expatriate consultant at the MoH, to gain traction. In 2003, the MoH engaged a South African consultant to assess the situation, but the delays continued. The consultant's report, submitted in 2004, proposed several enhancements, including the creation of a new software version tailored to Mozambique's specific requirements. However, this report faced critical scrutiny from another foreign consultant working at the MoH at that time:

"My overall impression of the report is similar to my impression of the consultancy done… A lot of statements, theories about Health Information Systems, suggestions, and recommendations. All with the overall aim of selling the Hisp product… nothing seems to be a problem, everything is possible and everything seems to be relatively easy. But … there is so far no working Sisd [DHIS] *in Mozambique… only a pilot project in 3 provinces using a small dataset… At this moment it is crucial for Sisd to survive to apply the required changes to the software and try to make the pilot provinces a success in the shortest time span possible, for the current tested datasets only. This would already be a huge step forward…. We have to solve our urgent problems first." (Excerpt from a letter with comments on the consultancy report)*

During discussions between the MoH and the HISP team, some of the consultant's suggestions regarding the need to incorporate changes in DHIS were deemed valuable for further development. An excerpt from Staring and Titlestad (2008, p. 5) illustrates how an insight gathered from the requirements in Mozambique influenced the development of DHIS2 abroad:

> "In late 2003, key actors were forwarded an evaluation of the DHIS v1 that had been sent to the Ministry of Health in Mozambique by an unidentified source: *'The DHIS system appears to be a tool mostly intended for small scale scientific research. Its technology is outdated by a decade and design is poor from a conceptual point. As a data gathering system is barely usable by today standards. As a data warehousing system is inadequate. The system should be migrated to SQL server and tiers should be split. WEB enabled user interfaces should be provided. WEB Classes should be constructed to encapsulate the business tier'.* This critique speeded up the work towards a complete overhaul and reimplementation, and by mid 2004, a group of Norwegian researchers and students had begun developing a new version, v2…"

The pressing need for a new system led the foreign consultant to initiate a parallel development of another application called *Módulo Básico* (MB-SIS), which the MoH later adopted in the same year:

> "…*Módulo Básico, the first electronic system that was used for routine data entry and basic information at different levels" (a participant from the central level)*

In the subsequent years, MB-SIS was deployed across Mozambique at national, provincial, and district levels, establishing itself as the main software underpinning the country's Health Information System (HIS). The successful implementation of MB-SIS can be attributed to both the capacity-building initiatives and the user-friendly design integrated into this digital solution.

> *"Módulo Básico was relatively simpler to use. When you introduce a system at the district level and ask for data entry, the simpler and easier it is they adhere to…" (a participant from the central level)*

The new system, developed in the Visual Basic programming language, was designed for operation on Windows systems. Its primary function was to collect and digitise aggregate data, moving it from district to central levels efficiently. This data originated from paper forms linked to various health programs and service areas (Lober & Quile, 2009). To facilitate ease of use for district-level health workers, the system's interface was designed to mirror the paper forms they were accustomed to

completing. It produced reports that were exported and forwarded to higher levels. At these levels, the reports were uploaded into a similar module, edited, and ultimately submitted to the Ministry.

> *"Módulo Básico worked and that is why we had health statistics…" (a participant from the support side)*

The developer continuously updated MB-SIS until the contract concluded in 2009 (Pinto et al., 2015). By that time, the system had been rolled out and was operational in all eleven provinces, 90 of the 154 districts, and at the central level of the Ministry of Health (MoH) (Lober & Quile, 2009).

Although MB-SIS was established as the primary system supporting the HMIS, various parallel systems, backed by donors and health implementation partners, were simultaneously implemented by different health programs. In the subsequent years, the MoH dedicated its efforts to developing a new strategic plan for the health sector (PESS 2007-2012), while concurrently striving to regulate its digital landscape. This focus was evident in several initiatives, including the Health Information System Development Program (2003-2005), the Restructuring and Reorientation of the Health Information System Plan (2006-2008), and the Health Information System Strategic Plan (PESIS) (Almeida, 2007; DIS, 2009).

5.5 Mutual transformation process despite the contrary outcomes

The perception of the DHIS pilot implementation varied among interviewees, with some recalling it as ambiguous and surrounded by conflicts of interest.

> "*…there was the first conflict, or let us say contradiction. The ministry had an immediate need to monitor the planning process… the first strategic plan was already in place… and we couldn't introduce DHIS… it was not adapted... This introduced… two people, both as external consultants, who have made a significant contribution… We… conduct a significant evaluation of the Strategic Plan, and it was accompanied by Módulo Básico and SIMP, which generated many data from the vertical programs." (a participant from the central level)*

> *"…one developer was in the Ministry of Health, the central level and the others were working in parallel… while the Ministry of Health did not approve the work of those… they did little with what they had in hand. Also, for the Ministry of Health to approve it depended a lot on the level of influence at the Central level within the Department of Health Information…" (a participant from the central level)*

"…with donors and expatriates building new software at the same time… He was building Módulo Básico and implementing it at the same time. The Ministry is behind and with ambiguity in deciding what system to use. Some people were discrediting DHIS and suggesting that a new system was needed..." (a participant from the academy side)

The pilot implementation of DHIS in Mozambique marked the beginning of potential transformative changes in the healthcare landscape, most notably in developing digital literacy and capacity building. This shift opened new avenues, especially in the health and education sectors, with professionals becoming more adept at handling digital systems. Moreover, expanding DHIS to new sites and contexts offered opportunities to customise and adapt the software to meet local requirements.

Since its introduction in Mozambique, DHIS has undergone several significant changes, including modifications to language and technical aspects, to better serve local needs and integrate desired features. The software's initial attributes have been progressively refined to align with the specific demands of the implementation environments and to keep pace with evolving technological advancements. The following excerpt illustrates the initial requirements to install DHIS and some of the developments conducted during the pilot in Mozambique, described by Lungo (2003, p. 61):

> "Minimum Hardware Requirements: DHIS will run on any PC that can run Access 97, like 16 MB of memory (RAM), and around 200 MB of free hard disk space is the absolute minimum... Operative System Requirements: The DHIS software runs on all Windows platforms, except Windows 95A (also called OSR-1) and NT 3.5x (…) Database Filter: extraction, transformation, and loading (ETL) software - Database Filter application software is the software I developed in order to accomplish a task of extracting health data from SISPROG to the DHIS. The software was aimed at integrating the technical design and implementation differences of SISPROG and DHIS, so that the two systems can communicate their data."

The process of change for DHIS was initiated with the pilot implementation in Mozambique, but the subsequent developments in this setting did not proceed as planned.

"DHIS 1.3 was not adapted to Mozambique… Politics, donors, and the Ministry behind with the ambiguity to decide what system to use… The process of change of DHIS2 started from there, but in 2006-2007 was terminated in Mozambique." (a participant from the academy side)

Since its establishment, the HISP initiative has broadened its reach to various global locations. By 2005, HISP groups were operational in 9 low- and middle-income countries (LMICs), including Mozambique (Aanestad et al., 2005). The Mozambique branch of HISP began with a team of researchers from the Universidade Eduardo Mondlane (UEM), who spearheaded the research and development project to introduce DHIS in the country. The initial team consisted of six members, including five PhD students and the local project coordinator. Over the following years, additional PhD and Master's students joined the team. As DHIS continued to expand globally as an open-source platform, a second version (DHIS2) began development from 2005. While the South African team provided support until 2006, the responsibility for ongoing assistance transitioned to the HISP-UiO team based in Norway thereafter. Essential contributions to these developments were made by the HISP teams installed in various countries and by various PhD and Master graduates in Mozambique and other countries in Africa and Asia. DHIS2's changes continued to have strong influences from the broad and global DHIS2 community[29] and their implementation processes. In 2008, another stage was initiated in the health sector, with the assessment of MB-SIS and a new project reintroducing DHIS2 (DHIS version 2), which is explained as part of phase 2 in the following chapter.

5.6 Summary: Institutional contradictions shaping the implementation processes

Viewing Phase 1 from an institutional lens reveals how socio-political and technological influences impacted the HMIS implementation processes. During this period, various studies in the setting identified and detailed numerous challenges in implementing digital health solutions. Notably, the work of five researchers from Universidade Eduardo Mondlane (UEM) who were directly involved in the DHIS pilot implementation – Chilundo (2004), Mosse (2005), Nhampossa (2006), Mavimbe (2008), and Muquingue (2009) – provided invaluable insights. Their experiences significantly enriched my analysis, offering a comprehensive view of the HMIS implementation processes through the eyes of active participants. My account of the HMIS implementation drew upon these narratives and incorporated diverse experiences from various perspectives.

These accounts revealed that the HMIS implementation faced numerous institutional contradictions arising from different sources. The setting's conditions were closely linked to recent historical events and the institutional frameworks established to either counteract or facilitate changes. Despite ongoing improvements in the context, several persistent obstacles remained, including inadequate

[29] The DHIS2 community concept exists since the first developments early in 2000. However, the online portal was developed later in 2018 to provide support, approximate the global practitioners and users, and promote the exchange of best practices between them (HISP, 2022).

infrastructure, external dependencies, and a shortage of health workers to support in-house development and the implementation process. The involvement of multiple actors in the HMIS support and their uncoordinated efforts led to further institutional challenges. While certain initiatives introduced in the setting to address these challenges yielded positive results, they also had unintended consequences. For example, the introduction of various digital systems intended to aid the health sector led to an increasingly fragmented HMIS. Consequently, the Ministry of Health (MoH) struggled with ownership issues over both the systems implemented and the data collected. As a result, achieving the HMIS's primary goal of providing a comprehensive overview of the health sector proved challenging.

While the significance of digital health solutions was recognised, it was evident that the sector's immediate priority was to recover from historical setbacks and deliver healthcare services to the populace. The development of regulatory instruments and strategic digital health interventions occurred subsequently, highlighting a phased approach to improving healthcare delivery.

The premises guiding the analysis of institutional contradictions included:

- Institutional processes are comprised of institutional contradictions arising from varying interests of institutional actors within the organisational field, shaping the trajectory of implementation processes.
- Institutional contradictions are not inherently harmful and can be potential catalysts for change, as actors negotiate and take action to resolve them.
- Institutional contradictions can be triggered by multiple sources, including exogenous, endogenous, or a combination of both.

During this phase, I identified key sources of institutional contradictions rooted in infrastructural, regulatory, human-led, financial, and technological limitations. From these, three primary institutional contradictions emerged: 'Resource scarcity hindering readiness for technological innovations'; ‘Multiple stakeholders with poorly aligned and often contradictory interests'; and 'Governance expectations contrasting existing technological and financial challenges'.

Resource scarcity hindering readiness for technological innovations

The first contradiction was evident in the institutional context where the technological artefact was to be implemented. The setting, burdened with human, technical, and financial constraints, was not conducive to supporting the introduction of digital solutions. Conversely, there was a pressing need for the MoH to engage in global developments and establish a consistent digital HMIS. Digital health

interventions demanded adequate human resources and computer infrastructure, which were largely unavailable. Personnel skilled in informatics and computers were confined to central and provincial levels, while rural areas suffered from a lack of resources. To bridge these gaps, the MoH sought external assistance from partners and donors, hiring foreign consultants with IT expertise. This approach mirrored the government's strategy of implementing plans and interventions to address institutional pressures from the previous period, including socio-economic challenges requiring continuous foreign support.

Although contributions from foreign donors, project implementation partners, and non-governmental organisations (NGOs) were essential and welcomed, they resulted in undesirable power imbalances in organisational decision-making. Collaborative relationships formed between local and international entities facilitated the development of new digital solutions (e.g., DHIS) and capacity-building initiatives, including doctoral and master's programs and in-service training.

The health sector's limited tools for governing digital health struggled with the legacy of fragmented systems. Early digital interventions lacked formal frameworks, and weak governance systems led to inconsistencies within the HMIS. The introduction of SIS-Prog and other systems suffered from a lack of consensus among participants, highlighting the need for stronger governance mechanisms to guide integration. Steps were taken to formulate new policies, such as strengthening ties between the MoH and national public universities, fostering new projects, and securing funding. New structures, like the Nucleus of Statistics at provincial, district, and hospital levels, were implemented to support HMIS at lower administrative levels. However, given the scarcity of human resources, this approach exacerbated human-led contradictions.

Multiple stakeholders with poorly aligned and often contradictory interests

The health sector encompassed multiple stakeholders with poorly aligned and often conflicting interests. The expectation surrounding DHIS was that it would streamline activities within the information cycle while supporting health programs and aiding decision-making processes at middle and lower levels.

The Ministry of Health (MoH) anticipated a rapid implementation of DHIS, advocating for a system that delivered complete, timely, and quality data. This system was intended to enhance their reporting processes and monitor the implementation of ongoing plans and activities. However, disagreements arose between the Department for Health Information (DIS) at the MoH and HISP/UEM researchers regarding the progress of the HMIS implementation. In response, the MoH employed a feedback

mechanism, relying on third-party and foreign consultancy evaluations to determine the next steps. A consultant who had previously collaborated with HISP on developments in South Africa and the transfer of DHIS to Mozambique submitted a report suggesting several measures to address inconsistencies in DHIS implementation. This report, however, was challenged by local consultants of foreign origins at the DIS/MoH. They advocated for the urgency of adopting a different digital system that would align better with the First Strategic Plan for the Health Sector, criticising DHIS as unsuitable. Given their proximity to the MoH and involvement in decision-making, their viewpoints gained more traction.

The part-time involvement of the HISP team at the pilot sites led to conflicts with their support responsibilities. Health workers, often left to manage the system alone, faced challenges, and in the absence of necessary support, the system was occasionally set aside. The training programs introduced were predominantly technical and did not adequately address the development of a social system understanding of health information system challenges. Furthermore, in the absence of researchers and students, health workers with limited data management experience were tasked with training responsibilities, which compromised the quality of the training. Subsequently, the MoH launched new initiatives to train statisticians in health data management.

The shortage of skilled health personnel to support data management functions contrasted with the increasing responsibilities placed on health staff to assist the HMIS. At the pilot provinces, lower-level managers accepted DHIS, recognising its relevance in facilitating upward reporting tasks. In contrast, upper-level managers viewed DHIS as unready for broader implementation and believed it required more support before further investment. Their stance was bolstered by unfulfilled expectations and the lack of consistent technical support for implementing and utilising DHIS. Health workers at the facility level, already facing heavy workloads, found data management to be an additional burden. Without formal directives from higher authorities to persist with the pilot, their commitment to DHIS implementation gradually waned. Furthermore, with the introduction of MB-SIS in 2004 and the recognition that data entered into this system would be utilised in reports, the motivation to continue using DHIS dissipated.

Meanwhile, managers, health workers, researchers, and developers involved in the project gained exposure to new technologies and learned valuable lessons throughout the process. This experience was instrumental in fostering collective awareness about data management processes and their value. Nonetheless, divergent needs, interests, and viewpoints posed challenges to decision-making and influenced the project's direction. Although there was a shared goal of strengthening the health sector

through improved HMIS, achieving consensus on methodologies and satisfying all stakeholders' expectations proved difficult. Consequently, the HISP project was put on hold, but educational activities at Universidade Eduardo Mondlane (UEM) maintained strong momentum.

Governance expectations contrasting existing technological and financial challenges

DHIS was recognised as a promising digital solution to support the HMIS, yet organisational transformations were not fully synchronised with it, particularly due to its technical limitations in addressing local needs. Developed primarily for South Africa, DHIS included specifications unsuitable for Mozambique. The software, initially in English, required extensive translation into Portuguese and adaptation to local contexts. The local team, responsible for these tasks, comprised Portuguese speakers lacking expertise in translation and a deep understanding of the specific technological terminology. Furthermore, integrating DHIS with SIS-Prog presented significant challenges due to their differing specifications and lacklustre political alignment, leading to a process marked by delays and challenges.

Unmet expectations from the Department for Health Information (DIS)/MoH at various stages spurred parallel developments. In 2002, the MoH, with assistance from an expatriate consultant, developed the Integrated System for Monitoring and Evaluation (SIMP), a response to the need for improved data quality from the fragmented systems. SIMP, an integration tool, collated information from SIS-Prog and other systems but offered limited support for health programs and lower levels. In 2004, MB-SIS was developed alongside DHIS to monitor strategic plan implementation and address reporting process gaps. For a decade, MB-SIS bolstered the HMIS, its acceptance at middle and lower levels facilitated by prior exposure to training and experiences with SIS-Prog and the DHIS pilot.

Despite some institutional contradictions from Phase 1 persisting into the subsequent phases, their impact on the HMIS implementation process varied, reflecting ongoing transformations in the setting and changes in the institutional context. Moreover, both the technological artefact and human actors evolved, acting as mediators and influencing the HMIS implementation processes, as detailed in the following two chapters.

Chapter 6 : Phase 2 – Reassessing the national Health Management Information System (2008-2014)

6.1 The socio-political and digital context shaping the health sector

During this period, the government focused on public sector reforms, as outlined in the second Plan for the Reduction of Absolute Poverty (PARPA II), spanning 2006 to 2009 and subsequently integrated into the 5-year government plan. The digital landscape played a pivotal role in implementing these reforms. Regulatory advancements were continuously made to facilitate e-governance and system interoperability strategies. There was notable growth in companies offering digital equipment and maintenance services.

However, the country still faced significant challenges, particularly in transport infrastructure. Developing urban transportation links with rural areas is crucial, yet expanding and maintaining road and railway networks require investments beyond the nation's financial capability (Dominguez-Torres & Briceño-Garmendia, 2011). These limitations impact healthcare delivery, access to health facilities, and the daily operations of health professionals within the HMIS. Overcoming the vast distances between rural areas and health facilities is a formidable task without adequate roads and transport. The entry of a third mobile company improved communication network coverage and Internet services, which was critical in addressing communication and information exchange challenges in the HMIS.

The health sector mirrored the digital revolution, initiating efforts to revamp the HMIS in 2006 with the Restructuring and Reorientation of the Health Information System Plan (2006-2008). The assessment of MB-SIS in 2008 marked the effectiveness of these efforts, further strengthened by the Health Information System Strategic Plan (PESIS) for 2009-2014.

In 2010, an MoH assessment of human resource systems uncovered discrepancies in data from existing systems, including an Excel-based system at the facility level and two government systems for managing finances (eCAF) and human resources (SIP).These were considered insufficient to support decision-making and motivated the MoH to engage in the development of a more reliable system between 2011-2015[30]. The new system, named eSIP-Saúde

[30] The development was done by the Center for Development of Financial Information Systems (CEDSIF), a MEF's information technology (IT) unit, with support from the MoH, and a team from Jhpiego (Johns Hopkins Program for International Education in Gynecology and Obstetrics). The latter plays the role of an implementation partner, representing the donor, the Center for Disease Control and Prevention (CDC) (Waters et al., 2016).

(electronic Personnel Information System for Health), integrated various components. It encompassed eCAF, which manages the payroll of state employees, along with an eCAF-health extension. This extension tracked the physical location of workers at health facilities and their respective professional categories. Additionally, two independent databases were incorporated: SIFIn (Initial Training Information System), which monitors pre-service training activities for enrolled and graduating students in health careers, and SIFo (Continuous Training Information System), which records data from in-service training courses (Waters et al., 2016).

Over the years, the MoH primarily focused on aggregated routine data reporting systems (Nhampossa, 2006). Thus, to support planning, monitoring, and evaluation of the health sector achievements while meeting the reporting needs of the government, donors, and other partners. As suggested by one of the interviewees,

> *"The ministry had an immediate need to monitor the planning process… the entire strategic planning process also meant consistent monitoring of the financial resource utilisation process." (a participant from the central level)*

Simultaneously, health programs continued introducing and supporting their systems[31], implementing local initiatives at the provincial, district, and facility levels. Despite significant support from foreign organisations, the growth in local capacity facilitated increased participation and local development initiatives. In this challenging environment, the Ministry of Health (MoH) faced the task of balancing its focus between aggregate and patient-based systems while striving to minimise inconsistencies in reporting.

The MoH's shift in perspective became evident as it incorporated various types of systems. Additional systems were introduced to register and monitor ongoing activities and services provided by hospitals at the central, provincial, and district levels. Examples of these included the Maputo Central Hospital Information System (*Sistema de Informação do Hospital Central de Maputo, SIS-HCM*) and the Information System for Hospital Mortality Registration (*Sistema de Informação para Registo de Óbitos Hospitalares - SIS-ROH*)[32]. Initially developed

[31] Electronic Medical Record (EMR) systems were available and in use to manage patient data at the facility level, implemented by health sector partners supporting the health programs. These include the DREAM software, the MSF eRegister (with two EMRs - Tier.Net and iDart), the FGH OpenMRS EMR, the TB EMR, the CCS Software, and SIS-ROH (HISP, 2014).

[32] The development of SIS-ROH in 2007 was led by a Researcher from UEM in collaboration with students from the Department of Informatics, at the Faculty of Sciences of UEM. This successful initiative led to the creation of the Living Lab at UEM, later designated MOASIS. More details in (Moasis, 2023b)

and implemented in the country's capital at the Maputo Central Hospital, the system recorded individualised data. Following its acceptance by the Ministry of Health (MoH), the system was adopted and scaled up nationwide, reaching 13 hospitals by 2011 (DIS, 2011).

Continuing its development, the MoH strengthened its local teams to support the HMIS, involving the Department of Information for Health (DIS) and the Department of Information, Communication, and Technologies (DTIC). Despite these efforts, limited experience and financial constraints necessitated continued reliance on partnerships to implement their digital initiatives. In this context, the MoH established in 2008 a relationship with a Living Lab initiative designated by the Mozambican Open Architecture Standards and Information Systems (MOASIS)[33]. This initiative was developed within the Eduardo Mondlane University (UEM) and spearheaded by a researcher with a background in informatics, who was instrumental in introducing the District Health Information Software (DHIS) in Mozambique in the early 2000s. The team also included former executives from the Ministry of Health (MoH) and received support from Jembi Health Systems, a South African information technology organisation.

During this period, MOASIS and Jembi were engaged in the Open Architectures, Standards, and Information Systems (OASIS) project, funded by the International Development Research Centre (IDRC) of Canada (Seebregts et al., 2012). This project advocated for the development of technological solutions under open architecture software, specifically the adoption of Open Medical Records System (OpenMRS). The project also facilitated the introduction of OpenMRS in Rwanda, South Africa, and Zimbabwe. In Mozambique, there was an effort to migrate SIS-ROH from Visual Basic to the OpenMRS platform, which was ultimately unsuccessful. The new software was unable to meet all the specifications of the former version, leading to the abandonment of the project.

> *"…one of our first activities in Mozambique was to establish whether there might be use for OpenMRS… essentially looking at reusing the existing health information systems in Mozambique based on the priorities of the ministry…" (a participant from the support side)*

> *"…we tried a migration from SIS-ROH to OpenMRS… although some features were not present in the new platform… we worked extensively on this… it was too complex*

[33] Website of the organisation: (Moasis, 2023c)

and eventually we opted to abandon the process…" (a participant from the support side)

The unsuccessful attempt to implement OpenMRS as an alternative software platform for SIS-ROH did not deter other organisations from adopting it. OpenMRS was favourably received by several partner implementers and played a supportive role in the nationwide systems for the HIV program.

> *"…eventually it was chosen as a system to be used by CDC[34] and implementing partners for HIV care treatment and patient management… we promoted the use of OpenMRS which is now used throughout Mozambique…" (…) "…not used by the ministry of health in Mozambique, it is used by the US government agencies..." (a participant from the support side)*

> *"HIV/EGPAF partners use OpenMRS for individual data. They share this with the DPS (Provincial Directorate of Health), which in turn cross-references it with the data extracted from the aggregated (main system). The compilation is made and then sent in a parallel report." (a participant from the provincial level)*

Meanwhile, in addition to OpenMRS, other platforms were being evaluated for implementation in the country, such as DHIS2 with its advanced online capabilities (Adu-Gyamfi et al., 2019). The successful experiences with this newer version in other African countries caught the attention of the MoH, leading them to consider it an appropriate solution for supporting the HMIS in Mozambique. Table 22 summarises the key developments within the HMIS from 2008 to 2014.

Table 22. Critical systems and developments within the HMIS between 2008 and 2014.

Year	Key events in Mozambique
2008	Maputo Central Hospital Information System SIS-HCM (SIS-HCM) [a]
2008	Health Information System for Mortality Registry (SIS-ROH), implemented at hospital level in various levels (13 Hospitals by 2011) [b]
2009	Development and implementation of Módulo Básico Anexo (MB-SIS.Anexo) [c]
2009	Adoption of OpenMRS by partner organisations operating in the health sector in Mozambique [d]
2010	OGUMANIHA Information System (OgIS) developed with DHIS2, for the Project OGUMANIHA (5 NGOs operating in the health sector in Zambezia province) [e]
2011	eSIP-Saúde (electronic Personnel Information System for health) development begins

[34] Center for Disease Control and Prevention (CDC)

2013	Developments within the HMIS with DHIS 2.13
2014	Pilot of the system developed with DHIS 2.13 and initial developments of a parallel system with DHIS 2.16

Sources: [a] *De Faria Leão* (2007)*;* [b] *DIS* (2011)*;* [c] *Interviews;* [d] *Massingue et al.* (2017)*;* [e] *Moon et al.* (2014) *and Saugene* (2014)*.*

6.2 Strengthened interventions to increase digital capacity

The landscape of research and capacity-building has undergone a significant transformation since 2000. Investments from both the local government and UEM have flourished at various levels. By 2010, approximately 23,504 students had graduated from institutions overseen by the Ministry of Health (MISAU, 2011).

Local universities and institutes were involved in educating health personnel, training various technicians, bachelor's and Master's graduates, and doctors locally and abroad. At the tertiary level, some of the interventions included the creation of University Lúrio (UniLúrio) in 2006 and University Zambeze (UniZambeze) in 2007[35]. These two public universities, situated in the north and centre of the country, respectively, each boast their own Faculty of Health Sciences. Additionally, several private universities offer courses tailored to the health sector.

The engagement of health personnel in research and education has proven to be beneficial in multiple aspects. Efforts to reinforce the Health Information System (HIS) were augmented by capacity-building initiatives, with their positive impact evident across the entire evolution of the HIS.

"We consider it foundational to build capacity in the country, and this part of the project was well succeeded: "Building capacity was a success." (a participant from the academy side)

The International Master program was jointly provided by UiO and UEM, with opportunities for doctoral studies at UiO. Between 2001 and 2007, at least 38 master's students[36] and 5 PhD researchers graduated from these programs, and their contributions were significant both locally and abroad. The participants were actively engaged in teaching, fieldwork, and developmental activities in Norway and their home countries (Kaasbøll et al., 2019). In Mozambique, the expertise they gained was instrumental in contributing to the local university. They developed master's programs specifically tailored to the nation's unique context and

[35] Website from University Lúrio (UniLúrio, 2023) and University Zambeze (UniZambeze, 2023)
[36] Attachment 5 lists the dissertations from these students.

needs. The existing Master's program at the Faculty of Medicine was significantly enhanced. Additionally, a new master's program in Informatics was established at the Faculty of Sciences in 2006 (DMI, 2011). These programs have consistently evolved, capitalising on the available human resources and broadening the involvement of local professionals from sectors beyond healthcare.

> *"… two major revisions to the curriculum, but always those key components of information systems for health, monitoring, and evaluation, and using information for decision-making have been there and been there strong… we can say that it seems to be a little far from the initial philosophy, but it has grown, in the sense of meeting the health manager's needs and, within the component of Information system…" (a participant from the academy side)*

> *"…I started coordinating the master's in (name of the program), first temporarily and then in (year) I became the coordinator of the master's in (name of the program) explicitly, with a formal position…" (a participant from the academy side)*

The contributions of the graduates were pivotal in the development of various initiatives, such as MOASIS and other HISP groups globally, thereby reinforcing the international DHIS2 community (Adu-Gyamfi et al., 2019). Another critical aspect of capacity building was the introduction of the DHIS2 Academy concept, along with its associated in-service training courses in 2011 (Adu-Gyamfi et al., 2019; K. Braa et al., 2014). In Mozambique, this initiative played a significant role in supporting the reimplementation of DHIS2 through a new system and fostering its continued development. Box 5 below outlines the origins of the HISP groups and HISP-Mozambique.

In practice, the HISP groups are organisations created as initiatives from local universities or settled independently, well positioned and related to the Ministry of Health (MoH) in their settings. These relationships have been established "through research and development projects... where many of the lead local experts in these organizations are graduates with a Ph.D. from UiO" (p.5) or have been associated with the HISP since its inception and all the way through the years. Despite that, the genesis of each HISP group is different. For instance, "HISP West and Central Africa started as a UiO initiative to support Sierra Leon 2008, with locals from Togo who had an affiliation with the UiO. Later, in 2012, the locals with support from the UiO formed the HISP West and Central Africa. HISP Tanzania, on the other hand, started as a project within the UDSM, but later registered HISP Tanzania as an incorporated company that now works in complementarity with the UDSM" (p.9). HISP-India commenced with one of the senior researchers leading the transfer of DHIS from South Africa to India and Mozambique, and that registered the group as a non-profit organisation.

HISP-Mozambique commenced as a group of researchers from UEM involved in a research and development project. Later, in 2014, an organisation designated Saudigitus[37], led by one of these researchers, was created as an entity separated from UEM to assume the demanding activities of development, implementation, and support closer to the MoH. Since then, HISP-Mozambique has been represented by Saudigitus. The UEM researches continue to take part of HISP-Mozambique, with a more direct involvement in the Master Programs ran at the university and engaging with DHIS2 Academies. Saudigitus, is more technical and includes +15 team members, which are enrolled with development and implementation roles, and participate in the organisation of the DHIS2 Academies.

Currently, HISP-Mozambique provides in-country support, to the MoH and other organisations, and extends its activities to the Lusophone countries in Africa. They work close to HISP-UiO and collaborate with other HISP groups, in cross-country projects, academies, and other activities scoped within their expertise.

Box 5. The HISP-Mozambique, genesis and profile. Source: Collinson et al. (2020)

[37] Website of the organisation: (Saudigitus, 2023)

Over a hundred in-country and regional DHIS2 Academies have been organised and held over the years, coordinated by HISP-UiO, regional and country HISP groups[38]. Table 23 summarises some critical developments related to the DHIS2 academies at the global level and also in Mozambique.

Table 23. Developments around the DHIS2 Academies in Mozambique and abroad.

Year	Event
2011	First DHIS2 Academy is arranged by HISP-UiO
2012	First DHIS2 Annual Conference, formally designated as Experts Academy
2014	First DHIS2 International Academy in Mozambique, held in Portuguese and English, including local and foreign participants

Source: Adu-Gyamfi et al. (2019) and Braa et al. (2014).

The next section describes the unfolding processes around the development of the new software to support the HMIS.

6.3 Reintroducing DHSI2 in the setting

The digital landscape surrounding the HMIS continued to evolve, marked by the emergence of new players, shifts in the roles of existing entities, and the formation of new alliances. Figure 18 visually represents some of the key relationships established during this period.

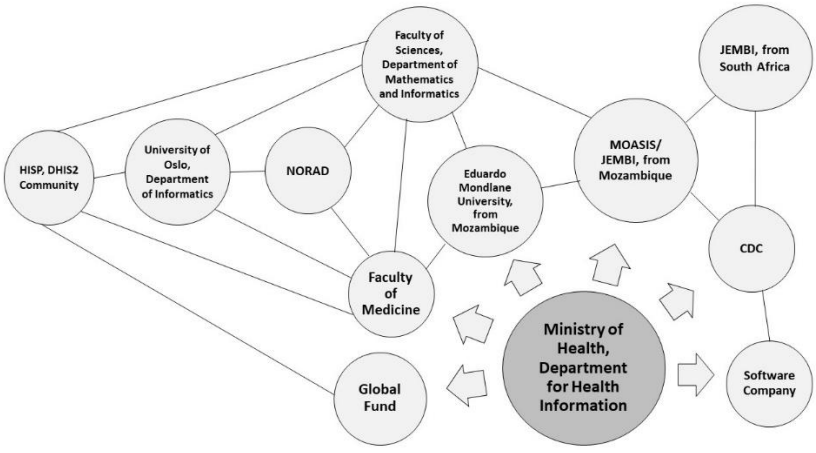


Figure 18. Entities involved in the second phase of the HMIS implementation in Mozambique.

The MoH recommended an assessment of MB-SIS, conducted between 2008 and 2009 by the International Training and Education Centre on HIV (I-TECH) (Lober & Quile, 2009). This evaluation revealed certain limitations of MB-SIS, particularly its inflexibility in incorporating

[38] Information compiled from https://training.dhis2.org/ and https://dhis2.org/academy/

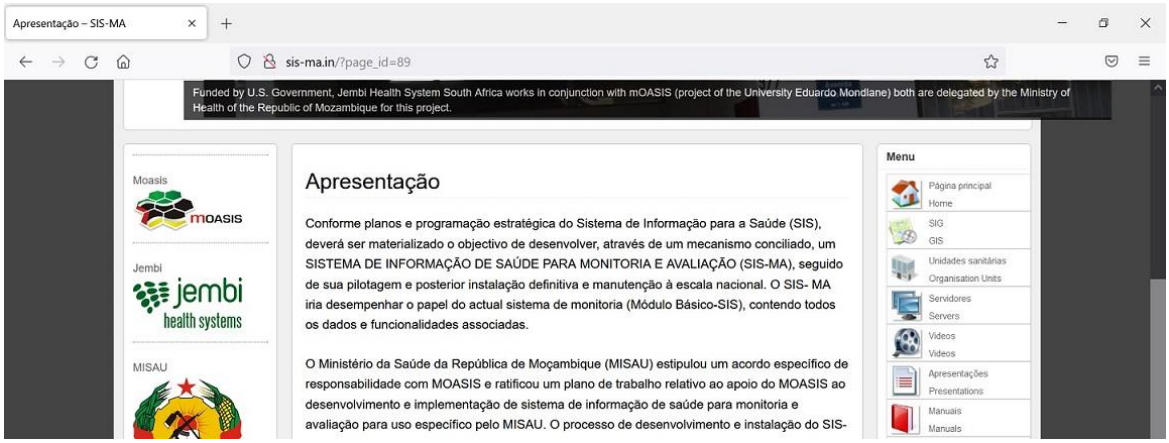
new forms and fields. Three potential courses of action were proposed: maintaining and enhancing the existing system, replacing it with a new development, or implementing a combination of both. In partnership with MOASIS, the MoH evaluated these options and decided on the hybrid approach.

Subsequently, MOASIS initiated an immediate intervention, creating a new application that seamlessly integrated with MB-SIS to expand its capabilities and ensure uninterrupted service. This additional module allowed health programs to introduce new forms and fields to the pre-existing structure, and was named MB-SIS.Anexo.

> *"…it became unsustainable. Its code was complex... Few changes could be made. In addition… there were limitations not only in the fields that we could put in the forms but also in the number of forms we could have in the system (…) We had to develop a mini application… and place a button into Módulo Básico to call it up. This application… was able to accommodate new forms… When people found out what we had done, they started asking to include more forms." (a participant from the support side)*

Building on the strong relationship established between the MoH and MOASIS, a Memorandum of Understanding (MoU) was signed (Pinto et al., 2015). This agreement granted MOASIS the authority to conduct either a national or international public tender on behalf of the MoH. Initiated in the first half of 2012, this tender was financially supported by the Centers for Disease Control and Prevention (CDC). Consequently, MOASIS's role expanded to include selecting a suitable software development partner for the project (ibid).

(a)



(b)

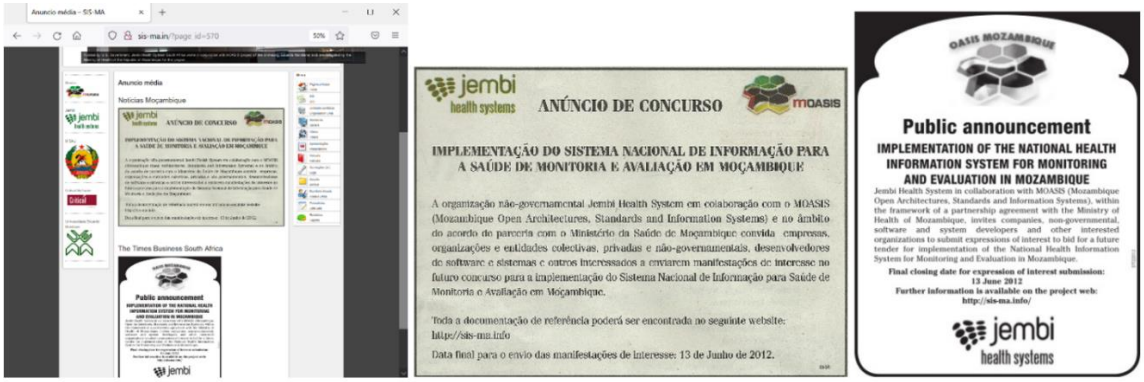


Figure 19. Announcements extracted from the project website (http://sis-ma.in/), on 21.03.2023. (a) Delegated responsibilities, and (b) Launch of the tender.

This initiative was publicised through a local newspaper and a project website where additional documentation was made available (Moasis, 2014)[39]. Figure 19 displays images from the website that are still accessible. The project received multiple proposals from potential partners both nationally and internationally, which included one from HISP Mozambique.

> *"There was one tender for a new system… in Mozambique, we bid for that, and another company from Portugal was selected." (a participant from the academy side)*

The software company engaged for the project advocated for the adoption of DHIS2, a web-based iteration of DHIS launched in 2006 (Adu-Gyamfi et al., 2019). Box 6 details the evolution of this software and highlights several significant initiatives undertaken in Mozambique. The MoH was persuaded by the argument that DHIS2, with its expanding

[39] More images captured and documents extracted from this website are included in the Attachments Section.

reputation as an attractive open-source platform, would be well-suited for future developmental needs.

The development of a new version of DHIS was initiated in 2005, through a collaborative work involving developers and researchers from Norway, South Africa, India, Ethiopia, and Vietnam (Saugene, 2014). The release of DHIS2 in 2006 brought with it new prospects for transforming this software due to its web-based architecture and open-source nature. The tendency to accommodate the demands from the field is reflected in a continuous process of shaping while being shaped. In 2009, the requests from Kerala, one of its crucial implementation sites at the time in India, stimulated the development of a new data model to collect and manage individual data records, which was later designated Tracker (Gizaw, 2014; Nielsen & Sæbø, 2016). The first implementation of DHIS2 in Africa was held in Sierra Leone in 2007 (HISP, 2022). In 2010 the Ministry of Health in Kenya implemented an online DHIS2 server (Adu-Gyamfi et al., 2019; Braa et al., 2014). Other implementation processes followed in more African countries, including Ghana, Rwanda, and Uganda (HISP, 2022). In Mozambique, during this period initiatives carried by private and public organisations related to DHIS2 use are acknowledged. These include for instance the project OGUMANIHA, held by a group of seven NGOs operating in the health sector, which adopted DHIS2 in 2010 as a framework to develop an information system that was designated OGUMANIHA Information System (OgIS) (Saugene, 2014).

Box 6. The developments of DHIS2 abroad and in Mozambique.

A team was created for the next phase, including members from MOASIS, the developer company, and the MoH.

> *"…we had a mixed team, with MOASIS… and (company name) subcontracted for the development." (a participant from the central level)*

The new system was designated in Portuguese as *Sistema de Informação para Monitoria e Avaliação* (SIS-MA), meaning information system for monitoring and evaluation.

> "*We presented this to the ministry proposing to implement a system for monitoring and evaluation (so-called SIS-MA). It was a different name, but we had DHIS behind it. We could not come as HISP or use the name DHIS, or else we would be fought*

automatically, but fortunately, DHIS was back and was there, but with a different name." *(a participant from the support side)*

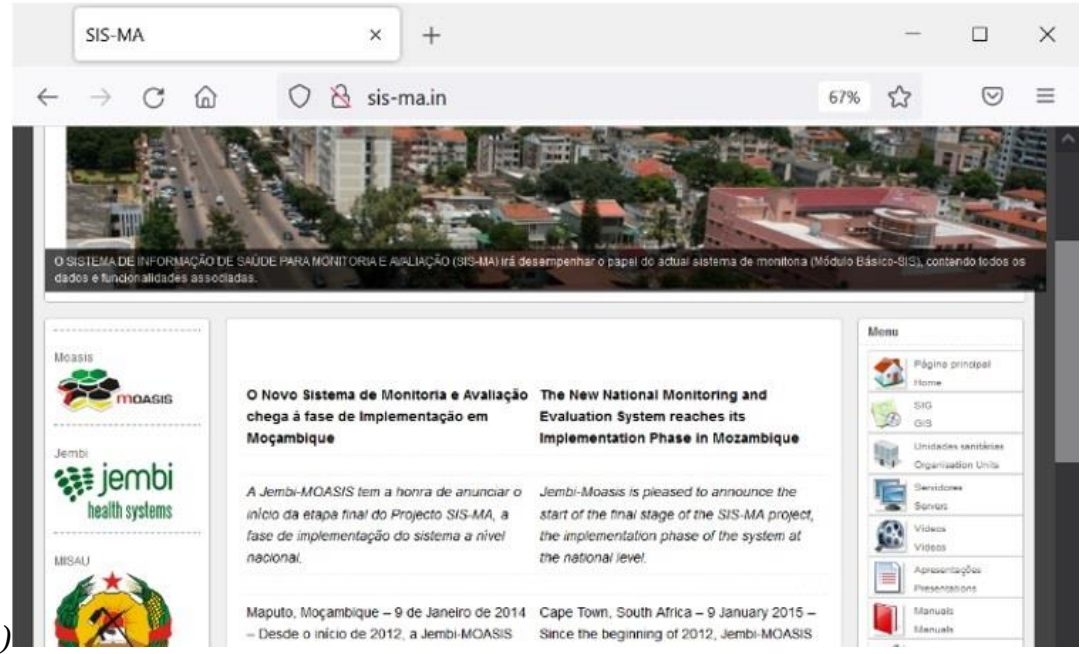
The experiences and opinions of various participants was solicited at the central level, with inherent divergences in opinions. Some recalled it as being organised and inclusive, while others recalled it as fraught with tensions and delays,

"I participated in many activities, with a group, a company, we had to collaborate with them and say what we needed. We had various meetings; it was an organised process." (a participant from the central level)

"*…the first attempt didn't work well. Because we had an entity in the middle and… the health programs and the funder. It took a long time to get an operational version because there were many interests, and it was difficult to coordinate a compromise…" (…) "It was difficult and tense." (a participant from the central level)*

Nonetheless, by the end of 2013, the new digital solution was nearing readiness for pilot testing and training, with a full rollout planned for 2014. In the early part of the subsequent year, several key activities commenced, including the distribution of computers, pilot testing at selected sites, and comprehensive training sessions. Figure 20 below displays an announcement from the project's website and an image of the manual produced for the upcoming training and practical application.

(a)



(b)

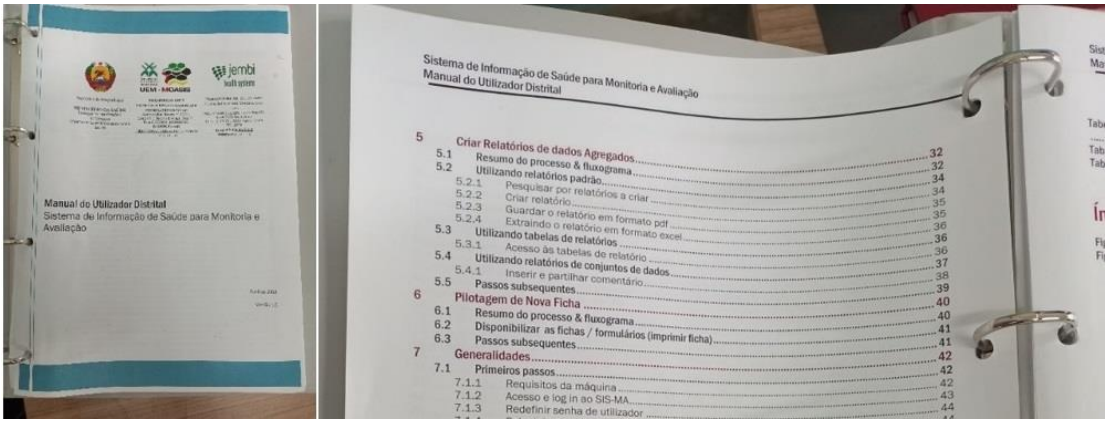


Figure 20. (a) Announcement in the project website and (b) Manual used for training and piloting SIS-MA in 2014. Pictures collected during the fieldwork.

The pilot of the first version of SIS-MA was conducted in some districts from Maputo City, as some of the participants recalled:

> *"...when they had a prototype... presented to the Ministry... when the Ministry accepted... they completed it and then came the next phase... the pilot phase, then a set of health units was selected... all these selected health units where in Maputo City... Inhaca and Katembe... all close so that they could go back and forth easily... a hybrid model was applied. A computer... Internet... to have access to the SIS-MA and they were asked to enter the data in SIS-MA in the same way that they entered in the Módulo*

Básico… collected the user experience… and based on that… the plan was revised… concerning the development…" (a participant from the support side)

Despite the progress in the implementation processes carried out by the developer company, under the coordination of MOASIS, the first version of the system, designated SIS-MA, did not reach the rollout phase. The controversies that emerged during this period are detailed in the subsequent section.

6.4 Controversies around the developments of the new system

The new system, named SIS-MA, was built using DHIS2—a newer version of DHIS that had previously been piloted in Mozambique. The development team began working with the latest version of DHIS2, version 2.13, which was released in October 2013 (HISP, 2013). That year also saw a change in the leadership of the MoH's Directorate of Planning and Cooperation (DPC). A UEM researcher with a medical background, who had been involved in the early stages of DHIS piloting, was appointed Deputy Director of DPC. Subsequently, the MoH commissioned a comprehensive evaluation of the entire HMIS, supported by the Global Fund, which included an assessment of the system currently under development.

In January 2014, the software development team announced and began piloting SIS-MA. Concurrently, the MoH emphasised the need to enhance the quality of existing reports produced by various health programs. In response, the DIS team, led by the Deputy Director, began developing a parallel instance of DHIS 2.16, a version released in July 2014 (HISP, 2016).

The report from the consultancy was delivered in 2014, which changed the course of events. The report highlighted inconsistencies[40] that needed to be addressed before further progress could be made, and the current implementation model was not approved. Some of the issues identified were related to the system's ability to perform continuous updates to the core, which was based on DHIS2, as well as the output data.

[40] According to the report findings, some issues were identified such as the lack of harmonization of data entry forms from the health programs and inconsistent technical decisions. Examples of the latter include the adoption of an offline approach when an online one was needed; the decision to include a 6 servers setup when one central data warehouse could be sufficient; the developments using an older version of DHIS (2.13) instead of a more updated (2.16) as requested by the MoH; "over-emphasis on coding" to include the facility list instead of using the existing and more adequate DHIS2 org unit structure (HISP, 2014).

The new leadership at the MoH negotiated the necessary changes, which involved significant modifications to the recently developed system. However, this was not well received by the previous funders, as one participant recalled,

> *"MISAU was not satisfied with the development approach" ... (amid a decision to recreate a new version of the system) ... "many conflicts arise with the donors who sponsored the (initial development), who saw the process as a waste of funds and decided not to finance MISAU in this process." (a participant from the central level)*

As a consequence, the new leadership at DPC-MoH sought alternative funding sources and secured support from the Global Fund. This assistance, coupled with backing from top MoH management, enabled a pivotal shift in the HMIS implementation process. Consequently, the rollout of the first version of SIS-MA, developed by the contracted software company, was suspended, and the launch of the new system was deferred. The DPC-MoH took over the development activities, introducing changes to the development team. The previous work with DHIS 2.13 was discontinued, and the new team, under the new leadership, proceeded with the development using DHIS 2.16. The system continued to be identified as SIS-MA.

6.5 Summary: Institutional entrepreneurs challenging their institutional context

In Phase 1, I outlined the institutional pressures that impeded digital initiatives in the country from 2000-2007. Additionally, I discussed various socio-political and technological evolutions that counteracted these pressures and enabled gradual transformations within the setting. The enhanced human capacity, nurtured through designated training institutions with PhD, Master's, and various professional programs, emerged as a key facilitator in Phase 2. Senior health sector managers became increasingly cognisant of the challenges, leading to numerous assessments and the implementation of more comprehensive instruments in this domain. The MoH engaged in the eGovernance process by launching its website and developing policies and other instruments that supported initiatives around interoperability and integration processes. Policies and strategies were formulated to guide healthcare provision, and various instruments were established to monitor the HMIS's evolution, aligning with the overall strategic plans.

However, the absence of a consistent framework was noticeable, and despite the HMIS being more regulated and initiatives following a more planned format, the HMIS revealed elevated levels of fragmentation. The global digital landscape provided various technological

alternatives[41]. HISP-UIO continued the development of the new DHIS2 and supported its implementation internationally. In Mozambique, NGOs active in the health sector adopted DHIS2 to enhance their operations. Initiatives like MOASIS championed OpenMRS as a platform for crafting digital solutions centred on individual data, especially for health programs requiring patient tracking and long-term treatment monitoring, such as HIV and TB. Partner organisations and other entities within the health sector became cognisant of these innovative digital solutions and engaged in their development. This involvement exerted pressure on the MoH to expedite the restructuring processes.

The analysis in this chapter is based on the following key premises:

- Organisations and individuals are not passive but possess 'embedded agency', enabling them to question their current situations and take actions attempting to change them.
- Organisations and individuals may gather resources and support from powerful actors, both internal and external to the organisation, thereby challenging the status quo of their institutional contexts. The model of institutional entrepreneurship may be internal, external, or hybrid.
- The institutional and historical context influences the behaviour and processes of the embedded organisational actors and the agency they can exert.
- Institutional contexts vary over time as they go through different developmental stages of foundational norms, regulations, and cultural values, requiring varied entrepreneurial approaches and strategies.

For this specific analysis, insights derived from the institutional context discussed in Chapter 4 are considered. During the period from 2008 to 2014, the institutional context was observed transitioning from its initial formation phase towards greater stability, especially with improvements in the health sector. Although organisational practices were well-established, other supporting aspects were still evolving, including enhancements in technical infrastructure and digital skills among support teams and users. Managers at the Ministry of Health (MoH) displayed increased awareness of the potential and implications of digital systems, and were better equipped with strategic tools for interventions within the sector.

[41] Examples of platforms developed and used in several countries include District Health Information System version 2 (DHIS2), open medical record system (OpenMRS), OpenELIS, Baobab Health Trust, Smartcare (Fraser & Blaya, 2010).

In this study, I have focused on the roles of various actors, including organisations and individuals, in the implementation processes. I recognise the involvement of local managers from the Ministry of Health (MoH), international agencies, implementation partners, both internal and external consultants, local and foreign organisations, and researchers, particularly in Phase 1. Certain organisations played dynamic roles in these processes, adapting their involvement as situations evolved. For example, HISP-UiO initially advocated for the introduction of DHIS in the early 2000s and later, during Phase 2, played a key role in evaluating and influencing the development of DHIS2. Another significant participant is UEM, represented by researchers who were involved in the DHIS pilot and contributed to the Master programs and the MOASIS Living Lab. The contribution of international agencies like NORAD, CDC, and Global Fund was crucial during this period. Consultants, especially in Phase 2, were instrumental in assessing the HMIS both before (led by ITECH) and during the development of the new system (led by HISP-UiO). Their feedback was vital in guiding the MoH's decisions throughout this process.

The narrative also details the efforts to develop the new system in line with previously established strategic plans. At that time, the MoH acknowledged its technical limitations and sought the expertise of MOASIS and Jembi. The MoH and CDC endorsed these entities and provided financial support. MOASIS included former senior managers from the MoH with extensive health sector experience, and was led by a researcher with an informatics background, who was involved in both the DHIS pilot and the successful implementation of SIS-ROH at the hospital level. MOASIS, in collaboration with Jembi, participated in the OASIS project, an international initiative involving other Ministries of Health across African countries. Their expertise was well-respected, positioning them as key implementation partners for the MoH. They assisted in selecting the software company for system development. However, despite the technical proficiency of the chosen software company, their approach was not favourably received by the MoH, leading to a pause in the process.

While the HMIS implementation was shaped by the existing institutional contexts, the organisations and individuals involved also played significant roles. The initiatives by MOASIS in Phase 2 and HISP-UiO in Phase 1 can be viewed as entrepreneurial actions, as both were authorised by the MoH and supported by external financial resources for the HMIS implementation. Their actions aimed to address the institutional challenges in the setting. However, their success was partial, as the trajectory of the HMIS implementation during both

phases was also steered by individual actors. I acknowledge the critical roles of two individuals who significantly influenced the HMIS trajectories, conceptualising them as institutional entrepreneurs.

In Phase 1, the HMIS implementation process was significantly influenced by an individual serving as a consultant. Although a foreigner, he was deeply involved with the Ministry of Health (MoH) activities. His technical expertise earned him a favourable position within the MoH, where he was regarded as part of the team and an internal actor in the health sector. This status helped him build legitimacy. During the DHIS pilot, he was among the few MoH experts who could critically assess the development's direction. His background, experiences in sectorial activities, and understanding of organisational needs and interventions were advantageous. He initiated an alternative development and influenced MoH's top management to adopt a new system (MB-SIS), which was deemed more suitable for organisational purposes than DHIS.

In Phase 2, the HMIS implementation processes were steered by an individual in the role of Deputy Director of DPC-MoH, representing the MoH’s top management. This individual, who participated in Phase 1 (2000-2007) alongside HISP and UEM researchers, was involved in the DHIS pilot and a PhD program at UiO. Beyond his health background, he developed a keen interest and experience in health informatics through the PhD program and pilot. His involvement in reintroducing DHIS2 in the country through the new system (SIS-MA's first version) represented the interests of various groups, including top managers, Health Programs, and information cycle participants. His profile and position enabled him to advise the MoH, assess the situation, attempt to redirect the process, and ultimately recommend suspending the project. He also played a key role in developing SIS-MA's second version, which was well-received, adopted, and scaled up nationally.

These experiences led me to recognise that both institutional entrepreneurs (in Phases 1 and 2) possessed the necessary attributes and were well-positioned to challenge interventions deemed inappropriate at the time. They were motivated, empathetic to others' needs and interests, intent on achieving their goals, and exhibited initiative and leadership skills. Their positions allowed them to garner support from MoH's top managers and donors and to benefit from technical support sources. This enabled them to implement strategic actions and exert control over the HMIS implementation process. They successfully motivated and involved various actors from different organisations in collective actions to alter the HMIS implementation trajectory.

However, as highlighted, the efforts of an institutional entrepreneur are vulnerable without the backing of influential groups in the organisation or access to vital resources like continuous financial and technical support. The subsequent chapter discusses these issues further, examining the impact of the Phase 2 institutional entrepreneur's actions on Phase 3. This led to the successful adoption of DHIS2 in 2016 and its subsequent institutionalisation, which is detailed in the following chapter.

Chapter 7 : Phase 3 – Restructuring the national Health Management Information System (2015-2020)

7.1 Effective implementation of DHIS2 in the setting

The Ministry of Health (MoH) assumed responsibility for restructuring the HMIS and took control of the SIS-MA developments from 2015 onwards. The Department of Information Systems (DIS) in-house team, led by the Deputy Director at the time and supported by HISP-UiO, embarked on necessary customisations of SIS-MA using an updated version of DHIS2 (2.16), moving away from the previous developments that utilised an earlier version (2.13). The system's customisations were designed to mirror the features of paper-based practices, such as the calendar, facility list, and data capture forms, ensuring the digital forms contained the same fields as their paper counterparts. Additionally, the system incorporated existing indicators to streamline reporting processes. Data extraction capabilities were enhanced, allowing the generation of information in familiar formats like Excel and PDF. Once the system was fully prepared, plans were set in motion for its comprehensive rollout.

> *"…hearing so many other countries saying 'I'm using DHIS (repeatedly)'… And we also have global organisations like the Global Fund, PEPFAR, like the entities that have also recognised DHIS as a most recommendable tool for any developing country to adopt it. Then comes WHO... It is also an Open source platform… I think these factors were very important. In addition to the existing capacity of DHIS through the staff that were trained, several trained individuals… there was sufficient capacity to make the use and the system sustainable in the long term. That counted a lot…" (a participant from the academy side)*

> *"And (a new deputy director at the MoH) comes, the factor of leadership… made the bridge between the technical part and the (top management at) MISAU… was in contact with the health departments… schedule meetings, implement and validate… the process was smoother and led by MISAU." (a participant from the central level)*

> *"…leadership and coordination... an understanding that will allow decision-making… If accepted at the top level... all the levels down will embrace... In the specific case of DHIS2, there was an acknowledgement that the 'leaders' had to understand, that this is a system that must be used, that it is a system that is here to stay, and it is a system that must be supported. I would say that to some extent this was understood at the ministry level. Much more so when*

(the new deputy director) took on some role… he was able to explain and there was this coordination..." (a participant from the academy side)

In 2016, with funding from Global Fund, the MoH organised regional training teams in three provinces: Nampula in the north, Sofala in the centre and Maputo in the South. This effort was led by the MoH, with support from trainees from the UEM, as some participants recall,

"The acceptance of the provinces was peaceful… We went from district to district of Nampula. When we went to Nacala, we arrived at 6 pm and the technicians were waiting for the training. The training was at night… and in two months it was implemented." (a participant from the central level)

"…in 2016… I remember that there were training sessions in which I participated in the north, central and south zones, in the three trainings I was involved in, so there were three consecutive weeks... first week in the north zone, everyone gathered there to talk about DHIS2, then in Beira and everyone from the central zone and then in Maputo... during the training the (new deputy director) was present and said that at the end of these training sessions... said that DHIS2 was officially starting." (a participant from the academy side)

After completing the training, the Ministry of Health (MoH) issued an official notice to discontinue the use of MB-SIS and transition to SIS-MA, which then became the primary system underpinning the HMIS. Following the rollout of SIS-MA and its expansion nationwide, the subsequent years were dedicated to reinforcing the system's institutionalisation. This effort included the development of various instruments and policies, enhancing capacity-building initiatives, bolstering training activities, and strengthening routine information cycle activities. The central team was composed of young, motivated, and skilled staff, predominantly state employees, with the exception of one official hired by Jembi/MOASIS. However, the MoH recognised the necessity of support from the provinces for consistent and ongoing implementation, despite limited resources. To mitigate this, a strategy was adopted to increase the number of implementers by identifying 'champions' from each province and enhancing their training. Health workers who outperformed their peers were invited to participate in the implementers' training in Maputo City. As reported by some participants, this approach yielded positive results in several aspects.

"The implementation strategy "snowball" consisted in, with the few resources, going to remote places, providing minimal conditions, and doing the same to the others located close to the provincial directorate, then see who had performed better… The task force of national

implementers has grown, reaching up to 104 trainers… the reporting rates were above 90 %..." (a participant from the central level)

The results achieved were promising, offering valuable insights for future developments and garnering increased support from donors. To enhance communication across the various hierarchical levels of the HMIS and support the new web-based system, substantial investments were made in infrastructure, equipment, and connectivity. The goal was to establish more reliable communication channels between health units in districts and their respective district and provincial headquarters. This initiative was also extended to hospitals, providing them with similar packages to support the aggregated data component of hospital management.

Additionally, the Ministry of Health (MoH) was committed to progressively reducing the number of disparate systems in use. The array of functionalities, packages, and tools available in DHIS2 presented a timely opportunity. These features were used as an appealing incentive to encourage health programs to either migrate their systems to SIS-MA or enable interoperability with it. Several health programs recognised the potential of DHIS2's Tracker and Android capabilities and embarked on developing new modules integrated with SIS-MA. The detailed description of these unfolding processes will be provided in the next section.

7.2 Embracing coexistence of different platforms

The evolution in the health sector was steered by pivotal policy documents, including the Health Strategic Plan for the Sector (PESS) for 2014-2019, which emphasised the development of the HMIS policy. As the Ministry of Health (MoH)'s understanding of HMIS routine activities broadened, the need for a system that could handle both aggregate and patient-specific data emerged as a critical requirement for the new systems. Additionally, there was a growing necessity to integrate disparate data sources, encompassing clinical and patient data, resource management, and logistics. It was also crucial to recognise and build upon the investments made by health programs and various initiatives that had been implemented over the years.

The implementation of SIS-MA in 2016 signified a transition to a more stable and distinct era for the HMIS. The MoH's dedication to addressing and reducing the existing fragmentation in the system became increasingly apparent. This commitment was notably observed and remembered by one of the participants, who stated,

"MISAU attempted to harmonise with the partners, as there were various systems in place, such as OpenMRS, Access…" (a participant from the central level)

"…nowadays, every partner has a system… most of them have a working DHIS2 and they have a great interest in sharing data with the Ministry… data has more value when it arrives at the ministry to be used by the country. There is indeed an interest on the part of NGOs in making this sharing and there are various initiatives already being conducted. Although the Ministry is also now with a vision… make them realise that perhaps the solution to their problems is not to create DHIS2 nodes in the country, but to incorporate the systems within the MoH itself, share the data and move forward with the implementation process..." (a participant from the support side)

The partnership between MOASIS and the Ministry of Health (MoH) persisted, paving the way for additional interventions and broadening the scope from systems based on aggregated routine data to initiatives focusing on individualised, patient-based systems. In 2018, the Point-of-Care (POC) initiative was launched at the health facility level. This initiative was specifically designed to collect individual data from HIV patients. This included SESP, a system developed with OpenMRS, and the SIS-Compact stations[42]. The system's development and implementation progressed through 2019, and it continued to expand in 2020 with an additional goal to integrate all existing Point-of-Care (POC-SESPs) with SIS-MA. To address two critical challenges – technical limitations (such as access to computers, internet connectivity, and computer viruses) and the scarcity of technical support at peripheral levels – the SIS-Compact stations solution was introduced at the district level.

"…we decided that it should be only one SESP and MISAU should be in control of everything. Previously the SESP was diversified, each NGO had different databases and control of data, but they decided that there should be only one system managed by MISAU and integrated with other systems, in particular with SIS-MA." (a participant from the support side)

"…it was a small innovation project that we started to address a very specific need, to keep the hardware isolated and keep them from viruses…" (a participant from the support side)

"was an innovation introduced to support the implementation of the Health Information System. A big difference in the way the systems operated was in the instruments used." (a participant from the central level)

[42] https://www.moasis.org.mz/project/sis-compact-station-sis-cs/

"…having viruses is a very common thing… at the central level, it is easier to manage... But when you leave the urban centre and go to a health unit or a somewhat remote district, if that computer gets a virus until you can do something, it's a problem..." (a participant from the support side)

The SIS-Compact stations comprised a combination unit that included a monitor, a processor, and a modem, all enclosed within a secure, locked black box. These stations were assembled in Mozambique using components sourced from South Africa. This initiative played a significant role in expanding the limited range of digital equipment available to support the HMIS. As of 2023, several of these units are still operational. Figure 21 displays different versions of the SIS-Compact stations, specifically models 2, 3, and 5.

Figure 21. SIS-Compact stations stored and at use in Mozambique, pictures collected by me during the fieldwork (2019-2022), on four different sites visited in Niassa and Inhambane provinces.

The Ministry of Health (MoH) persistently worked towards integrating various health programs with SIS-MA. This involved accommodating their specific data requirements, including logistics, patient, and clinical data, and incorporating new functionalities. The adoption of DHIS2 Tracker and Android in 2019 marked a significant step closer to fulfilling these objectives. For instance, the Malaria Health Program was among the first to achieve integration, successfully combining SIS-MA with SIS-Malaria. It also enabled the Extended Program for Immunisation (EPI)[43], to be integrated with SIS-MA, incorporating data on vaccine logistics and monitoring of the vaccination process. The Tuberculosis health program implemented a module within SIS-TB, enabling doctors to effectively track and follow up with their patients. Additionally, a new module of DHIS2, named SIS-HOSP, was

[43] In Mozambique designated PAV (*Programa Alargado de Vacinação*)

specifically developed for hospital use. Table 24 illustrates these and other significant developments within the HMIS.

Table 24. Critical systems and digital developments in the HMIS between 2015 and 2020.

Year	Key systems
2015	Global Health Supply Chain – Procurement and Supply Management (GHSC-PSM) project, supported CMAM, the Provincial Health Directorates (DPS) and the Central Department of Laboratory (DCL) to improve logistics and supply chain systems*
2016	SIS-MA version 2 with DHIS2
2017	Ferramenta Central (FC) platform, Higher-level data repository and integration tool used to collate and store cross-platform logistics information relating to various health programs including HIV, TB, malaria, and nutrition. Developed by Chemonics to interconnect DHIS2 with existing and new logistics platforms and data sources. *
2018	Component MFL (Master list of all the health units, with a unique identifier for SIS-MA and geographical coordinates)
2017	Interoperate SIS-MA with other data sources and tools, such as the OpenLMIS, the Master Facility List (MFL), and the Master Product List (MPL), through the Ferramenta Central (FC) platform*
2017	SESP, open source Collaborative Platform to create applications and support health care services delivery**
2017	DISA e DISA-LINK (*Sistemas de Gestão de Laboratórios e de Referenciamento de Amostras Electrónico*) **
2017	Electronic Pharmacy – SIGLUS**
2017	Pilot of SIS-HOSP**
2018?	LIS Open Source**, Implementation in rural areas
2018	Point-Of-Care, developed with OpenMRS, with SIS-Compact stations
2018	OpenMRS for individual data used by HIV Health Program Partners such as EGPAF and DHIS for Elizabeth Gleiser AID
2018	SIS-HOSP, Hospital Module connected with SIS-MA, manage hospital data / Hospitalisation Events / individual data on hospitalisations in Rural and General Hospitals and Health Centers
2019	SIS-TB, monitor simple and drug-resistant patients using DHIS2 for aggregate and Tracker programs side-by-side***
2019	SIS-Vaccination Surveillance, Individual and aggregate PAV data, used in the process of implementing the DHIS2 eRegistry for immunisation HPV, BCG, and others. ***
2019	SIS-Vaccination Surveillance, The National Disease Surveillance unit is expanding on their DHIS2 Covid-19 implementation to include eIDSR (electronic Integrated Disease Surveillance and Response) programs for other diseases such as Neonatal Tetanus, Yellow Fever, and Measles. ***
2019	SIS-MALARIA, National Malaria information system for surveys and supervision, and is now expanding into tracking individual Malaria cases at the community level***
2020	SIS-COVID, developed using the DHIS2 COVID-19 toolkit package
2020	DHIS2 D2D app, developed by HISP-Mozambique and shared with the DHIS2 community
2020	DHIS2 Datasets Expiry Days app, developed by FGH - Mozambique and shared with the DHIS2 community
2020	DHIS2 for Education, pilot in Zambezia province

During this time frame, nearly all the stakeholders from the second phase remained involved, though they assumed different roles. The contract with the company initially hired in 2012 to begin developing SIS-MA concluded in 2014. Subsequent developments were spearheaded by the Ministry of Health

(MoH), with the active participation of the HISP-Mozambique team, known as Saudigitus. This collaboration leveraged their historical relationships, which had evolved over time. Saudigitus became an integral part of the development of SIS-MA. Figure 22 depicts the interconnections between these entities and their contributions to the advancements within the HMIS from 2015 to 2020.

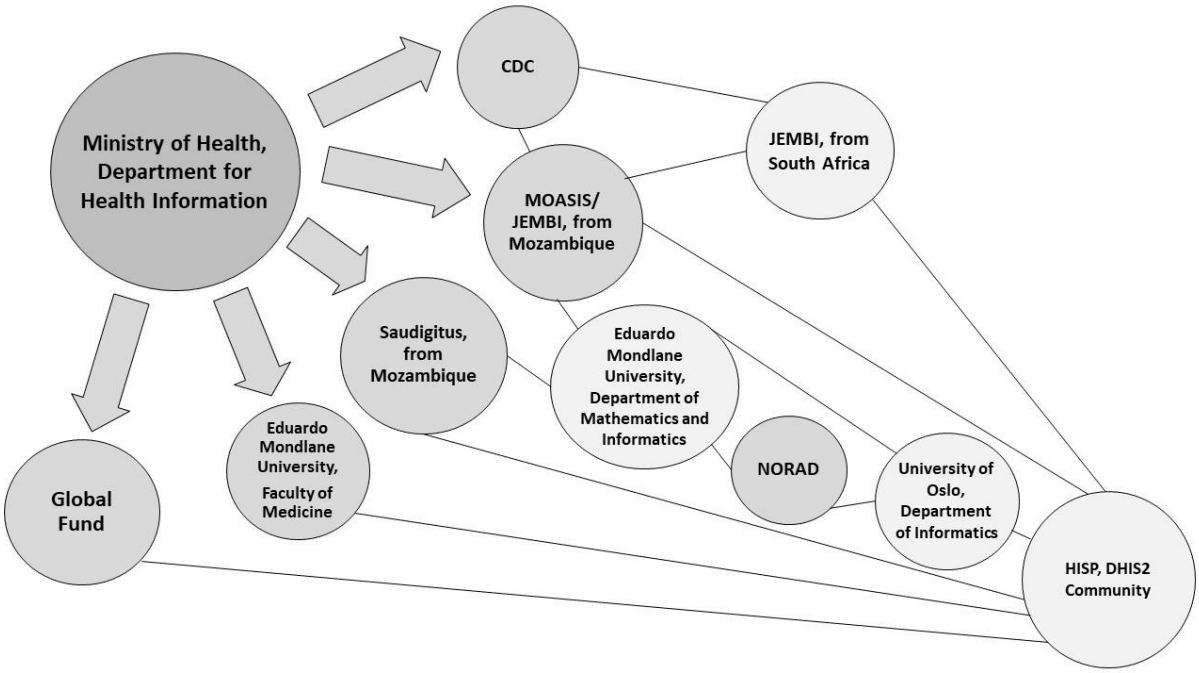


Figure 22. Relationships developed during the period 2015 to 2020.

7.2.1 Diversifying the sources of knowledge to support the national HMIS

A consistent element throughout the various phases of the HMIS implementation process was the focus on capacity building. The country's efforts to address personnel shortages, a consequence of the exodus after independence and the 16-year civil war, yielded significant results. Notable investments in both public and private universities became evident, enhancing training for medical doctors, nutritionists, pharmacists, and other health-related professions. The introduction of diverse training sources for health professionals, particularly in technical degrees, led to an increase in the number of nurses and technicians across various specialisations, such as preventive medicine and health statistics. These efforts have markedly improved the reach of health services nationwide, extending to more remote areas and consequently impacting the HMIS. The technical and informatics components were included in some of these educational programs, as described by some of the participants:

> *"So, if we look now at the master's degree that is in the faculty of medicine… it has grown, in the sense of meeting our client, who is the health manager, and the component of Information system DHIS has always had its space. A module on health information management systems*

has just been completed, less than two weeks ago… attracting not only physicians or healthcare personnel, but also colleagues who like and are interested in area of information technology for health." (a participant from the academy side)

These achievements have played a significant role in reinforcing and supporting the HMIS. A range of capacity-building interventions has been instrumental in addressing the varied training needs at different levels. At the upper echelons, capacity building was essential to support and maintain the routine system, which forms the backbone of the HMIS and intersects all hierarchical levels. Training also extended to the middle and lower levels, enabling participants to grasp the underlying logic of the system.

Long-term commitment to capacity building has been identified as a key factor in the success of the various implementations carried out over the years within the HMIS. For example, over time, teams responsible for Health Information System (HIS) management activities have increasingly included professionals trained in health statistics. This shift has alleviated the workload of the overburdened preventive medicine technicians and enhanced the potential for data quality improvements, as observed by some of the participants.

"Previously, preventive medicine technicians were hired for the [District Nucleus of Statistics] NED, who were also heads of programs, in the absence of planning technicians, sometimes they even took the place of the head of environmental health. The new statisticians work only with data." (a participant from the middle level of the health sector)

"Of the 14 districts that the province has, 13 have personnel trained in health statistics. Only one district has a health technician of preventive medicine playing the role of NED." (a participant from the middle level of the health sector)

7.2.2 Building in-house and local capacity teams to maintain the system

An in-service training initiative was introduced by the MoH alongside the first attempt to introduce DHIS in the country in 2000 and has persisted over the years. This has been adopted as an organisational practice to be followed, whether after the introduction of new systems or to reinforce the practical knowledge of the health workers involved in the data management processes. The in-service training continued to evolve as one of the sector's best practices that enabled the HMIS implementation process, as some participants noted,

"The training covered all employees at the central level of MISAU. Over time, data managers in the provinces (NEP) were also brought in. To train technicians who would be involved in training at the regional level, we brought together technicians from the provinces of the same region down to the district level, including the head of the district statistics nucleus (NED)." (a participant from the central level)

"…and a lot of resources have been used to train a lot of people in the use of DHIS over all these years… most of the people who were participating in those training were individuals who had already had various DHIS training. So, they knew how to work with DHIS, only with DHIS1 and they were getting familiar with DHIS2. So, it wasn't too complicated to migrate." (a participant from the academy side)

The Ministry of Health (MoH) made significant investments in training for its in-house support teams across various levels. This included engaging personnel from the Department of Information for Health (DIS) and the Department of Information, Communication, and Technologies (DTIC) at the upper levels, as well as members from the Nucleus of Statistics at the province, district, and hospital levels, which represented the middle and lower tiers. The introduction of DHIS2 academies, encompassing international, regional, and local levels, was also a noteworthy development in this context. These groups, whenever possible, participated in DHIS2 academies to enhance their skills and knowledge. The first such academy in Mozambique took place in 2014. It was an international event conducted in Portuguese and saw attendance from both local and international participants. This initiative was fondly remembered by one of the participants:

"*In international academies, we received colleagues from the PALOP*[44]*, ministries, some provincial managers." (a participant from the central level)*

The ongoing presence of DHIS2 Academies in Mozambique has been particularly crucial in supporting the continuous processes within the health sector. In the 9 years following the inaugural DHIS2 academy in 2014, HISP-Mozambique has organised over 10 academies. These sessions have been beneficial not only to participants from both the public and private sectors within the country but also to members of the Lusophone community using DHIS2. A summary of these developments is presented in Table 25.

[44] Portuguese-speaking African countries (*Países Africanos de Língua Oficial Portuguesa*).

Table 25. Developments around the DHIS2 Academies in Mozambique and abroad.

Year	Event
2016	First DHIS2 Tracker Academy in Mozambique, held in Portuguese and English
2017	First Online Academy is released to offer DHIS2 Fundamentals as a self-paced course.
2017	DHIS2 Design & Customisation Academy and Information Use held in Mozambique
2018	A DHIS2 Design & Customisation Academy is held in Mozambique, and a DHIS2 Tracker Academy is held in Guinea Bissau, resulting from a collaboration between HISP-UiO, Saudigitus (HISP-Mozambique) and INASA (Health Institute in Guinea Bissau)
2019	The first level 2 DHIS2 Android Development Academy is organised for the Lusophone community in Mozambique, and other DHIS2 academies continue to be organised in Mozambique, covering different topics such as Tracker, Design and Customisation, Data Quality
2020	Two new DHIS2 academies are organised to be held in Mozambique to cover Server administration and Community Health Information Systems (CHIS)
2020	The DHIS2 Analytics Tools Academy, organised by HISP-UiO and Saudigitus (HISP-Mozambique) is held for the first time in an online format due to the COVID-19 pandemic restrictions
2021/22	DHIS2 Fundamentals is transformed into a series of self-paced online courses

Sources: Adu-Gyamfi et al. (2019) and HISP (2023a).

HISP-Mozambique, in collaboration with HISP-UiO and other HISP groups internationally, delivers training designed to empower in-house support teams in various countries. This training equips them with the skills necessary to integrate new forms, maintain, and manage the supporting infrastructure. Additionally, it provides them with the ability to offer user support at all levels, thereby promoting self-reliance within these teams.

7.2.3 Inclusive external technical support from various sources

Over the years, the Ministry of Health (MoH) managed to address the challenges of hiring and building an in-house software development team, thanks to external support. Consultants, either hired directly by partners or representing the interests of specific donors, were engaged through established Memorandums of Understanding (MoUs) with local research and development organisations.

This external technical support took various forms and covered different areas. It ranged from providing individual consultancy and training to deploying technicians across multiple locations. Key areas of support included the introduction of digital innovations, the development and expansion of the Health Management Information System's (HMIS) functionalities, and the integration and interoperability of SIS-MA with other existing systems. These systems spanned various levels within the health sector, systems of implementation partners, and those outside the sector, highlighting the growing need for data exchange between different systems. For instance, concerted efforts were made to enable interoperability between the HMIS and the Ministry of Justice's central system, particularly

for the exchange of birth and death data. This endeavour required the collaborative efforts of Jembi/MOASIS and HISP-Mozambique.

> *"In interoperability scenarios, DHIS2 only receives and does not harvest. An example is the case of the collection of vital statistics data from the Ministry of Justice (SIS-MA with the SiRCEV)" (a participant from the support side)*

The challenge of sharing data across various systems extends beyond just technological capabilities and includes aligning the common interests of all parties involved. While there have been limited experiences in this area, the outcomes have been positive and hold potential to serve as models for future projects, as suggested by one of the participants,

> *"…Social action is using DHIS2 (with Jembi support). There are shared areas that need to be integrated. For example, violence…These systems and the police are intertwined… There should be interoperability between these three systems to make crossovers… SIS-MA collects this data through the hospital management module (SIS-HOSP)" … "The SINAS of the Ministry of Public Works, Housing and Water Resources does not communicate with SIS-MA… but there is a possibility… If, for example, there is a need to check the incidence of cholera, it has to do with sanitation… integrate scenarios of urban, peri-urban, or rural communities, carry out studies to find out to what extent sanitation influences… look at the malaria rates in (a province), because it rained a lot and there is no sewage and no drainage, to see what the potential for a solution is." (a participant from the support side)*

Since 2019, the Ministry of Health (MoH) has opted to incorporate permanent in-house support members from its two technical support partner organisations, MOASIS and HISP-Mozambique, into the staff of the Department of Information for Health. Initially, there were some tensions stemming from their affiliations with different organisations. However, over time, these individuals have begun to be recognised as integral members of the MoH's in-house support team. This transition was reflected in the recollections of one of the participants,

> *"… (one of the seniors at the ministry) … commented on how … work plans overlapped and didn't know clearly what (they) were doing there... But over time ended up changing the 'shape' and said: "I don't care where you come from, you are here, you belong to the department, and you will do the work we need… Here you are the ministry so you work with the ministry, these matters of yours will be resolved at home, but inside here we are a single team" …" (a participant from the support side)*

Over the years, external technical support teams have collaborated extensively with the Ministry of Health (MoH) to enhance the digital aspects of the systems implemented and contribute to the evolution of the HMIS. More recently, their involvement has broadened to encompass the development of external applications and the extension of DHIS2 functionalities, tailored to meet local needs.

7.3 Controversies around the implementation process

> "*…it is good to have more systems. Then the challenge is to share and analyse data to provide information. The problem is not technical; the problem is more related to politics and money, various sources and interests, and loose power.*" *(a participant from the academy side)*

Despite considerable progress in the HMIS, a number of longstanding challenges have continued to persist. These include social factors like the rotation and mobility of health personnel, alongside political and legal issues encompassing laws, policies, procedures, and practices. Technical challenges, such as infrastructure, communication, the coexistence of multiple systems, and the technical limitations of the system itself, have also remained. Participants have noted and reflected on these challenges:

> "*(in 2000, DHIS pilot) …the strong mobility of health personnel at the peripheral level was not favourable. It was not possible to train more health personnel or remove them from essential tasks, given the shortage they faced. Even trained personnel were moved to head a new unit or head a district." (a participant from the central level)*

> *"(after 2016, with DHIS2) … in the field, they complained about the Internet, mobility of technicians (transferred within the system), work overload, insertion of files for various programs" … "As far as mobility is concerned, it depends. A technician, when leaving the school, must be on duty for 2 years. But they can be transferred from the district to the province if they are skilled, to support the province. But in other cases, after 2 years, they may look for better conditions and some will join the partners (NGOs working with the health sector)." (a participant from the central level)*

> *"There is partial mobility. Not complete, note that a person my age is not going to climb a tower. There must be young people. But unfortunately, oil and gas has led to the drain of computer science technicians…" (a participant from the central level)*

> *"…we implement rotation and mobility…" (a participant from the province level)*

The introduction of new technical developments in the health sector brought with it a set of fresh challenges. Routine data fed into SIS-MA depended on aggregate data collected and periodically submitted to Data Officers at the district levels. Systems necessitating individual data entry proved more demanding and time-intensive. For example, while only a single device was necessary at the district level, the facility level required the deployment of multiple devices within a single district. Additionally, there was the challenge of overlapping functions being performed by the same health staff, a point highlighted by one of the participants:

> *"…for aggregated data, it is simple for the (health) program to tell the health unit staff that they must send a monthly report by day X, but then they may not have the same openness to tell the same person that they should introduce 500 patients in 10 days in the system… the person who must enter the data must be assisting the patients" (a participant from the support side)*

In 2004, Mozambique's constitution underwent a significant revision, with critical amendments to the central government structure and its establishment mechanisms announced in 2018. These changes were legally sanctioned within the same year (INM, 2018). The revised constitution/law introduced a dual power structure at the provincial level, significantly impacting the health sector. Provincial Governors began to be appointed through an electoral process, while a State Secretary, nominated by the President, represented the central government in each province. This reorganisation had direct consequences for the health sector, particularly in the distribution of responsibilities between the Provincial Directorate of Health (DPS) and the Provincial Health Services (SPS). The DPS, subordinate to the Provincial Government, took charge of managing primary care in health units and centres. Conversely, the SPS, answering to the State Secretary, focused on healthcare services provided in hospitals. Data managers found themselves navigating between these two structures. This restructuring led to questions and uncertainties, especially at the lower levels, as one participant observed:

> *"…where are we going to report...?"* and how to *"…restructure the information…?" (a participant at the provincial level)*

In 2020, the COVID-19 outbreak presented numerous challenges for the sector, leading to delays in the implementation of new administrative structures and disrupting established routines around the HMIS. This situation required readjustments to accommodate the reporting needs and other demands of the sector. Concurrently, a new module for DHIS2 was introduced that year.

"*UiO adapted the 'capture' function to collect individual data for COVID-19 and reporting cases. Thus, it is possible to have a more comprehensive coverage of the information… A module was recently introduced in 2020 for the entire country. But with that came other challenges in using the new system. We have had challenges for its implementation for COVID-19 and TB… SIS-MA and SIS-MA-capture are two different modules with URLs and similar organisation structures; they communicate well, there is interoperability between them… SIS-MA has a capture system, but 95% is being used for aggregated SIS-MA and retrospective analysis.*" *(a participant from the central level)*

The National Institute for Health (*Instituto Nacional de Saúde* – INS) played a crucial role in the process. This entity was tasked with screening COVID-19 cases, necessitating the daily production and dissemination of information. All this data served as both the input and output of their system, which, at that time, was not integrated with SIS-MA. It became apparent that the Ministry of Health (MoH) still lacked an adequate framework to guide the integration of digital solutions within the HMIS, a point underscored by one of the participants.

"At a central level, we have platform management problems… MISAU opened SIS-COVID, but we have the INS next to it, which also has a platform to monitor COVID-19. The MISAU and the INS are state entities. Everything was supposed to be integrated into the Ministry's management, but on the contrary, they are in parallel." … "Government issues create constraints that are at the grassroots level" (a participant at the provincial level)

7.4 Leveraging the DHIS2 potential to institutionalise SIS-MA

The development of the DHIS2 software has persistently progressed over the years, adapting to shifting needs through its numerous global implementations and evolving into a comprehensive software platform. An overview of DHIS2's acquired characteristics is provided by an extract from Adu-Gyamfi et al. (2019, p. 75):

"…is a Java-based web application and runs on multiple platforms including Windows, Linux, Mac OS X and Solaris. It's rich RESTful Web APIs, enable Java Scripting, CSS and HTML5 apps and by using the W3C standard compatible with all major web browsers. DHIS2 runs on PostgreSQL, MySQL and H2 database systems and with minor development efforts, DHIS2 can run on any mainstream relational database. Using the BSD license makes DHIS2 free and open-source with its code available to be used modified and redistributed freely. It interoperates with other relevant applications such as OpenLMIS, iHRIS, OpenMRS [23] and the World

> Health Organisation (WHO) tools in the public health domain… DHIS2 interfaces with third party web portals and technologies, including SMS, E-mail, and Geographical Information Systems (GIS) to enhance its functionality. The software user interface and meta-data are internationalised and currently available in English, French, Spanish, Portuguese, Hindi, Vietnamese, Chinese and Norwegian. DHIS2 mobile supports offline operations in areas with a poor and fluctuating Internet connection, based on HTML5, SMS and Browser and Java-based clients. DHIS2 Android apps support offline data capture, including a Dashboard app for data visualization."

The adoption of DHIS2 in Mozambique has not only continued in the health sector but has also expanded to other sectors. Notable examples of DHIS2 developments include projects by Jembi/MOASIS in collaboration with the Ministry of Gender, Children, and Social Action, as well as with the Ministry of Justice, Religious, and Constitutional Affairs. The developments from the former resulted in the Information System for Monitoring and Evaluation (SI-M&A)[45]. The latter concerned the interoperability between the Civil Registration and Vital Statistic System (SiRCEV) [46] and SIS-MA's hospital module.

The ongoing demands from various Ministries and organisations using DHIS2 for new functionalities in the generic software have catalysed new software developments. As a result, the architecture of the DHIS2 software has evolved, and it is now considered a software platform. HISP-Mozambique played a significant role in this evolution, meeting the requirements stemming from the Ministry of Health (MoH). This team, working through Saudigitus, was actively involved in developing local applications to supplement features not present in the new DHIS2 architecture. Figure 23 showcases two applications developed by Saudigitus, alongside another from an organisation operating within Mozambique's health sector.

[45] More details in (Moasis, 2023a)
[46] More details in (Dickens, 2021)

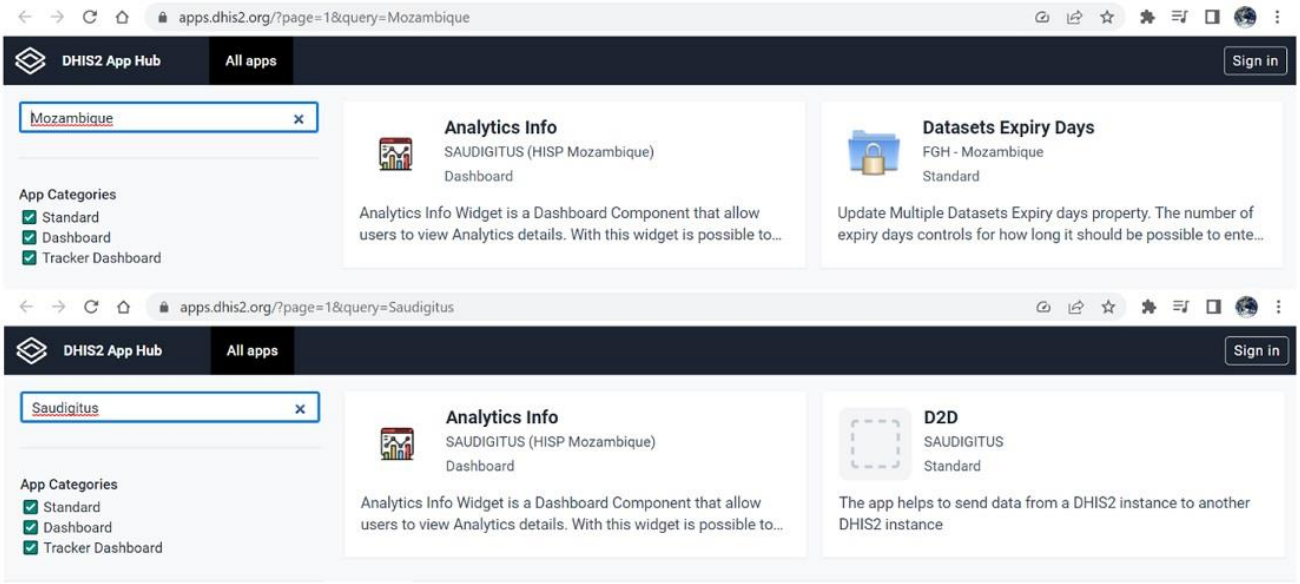


Figure 23. Examples of contributions from developments in Mozambique to the DHIS2 community, extracted from DHIS2 website.

During the COVID-19 pandemic, the global DHIS2 community united to develop digital solutions to support local implementations, which contributed to DHIS2's evolution as a global platform. A notable precedent was set in Liberia in 2014, where the Tracker was implemented in response to the Ebola outbreak. This experience was pivotal in enhancing DHIS2 functionalities and developing packages for case-based disease surveillance, including Covid-19 (HISP, 2022).

In Mozambique, Saudigitus played a crucial role in supporting the Ministry of Health (MoH) during the COVID-19 pandemic. The organisation was involved in developing local solutions that were compatible with DHIS2. These efforts were also significant in the deployment of DHIS2 COVID-19 packages, benefiting the DHIS2 global community. In 2021, Mozambique began utilising DHIS2 packages tailored for COVID-19 surveillance (including case-based surveillance, contact tracing, port of entry screening, hospital stay monitoring, call center data, and exposure risk assessment) and COVID-19 vaccine delivery (encompassing aggregate data, electronic immunisation registry (Tracker), and AEFI package) (HISP, 2023). To support health sector activities, the MoH has adopted various packages and tools integrated into DHIS2, as recommended by the WHO. These include Data Quality Apps, EPI Data Package, Malaria Data Package, TB Data Package, and Mortality Data Package.

> "*The level of institutionalisation is good. DHIS2 is being used in 162 districts and 10 more health units. It's becoming a robust repository.*" *(a participant from the central level)*

The transformation of DHIS2 to serve as an Education Management Information System (EMIS) for the education sector officially commenced in 2019 (HISP, 2022). In Mozambique, this shift was facilitated by Saudigitus, which developed a country-specific instance and piloted it at the provincial level in 2020. These efforts were recognised and valued by HISP-UiO as a significant contribution to the overall EMIS project.

7.5 Summary: Strategic actions towards institutionalisation

This third phase has detailed the re-establishment of the HMIS in its setting, focusing on the adoption, scaling, and institutionalisation of the new system based on DHIS2. During this period, the concept of interoperability became more tangible. Various initiatives were undertaken to link existing systems within the health sector to other public sector systems across different domains. The introduction of features like Tracker, Capture, and Android facilitated the development of new DHIS2 instances for health programs, integrating them with SIS-MA and other technological platforms like OpenMRS. The enhancements to the DHIS2 architecture enabled the development of local applications tailored to the specific requirements and needs of the setting. This development was seen as a significant contribution, expanding both the applications portfolio and the services offered by the generic DHIS2 platform globally.

This study demonstrates that while the adoption, scaling, and institutionalisation of the new system were in progress, several parallel strategic actions supported these processes. These actions, led by legitimate institutional entrepreneurs, represented their entrepreneurial efforts throughout the process. They aimed to gradually foster ownership of the new system, ensure reliance on the workforce, and reinforce the system's capacity to sustain ongoing processes within the HMIS. These actions spanned various dimensions, including governance, budgeting, capacity building, infrastructure, and systems. The COVID-19 pandemic presented an unforeseen challenge to the global health sector. Through this narrative, I have described how the MoH navigated this phenomenon, maintaining stability amid the uncertainties and shifts in the global context. Additionally, I have outlined the impact of COVID-19 and the responses of the MoH to this global event that significantly affected the health sector.

The three phases described illustrate the Ministry of Health's (MoH) efforts as the manager and coordinator of the HMIS to address institutional pressures and contradictions that hindered the HMIS implementation processes. Throughout these phases, the MoH adopted various strategies in response to different situations. In the first phase (2000-2007), the MoH recognised its financial constraints and limitations in material and human resources and accepted support from external partners. During the

second phase (2008-2014), with financial limitations still prevalent, the MoH explored various strategies to mitigate these constraints. This included managing power imbalances between external and local organisations, facilitating support, and mediating the institutional challenges impeding the HMIS implementation.

In the third phase (2015-2020), the MoH's efforts focused on regaining control over the HMIS implementation processes. This involved strategies to strengthen technical teams by integrating diverse sources of external support, embracing different platforms, and bridging them through interoperability and integration initiatives.

The third phase marked a more effective implementation of DHIS2. Insights from the analysis of the institutional context for this period (2015-2020) were considered. The focus was on how institutional entrepreneurs challenged this context through strategic actions and their roles. One individual was identified as an institutional entrepreneur, consistent with the one identified in Phase 2, who led the development and rollout of the new system with DHIS2, alongside two organisations implementing entrepreneurial actions.

> *"…the factor of leadership… made the bridge between the technical part and the (top management at) MISAU… with the Health Departments… schedule meetings, implement and validate… the process was smoother and led by MISAU." (a participant from the central level)*

The two organisations involved in this phase were MOASIS, which continued to provide technical support and introduce digital innovations to address existing institutional contradictions arising from the context. Their entrepreneurial actions included allocating technically skilled human resources at both central and provincial levels and providing specialised computers with internet access specifically for SIS-MA, known as SIS-Compact stations. The second organisation, Saudigitus, representing HISP-Mozambique, dedicated itself to supporting the MoH by extending local developments and integrating them with SIS-MA. This challenged DHIS2's limitations in meeting the ongoing demands from the sector. Some of Saudigitus's entrepreneurial actions involved developing new local applications and collaborating with MOASIS for system interoperability, both within the health sector (integrating SIS-MA's aggregated data with POC-SESP's HIV patient data) and across sectors (linking SIS-MA from MoH with SiRCEV from the Ministry of Justice).

These actors—two organisations and one individual – gained legitimacy and support from various groups, providing different types of resources and engagement. The process led by the institutional entrepreneur depended on approvals from top MoH managers and donor funding. The overall process

was not straightforward, featuring gradual transformations and accomplishments. Various sub-processes involved numerous institutional entrepreneurial actions by the organisations, offering essential support for the HMIS implementation. Saudigitus, representing HISP Mozambique, received support from HISP-UiO and the Global Fund, while MOASIS benefited from Jembi's backing, funded by the CDC.

The efforts of the MoH, Saudigitus, and MOASIS were enhanced by the collective engagement of all health sector participants, including health programs, partners, HMIS managers, and users. From the outset, there was a sense of 'inclusive participation'. Acknowledging the importance of involving health programs in system development was crucial for introducing the necessary forms and indicators tailored to their needs, thereby fostering system ownership. Introducing training opportunities to enhance health workers' data management skills was vital, increasing their system ownership and encouraging greater dedication to improving their performance.

> *"Previously, preventive medicine technicians were hired for the NED (District Nucleus of Statistics) …" (a participant from the provincial level)*

Throughout the HMIS implementation process, various strategies were employed. To leverage previous learning experiences, a mimicry strategy was adopted. The developers customised the software to include the existing calendars, the health sector structure (encompassing all health facilities), and data capture forms that mirrored the fields used in paper-based systems. Existing indicators were integrated to streamline reporting processes, and data extraction capabilities were enhanced to generate information in familiar formats like Excel and PDF. User profiles were also appropriately linked. This new system gradually became part of the organisational practices. The Ministry of Health (MoH) continued to develop capacity-building initiatives through education. This was achieved by blending traditional formats (like formal courses at universities, schools, or institutes) with innovative approaches for regional and in-service training. In collaboration with the Academy (UEM and UiO), the DHIS2 Academies became a regular activity, providing opportunities for users to broaden their knowledge and share experiences. This approach was crucial in fostering a sense of ownership and self-reliance among the users. Normative networks were established by aligning components of the organisational practices with the software, such as the calendar and the reporting system. This alignment also involved reinforcing the roles of data management officers to integrate and promote network building, encouraging them to assume more proactive roles in providing support at their respective work levels. Additionally, the strategy included enhancing the monitoring of system

usage, facilitating interaction among users to share experiences, and providing support during routine discussions and reporting processes.

> "*…in 2016… there were training sessions in which I participated in the north, central and south zones… many resources have been used to train many people in the use of DHIS over all these years…" (a participant from the Academy)*

As the Ministry of Health (MoH) introduced the new system, it concurrently had to phase out the old one. The initial steps to discontinue the old system, seen as an established institution, were taken decisively through the "Replacement of formal directives". Clear instructions were issued to terminate the use of the existing central system and implement SIS-MA, communicated through a formal notice. This change was necessary to ensure that reports were submitted based on data captured by the new system. Consequently, some previous practices, like extracting data and sending it via email or flash drive to the MoH, were discontinued as the new system introduced alternative methods.

To expand the pool of implementers, a rewarding strategy was implemented. Health workers who excelled in system usage and had high reporting rates were chosen for training sessions in the capital city. This strategy served a dual purpose: it encouraged health workers to engage more effectively with the new system and eased the shift away from the old system.

> *"…during the training, the (new deputy director) was present and said that at the end of these training sessions... that DHIS2 was officially starting." (a participant from the central level)*

> *"a strategy to increase the number of implementers by identifying the "champions" (…) the health workers who performed better than the others were invited to join the implementer's training in Maputo City." (a participant from the central level)*

The implementation of the new system involved various strategies aimed at maintaining and institutionalising it as a new institution. These strategies encompassed policing, investment in infrastructure, enhancement of practices through training, embedding and routinising processes, expanding capabilities by integrating external support, and bridging diverse interests. One key approach was the introduction of policies to guide the implementation process and align sectorial objectives. Another tactic involved reinforcing the roles of program heads and Statistics Nuclei at different levels - provinces, districts, and hospitals - in participating and overseeing the entire information cycle, from data entry to reporting.

A significant portion of the received investments was allocated to improving infrastructure, equipment, and connectivity. This enhancement was crucial for facilitating effective communication among actors at all levels. Additionally, strengthening other relationships was vital for boosting equipment and connectivity capabilities. Emphasising training was recognised as essential for reinforcing practices and system usage. A particular challenge noted by several participants was the internal mobility of health workers. By bolstering in-service training, the continuity and efficiency of practices were maintained. In cases where team members were transferred, the service would be sustained by other colleagues until a suitably trained health worker could be integrated into the local team.

> "*The task force of national implementers has grown, reaching up to 104 trainers… the reporting rates were above 90%...*" *(a participant from the central level)*

System usage became an integral part of the health sector's routines. It was configured to align with the country's calendar, dictating the timelines for data capture, validation, discussion, and reporting. This integration was also facilitated by engaging the Department of Information for Health (DIS) and support teams in developing new solutions for emerging issues, responding to health workers' needs, and incorporating new functionalities into their workflow. By integrating external support, they addressed existing limitations in hiring and retaining IT professionals. The Ministry of Health (MoH) formed partnerships with external organisations connected to the Academy, bringing in skilled and expert human resources to contribute to the maintenance and advancement of the HMIS.

Another strategy employed by the MoH was to bridge various interests. They opted to accept the multiplicity of systems, provided they could communicate and share or exchange data with the HMIS. This approach acknowledged and respected the significant investments made by health programs in developing and implementing their systems over the years. Moreover, it reinforced their ownership of the data, helped fill information gaps, reduced redundancies, and minimised inconsistencies in the information generated from these various systems. In cases where integration was not feasible or there was strong resistance to abandoning parallel systems, efforts were made to make them interoperable.

> "*… you work with the ministry… inside here, we are a single team.*" *(a participant from the support side)*

A statement from a participant at the central level highlights the success of the strategies implemented by the institutional entrepreneurs to uphold the institution (the new system), even in the face of persistent or emerging challenges over the years: "The level of institutionalization is commendable. DHIS2 is currently in use in 162 districts and 10 additional Health Units, making it a robust repository".

Chapter 8 : Historical analysis

In this chapter, I present a comprehensive historical analysis, building upon the framework introduced in Chapter 2. The institutional context for the three distinct phases over a 20-year timeline was outlined in Chapter 4. In Chapter 5, I focused on Phase 1, offering a detailed description and an initial analysis framed by the concept of institutional contradictions. Chapter 6 detailed the events of Phase 2, examining the rise and evolution of actions related to institutional entrepreneurship. The processes of institutionalisation concerning the HMIS were elucidated in Chapter 7. This chapter synthesises the historical analyses of these phases, laying the groundwork for discussing the research contributions, which are detailed in Chapter 9.

The structure of the chapter is as follows. Section 8.1 begins with a reiteration of the main research question and its subsidiary queries. In Section 8.2, the analysis of Phase 1 is extended to examine the evolution of institutional contradictions in the subsequent phases. Section 8.3 delves into the description and analysis of institutional entrepreneurship actions, including the emergence and development of institutional entrepreneurs across the phases. Section 8.4 investigates the patterns of actions that have influenced the unfolding institutional processes, highlighting those crucial for the adoption and institutionalisation. Lastly, Section 8.5 offers potential explanations pertaining DHIS institutionalisation.

8.1 Answering the research question

This overall analysis helps to answer the main research question guiding the research:

> *How do the institutional dynamics shape historically grounded Health Management Information Systems implementation processes in Low- and Middle-Income Countries context?*

This is broken down into the following two questions:

> *(a) What are relevant institutional dynamics, and how do they change over time?*
>
> *(b) How do these dynamics shape Health Management Information Systems implementation processes over time?*

To address the question (a), I investigated the historical evolution of institutional contradictions, focusing on their origins, development, and the actors involved. Additionally, I analysed how these contradictions spurred actions in institutional entrepreneurship aimed at resolving them. In response

to question (b), I detail the institutional processes across various phases, examining their progression and establishment over time. I observe that both the contradictions and entrepreneurship actions play significant roles in the gradual process of institutionalisation.

8.2 Building a historical perspective: the origins of institutional contradictions

The premises guiding the analysis of institutional contradictions are as follows:

- Institutional processes are comprised of institutional contradictions arising from varying interests of institutional actors within the organisational field, shaping the trajectory of implementation processes.
- Institutional contradictions are not inherently harmful and can be potential catalysts for change, as actors negotiate and take action to resolve them.
- Institutional contradictions can be triggered by multiple sources, including exogenous, endogenous, or a combination of both.

I analysed three fundamental institutional contradictions: 'Resource scarcity hindering readiness for technological innovations', 'Multiple stakeholders with poorly aligned and often contradictory interests', and 'Governance expectations contrasting existing technological and financial challenges'. Initially, I describe the nature of these contradictions using examples from the historical narrative. Then, adopting a historical perspective, I examine how these contradictions emerged, evolved, were mediated, or persisted over time.

Scarcity Hindering Readiness for Technological Innovations

The first institutional contradiction I examined is 'Resource scarcity hindering readiness for technological innovations''. This contradiction arises from an accumulation of various exogenous factors, including historical, political, economic, and technological processes, impacting the health sector and HMIS. Despite the Ministry of Health's enthusiasm for implementing a consistent digital HMIS, the setting faced multiple constraints. These contradictions surfaced in the early nineties with the initial efforts to introduce digital health solutions, presenting a mix of opportunities and challenges for HMIS implementations and related reforms.

Plurality of Interests Promoting Misalignments

The second institutional contradiction analysed concerns ‘Multiple stakeholders with poorly aligned and often contradictory interests’ in the HMIS implementation process. This contradiction is intricately linked to resource scarcity, as the government's efforts to address this shortfall led to various external financial and technical dependencies. These dependencies arose from engaging internal and external consultants, creating reliance on foreign assistance from agencies like NORAD, the CDC, the Global Fund, and non-governmental organisations, including the University of Oslo. While these partnerships brought significant benefits, such as strengthening the tertiary education sector through the establishment of Master's programmes, they also led to a multitude of misaligned digital initiatives, furthering processes of fragmentation.

Governance Expectations Limited by Technological and Financial Challenges

The third institutional contradiction pertains to ‘Governance expectations contrasting with existing technological and financial challenges’. The introduction of digital initiatives in the health sector, especially those targeting national scale implementation, had to navigate the sector's complex governing structure. National directives from the MoH are issued at the central level, with decision-making processes occurring at provincial and district levels, influenced by various national health program directives. The study examined how HMIS implementations intertwined with institutional contradictions. Although projects introducing digital initiatives aimed to operationalise existing organisational practices and evaluate achievements, they were limited by timelines, budgets, and resources. Additionally, interpreting and translating system requirements to meet needs and expectations across all governance levels while balancing existing conditions proved challenging.

The Historically Existing Challenges

The period from 1975 to 2000 was critical in influencing the emergence, growth, and persistence of institutional contradictions. Political decisions post-independence in 1975 and the subsequent 16-year civil war greatly affected the country's resource scarcity and socio-economic trajectory. These factors were integral to the development of the first institutional contradiction, characterised by:

- Inadequate infrastructure and technical capacity to support digital systems.
- Slow development of governance instruments for digital health, conflicting with the rapid introduction of technological innovations and the proliferation of fragmented legacy systems.

- Shortage of skilled health personnel for data management, contrasting with increased responsibilities for health personnel in supporting the HMIS.

Continued efforts to address these challenges led to the emergence of the second institutional contradiction, ‘Multiple stakeholders with poorly aligned and often contradictory interests’. The genesis of the third institutional contradiction was rooted in local government efforts to participate in global developments and address their emerging and established agendas.

Early recognition of these contradictions by the HISP-UiO and UEM teams in 2000 was pivotal for planning future actions. These included leveraging opportunities and mitigating challenges. Initiatives like strengthening education, research, and in-service capacity building were critical to addressing the severe lack of human resource capacity, with efforts that continue to this day. Introducing modern digital tools to enhance the HMIS represented another intervention, which collided with various existing systems and the institutional arrangements (budgets, interests, infrastructure) associated with these systems. These interventions mitigated some challenges while also introducing new ones.

The health sector had developed an extensive installed base, comprising legacy systems, established work practices, routines, structures, organisational culture, and resources. For instance, systems like SIS-Prog were already operational. Addressing inefficiencies in such systems created institutional space to introduce DHIS, but this was challenging due to existing dependencies, particularly donor funding. It also highlighted power asymmetries that fuelled resistance to reform efforts. Expatriate consultants in the MoH questioned DHIS's technical efficacy and its design, noting contradictions as it was tailored to South African requirements, which differed significantly from Mozambique's needs. A key tension emerged:

- The potential of DHIS to facilitate organisational changes versus its technical limitations in meeting local needs.

- This tension led to ongoing delays, exacerbated by the Ministry's reluctance to formally instruct districts to adopt DHIS. Technical support at the district level depended on UEM researchers, torn between their study responsibilities and their coursework in Norway. Two major conflicting scenarios were evident:

- The HISP team’s part-time nature and coursework commitments were misaligned with their support duties at the pilot sites.

- District-level managers' recognition of DHIS's technical potential conflicted with the MoH's unmet expectations and lack of support.

These incompatibilities, along with the inability to incorporate new requirements within project timelines (such as a web-based architecture), fuelled arguments against the DHIS introduction. The accumulation of institutional contradictions led to continuous attempts to resolve or mitigate their impact on the HMIS implementation process. This resulted in institutional entrepreneurship interventions, such as HISP's efforts, which were partially resisted by an institutional entrepreneur (a foreign consultant at the MoH) who advocated for another digital solution (MB-SIS) instead of DHIS. Despite these tensions, various institutional entrepreneurial interventions enabled the adoption and national-level institutionalisation of this new digital solution, which remained in use for over ten years.

Continuous transformations within the setting, including technological and political changes, natural or economic crises, also led to shifts in institutional contexts, introducing new structures and practices. Examples include the development of the HMIS Restructuring Plan, strategic plans over the years, an assessment of MB-SIS, the creation of new partnerships, and the emergence of new technologies. Such socio-technical arrangements sparked the MoH's interest in initiating another HMIS implementation process in 2008. This interest was reinforced by the recognised limitations of MB-SIS and the potential of new technologies, such as OpenMRS and DHIS2, promoted by partners and donors and validated by testimonies from other governments.

The proposed implementation approach for the new system was deemed highly demanding, with significant financial, technical, and human resource implications for the HMIS's sustainability and self-reliance. This approach reinforced existing dependencies. The anticipated benefits of transforming DHIS's open-source code did not outweigh the advantages of adopting DHIS as it was. Such transformation would have imposed considerable challenges for maintenance and further technological adaptations by the MoH's constrained local technical teams. Additionally, these teams would have limited opportunities to utilise DHIS's customisable features and engage in its global community of practice. The conflicts arising in this process were also addressed through institutional entrepreneurship interventions. An institutional entrepreneur, identified as a local deputy director from the MoH, led a collective action to alter the HMIS implementation trajectory (refer to section 8.3 for more details).

The three institutional contradictions identified in this historical analysis persisted over time, sometimes perceived as constraints and other times as opportunities for change. They were addressed

through various entrepreneurial actions, requiring commitment and involvement from several groups for replication. Some entrepreneurial actions introduced and adopted by these actors include (1) the combination of research, education and practice, (2) tailored technological innovations for extended support, (3) diversifying to strengthen capacity, (4) building networks of support, resources and legitimacy, and (5) embracing platform coexistence while bridging interests. These are introduced and developed further in sections 8.3 and 8.4.

8.3 Entrepreneurship actions and the becoming of an institutional entrepreneur

Building change through institutional entrepreneurship is paradoxical, as it challenges embedded actors to alter the very institutional routines they are a product of. As institutional processes evolve, institutional contradictions may arise, creating new opportunities to instigate institutional change while resolving these contradictions. While some contradictions are obvious, others may develop over time, often obscured by the institutional context and history. An example is the public sector's hiring restrictions in contrast to the growing need for human resources to support new digital initiatives. The existence and influence of these contradictions are not inherently negative and can present opportunities for change. They need recognition, though they are sometimes overlooked. Dealing with institutional contradictions is often culturally influenced by how the institutional entrepreneur perceives, acknowledges, and addresses them. From a historical perspective, I leverage hindsight to understand how actors engaged with these contradictions, learned from their actions, and introduced reflective change. I adopt the viewpoint that the institutional entrepreneur does not emerge abruptly but evolves and develops historically. The following premises are crucial in understanding the historical process of becoming:

- Organisations and individuals are not passive but possess 'embedded agency', enabling them to question their current situations and take actions attempting to change them.
- Organisations and individuals may gather resources and support from powerful actors, both internal and external to the organisation, thereby challenging the status quo of their institutional contexts. The model of institutional entrepreneurship may be internal, external, or hybrid.
- The institutional and historical context influences the behaviour and processes of the embedded organisational actors and the agency they can exert.
- Institutional contexts vary over time as they go through different developmental stages of foundational norms, regulations, and cultural values, requiring varied entrepreneurial approaches and strategies.

Over the 20-year period analysed, multiple actors (organisations and individuals) have played significant roles in the HMIS implementation processes, as illustrated in Tables 26 and 27. Analysing their roles enabled the identification of five key entrepreneurial actions and two institutional entrepreneurs. Notable examples of entrepreneurial actions undertaken to address existing institutional contradictions include (1) integrating research, education, and practice and (2) developing tailored technological innovations for extended support. In this section, I first elucidate the nature of these two actions, using examples from the historical narrative. The subsequent section introduces the remaining three entrepreneurial actions, considering their contribution to institutionalisation. Then, I examine the positioning and roles of the two institutional entrepreneurs in the HMIS implementation processes. Adopting a historical lens, I explore the interplay between institutional contradictions and institutional entrepreneurship, focusing on the tensions and conflicts analysed in section 8.2 and how institutional entrepreneurial actions mediated the HMIS implementation processes.

Table 26. List of organisations and individuals involved in the DHIS-related HMIS implementations.

Phase	Key Actors	Roles
Overall Process	- MoH	Recipient and manager
Phase 1 (2000-2007)	- HISP	Proponent of DHIS, with projects funded by NORAD
	- UEM researchers	- Providing local technical support for the pilot - Supporting the international master program UEM-UiO
	- NORAD	Funding the HISP/ UEM-UiO project
	- WCU researchers	Providing external technical support for the pilot
	- External Consultant	Evaluating DHIS pilot
	- Internal Consultant at MoH	Developer of MB-SIS
Phase 2 (2008 - 2011)	- Internal Consultant at MoH	Developer of MB-SIS
	- UEM researchers	Supporting local master programs at UEM
	- ITECH	Evaluating the HMIS and MB-SIS
	- MOASIS/UEM	Introducing digital innovations
	- MOASIS/JEMBI	Providing local technical support to the MoH
	- CDC	Funding development of SIS-MA
	- Contracted Software Company	Proponent of SIS-MA with DHIS2
	- HISP	Evaluating the HMIS and SIS-MA
	- Global Fund	Funding the assessment and transformation of SIS-MA
Phase 3 (2015 - 2020)	- UEM researchers	Supporting local master programs at UEM
	- MOASIS/ JEMBI	Providing local technical support to the MoH
	- CDC	Funding development of SIS-MA
	- Saudigitus/ HISP	Providing local technical support to the MoH
	- Global Fund	Funding the assessment and transformation of SIS-MA

Combining education, research and practice

Despite being an external organisation to Mozambique, HISP-UiO actively participated in the entrepreneurial actions of the HMIS implementation processes. I analyse their involvement to understand how an entity from outside the setting contributed to transforming the institutional context within the researched setting. Table 29 illustrates the various roles HISP-UiO played during the analysis period. This organisation was introduced to the MoH by UEM, leveraging their longstanding relationship for effective intervention. UEM, the country's first public university, played a pivotal role, having graduated its first locally trained physicians. The MoH recognised HISP-UiO's previous work in South Africa, leading to a welcomed collaboration. The collaborative efforts of these three entities included a comprehensive assessment of the digital landscape in Mozambique, identifying numerous challenging conditions (as discussed in section 8.2, relating to sources of institutional contradictions). These challenges were viewed as opportunities, leading to initiatives for introducing DHIS and various capacity-building interventions, which also aimed to strengthen the connections between education, research, and practice.

Table 27. Roles played by the most active actors during the HMIS implementations over the three phases.

			Roles assumed in the different phases		
#	**Actor**	**Institutional Process**	**Phase 1 (2000-2007)**	**Phase 2 (2008-14)**	**Phase 3 (2015-2020)**
1	HISP-UiO	DHIS 1.3 pilot implementation	(2000-2004) Proponent of DHIS 1.3 with projects funded by NORAD (2000-2007) Providing support	(2012) Proponent of DHIS2 in the tender (2013 - 2014) Evaluating the HMIS and SIS-MA (with DHIS 2.13)	(2015) Supporting DHIS 2.16 implementation and following developments
2	Internal Consultant (Institutional Entrepreneur #1)	MB-SIS implementation	(2004) Development of MB-SIS in parallel to DHIS 1.3 (2004) Adoption of MB-SIS, disruption of SIS-Prog and SIMP	(2005-2009) Institutionalisation (2009-2015) MB-SIS Reinstitutionalisation, through MB-SIS Anexo	(2016) Disrupted by the adoption of DHIS 2.16
3	UEM researchers	Establishing and developing capacity-building initiatives within the health sector, UEM and UiO	- Providing training support within the health sector -Coordination and lecturing in the master program UEM-UiO - PhD students at UiO	(2008) One founder of MOASIS (2008-2014) Involved in the Master's and PhD programs at UEM and UiO (2014) One founder of Saudigitus	-Providing training support within the health sector -Involved in the master programs at UEM
4	UEM students	-Capacity building development -Reintroduction of DHIS2	Involved in the master program UEM-UiO PhD program at UiO	-Involved in the master programs UEM-UiO PhD program at UiO -Involved in DHIS2 developments	-Involved in DHIS2 developments -Involved in the master programs at UEM
5	MOASIS/ Jembi	Reintroduction of DHIS2	-	(2008-2014) Proponent of OpenMRS in the country (2009-2014) Providing local technical support for the MoH	(2015-2020) Providing local technical support for the MoH
6	Contracted Software Company	-Reintroducing DHIS with version 2.13 -DHIS 2.13 pilot	-	Proponent of SIS-MA with DHIS 2.13 Development of SIS-MA Pilot (with DHIS 2.13)	-
7	UEM researcher (Institutional Entrepreneur #2)	Reintroduction of DHIS 2.16 Disruption of MB-SIS/MB-SIS Anexo	(2000-2004) Providing support in the DHIS 1.3 pilot (2000-2007) Providing support in the Master Programs at UEM	(2008-2014) Providing support in the Master Programs at UEM (2012) Proponent of DHIS2 in the tender with HISP (2013-2014) Deputy Director at the MoH (201 4) Development of a DHIS 2.16 instance	(2015) Development of SIS-MA (DHIS 2.16) (2016) Training and adoption of DHIS 2.16, disruption of MB-SIS/ MB-SIS Anexo (2017-2018) Institutionalisation of DHIS 2.16 (2015-2020) Providing support in the Master Programs at UEM
8	Saudigitus	Reintroduction of DHIS Disruption of MB-SIS/MB-SIS Anexo Adoption and institutionalisation of SIS-MA	-	(2014) Development of DHIS 2.16	(2014) Participation in the development of DHIS 2.16, later providing support alongside HISP-UiO

HISP-UiO established a local branch in Mozambique, known as HISP Mozambique, which included researchers from UEM's faculties of medicine and science. These teams united their interests in transforming the digital landscape of the setting. Utilising their established legitimacy, they reached out to influential groups possessing vital resources. HISP-UiO's collaborative efforts, involving partner universities in South Africa and the local university, led to the design of a capacity-building project. This project integrated interconnected components of research, education, and practice. NORAD's funding was instrumental in supporting these interventions and further solidifying HISP-UiO's legitimacy in the country.

Two key entrepreneurial actions undertaken by HISP-UiO were: (1) the introduction of an International Master's course at UEM and the enrolment of UEM researchers in a PhD program at UiO; (2) the engagement of students and researchers in training, software development, and research. The Master's and PhD programs encompassed three core components—education, research, and practice. These components contributed to: (1) enhancing the capabilities of professionals in health and informatics; (2) expanding knowledge production by linking practical problems with theoretical frameworks; (3) developing training and software related to DHIS.

The impact of these two entrepreneurial interventions was significant over the entire period of analysis, ensuring the sustainability and self-reliance of the evolving activities. UEM researchers involved in the Master's and PhD programs played pivotal roles in the HMIS implementations over time. They took on responsibilities related to the Master's courses at UEM and courses offered through DHIS2 Academies. One UEM researcher founded MOASIS, another assumed the role of Deputy Director at the MoH during Phase 2, and a third founded Saudigitus (representing HISP Mozambique) in Phase 3. These organisations and individual actors developed crucial entrepreneurial actions throughout the HMIS implementation process. The experience gained in the Master's and PhD programs equipped them with valuable skills, facilitating the further development of DHIS2 locally and internationally, as exemplified by the founder of Saudigitus.

Tailored technological innovations for extended support

Some persistent institutional contradictions in the public health sector were inherited from the setting and proved challenging to overcome. The role of social responsibility from other entities, including private, for-profit, or non-profit organisations within the same context, is critical. These organisations often possess greater administrative flexibility, enabling them to compete for funded projects and acquire resources essential for engaging in social

responsibility projects. Furthermore, they are often more successful in winning tenders, especially when partnering with public organisations on projects that align with developmental agendas. In return, beyond funding, these organisations gain recognition from their association with the State, thereby reinforcing their legitimacy. One strategy adopted by public institutions in this context has been the formation of strategic partnerships with such entities. These partnerships have been evident throughout the HMIS implementation process, giving rise to various entrepreneurial initiatives. Two such organisations that sought to implement changes in their institutional context are MOASIS and Saudigitus, both led by UEM researchers involved in the HMIS implementation during Phase 1 and affiliated with both the MoH and UEM. The establishment of these organisations and their legitimisation by the MoH signified the development of local technical capacity. Each organisation built its own support networks, enabling access to diverse resources.

MOASIS, a Living Lab project from UEM, included former MoH executives on its team and partnered with Jembi, a South African software company. Their legitimacy in the health sector was bolstered by introducing a system at the hospital level for death registration and certificate issuance. Their efforts gained prominence through the OASIS project, which introduced OpenMRS to the setting and was adopted by various health sector implementation partners. A formal relationship with the MoH was established through an MoU for technical support. Additional entrepreneurial actions included developing Point of Care (POC) units for HIV patient care at hospitals and introducing SIS-Compact stations for accessing DHIS2 in low-resource settings.

The creation of Saudigitus, independent from UEM, was vital for providing flexible DHIS2 technical support to the health sector, enhancing the role of HISP Mozambique. Relying on strong relationships with UEM and HISP-UiO, Saudigitus evolved into a trusted DHIS2 support partner. Their entrepreneurial actions encompassed local app development to expand DHIS2 usage, integration and interoperability projects, and capacity building through DHIS2 academies, leveraging resources from HISP-UiO.

Both MOASIS and Saudigitus adopted and extended the HISP-UiO model of linking education, research, and practice, even incorporating it at the bachelor's level. By recruiting informatics students to contribute to digital solution development, they continued to expand capacity building and skill development in the setting.

Institutional entrepreneurs: engaging collective action

The restrictions on hiring personnel due to limited budgeting in the public sector posed several challenges, particularly in the health sector. These challenges were compounded by the scarcity of doctors and health personnel and the necessity to hire administrative and technical staff. This led to a dependency on external technical support for maintaining and developing systems and infrastructure. Initially, in the 1990s, there was a lack of local skilled technicians and technology experts in the setting. Consequently, the health sector predominantly relied on foreign experts hired by donors and partner organisations to bridge these gaps and provide the needed assistance. Over time, there was a gradual shift towards hiring local skilled personnel for these roles. However, this change has not been complete, as funding dependencies often dictated these hiring decisions by the fund providers. With limited administrative staff, the health sector often relied on medical doctors to undertake administrative tasks when possible. This situation presented a significant opportunity to further develop their profiles and involve them in HMIS implementation processes.

I have identified two key internal actors as institutional entrepreneurs who actively intervened to alter the trajectory of institutional processes at different times. To clarify, I will refer to them as IE1 (Institutional Entrepreneur 1) and IE2 (Institutional Entrepreneur 2) henceforth. IE1, a foreign technical support hire, served as an internal consultant in the Department of Information for Health at the MoH. He played an active role during Phase 1, responding to institutional contradictions surrounding the DHIS 1.3 pilot. IE2, a local hire by the MoH for the Directorate for Planning and Cooperation as Deputy Director, was influential during Phase 2. He responded to institutional contradictions that emerged in the development of the new system. Table 28 provides a summary of the key characteristics of these two institutional entrepreneurs.

Table 28. Characteristics and strategies from the institutional entrepreneurs participating in the three phases.

Process	Institutional Entrepreneur #1 (IE1)	Institutional Entrepreneur #2 (IE2)
Phase	Phase 1	Phases 2 and 3
Origin	Foreign	Local
Background	Informatics	Medicine/ Information Systems
Position within the MoH	Department of Information for Health (DIS)	Directorate for Planning and Cooperation/ Department of Information for Health (DIS)
Role	Internal consultant	Deputy Director
Systems replaced	SIS-Prog, SIMP	MB-SIS, MB-SIS Anexo
Pilots in place	SIS.d (DHIS 1.3)	SIS-MA (DHIS 2.13)
System introduced	MB-SIS	SIS-MA (DHIS 2.16)
Initial development	2004 (in parallel to the pilot)	2014 (in parallel to the pilot)
System Lifetime	2004-2014	2016-2023 (still in use)

The interventions of the two institutional entrepreneurs, despite facing challenges, showed some similarities. In Phase 1, the institutional context was still forming, with regulative and cultural norms related to the digital component not fully established. The limitations of existing legacy systems were recognised, and the MoH was keen on implementing a new, modern digital solution. The parallel software developed and introduced by IE1 (the internal consultant) received support and endorsement from both the MoH and donors at that time. In Phase 2, the institutional context was transitioning towards greater stability. The MoH had a clearer understanding of their digital needs and potential. Similar to Phase 1, neither the existing software nor the one under development met the requirements. This situation was perceived as an opportune moment for intervention and entrepreneurial actions. IE2 (the Deputy Director) garnered support from influential actors like the MoH and the Global Fund. This support proved valuable in subsequent stages, as I will describe in section 8.4. From a historical perspective, it becomes clear why these two individuals were able to challenge their institutional context. They were internal actors, products of their institutional context, yet with notable differences.

IE1, of foreign origin, was integrated into the ministry's team. He assumed an internal role, providing technical support for HMIS-related activities and being recognised as a legitimate MoH team member. His life experiences and prior relationships with external organisations allowed him to broaden his perspectives and generate new ideas. While internal, he was not deeply entrenched in the MoH's institutional context.

IE2, a local individual, was one of the UEM researchers involved in Phase 1 of the DHIS pilot with HISP-UiO. During the pilot, IE2 engaged in capacity building while also pursuing a PhD. This exposure expanded his background and experiences in HMIS implementations, which proved crucial when he later joined the MoH as a legitimate, high-level team member. His position enabled him to recommend more appropriate approaches and advocate on behalf of the MoH.

This analysis has been instrumental in exploring how various internal and external actors in the health sector collaborated to transform it. It has also shed light on how these actors identified institutional contradictions and responded to them. Adopting a historical lens has enabled an in-depth exploration of the development of institutional entrepreneurs and their entrepreneurial actions. In the next section, I will analyse how institutional contradictions and entrepreneurial actions influenced the processes of institutionalisation.

8.4 Patterns of action paving the way for institutionalisation

Some of the institutional contradictions identified and analysed previously persisted throughout the analysis period. However, their significance was perceived differently over time. Gradually, investments in the country helped to reduce the impact of scarce resources. Additionally, the proactivity of organisations and individuals within their institutional context proved valuable. For example, in Phase 1, the accumulation of institutional contradictions hindered the progression of the DHIS pilot, leading the MoH to opt for MB-SIS. The adoption of MB-SIS was facilitated by the improved conditions in the institutional context and the heightened awareness of various actors. Furthermore, the role of IE1 was critical in identifying the unmet requirements and expectations that needed to be addressed in the new digital solution. To gain a deeper understanding of how institutionalisation unfolded, it is important to consider the role of institutional entrepreneurship in facilitating this process through strategic action.

The institutionalisation process of MB-SIS, led by the internal consultant in Phase 1, and DHIS 2.16, led by the deputy director in Phase 3, exhibited both similarities and distinct challenges. Initially, the digital context in Phase 1 was still forming, while in Phase 3, it was more established and stable. Despite facing different challenges, the strategies and dynamics implemented by the institutional entrepreneurs identified in each phase were pivotal. Both entrepreneurs gained legitimacy to represent and guide their respective collectives, secured resources and support, and leveraged their sense of opportunity to act strategically. The strategies adopted by these institutional entrepreneurs are summarised in Table 29 below.

Table 29. Institutional entrepreneurs' strategies according to their perception of the institutional context.

(Historical Moment) Institutional Context	Activities	Creation	Maintenance (institutionalise)	Disruption
(2000 – 2007) Formation	Capacity Building	- Educating	- Enabling work - Embedding and routinising	-
	Development and pilot of Sis.d (DHIS 1.3)	- Educating	-	- Undermining Assumptions and Beliefs
	Development and implementation of MB-SIS	- Advocacy - Mimicry - Educating	- Enabling work - Policing - Embedding and routinising	- Camouflaged Replacement
(2008- 2014) Transiting between Formation and Stable	Transform MB-SIS and implement MB-SIS Anexo	- Mimicry	- Embedding and routinising	- Replacement - Disconnecting Sanctions/Rewards - Undermining Assumptions and Beliefs
	Development and pilot of SIS-MA (DHIS2.13)	- Educating	-	Undermining Assumptions and Beliefs
(2015-2020) Stable	Development and implement SIS-MA (DHIS 2.16)	- Advocacy	- Policing	- Replacement - Disconnecting Sanctions/Rewards
		- Inclusive Participation	- Embedding and routinising	
		- Mimicry	-Investment in infrastructure	
		- Educating	- Strengthening practices through training	
		- Constructing Identities	- Extending capacity by integrating external support	
		- Constructing Normative Networks	- Bridging interests	

When DHIS 2.16 was introduced in Phase 3, the digital landscape within the health sector had become more stable and mature. Despite MB-SIS still being in use and well-integrated within the installed base dynamics, its limitations have become apparent. This was further highlighted by the crisis in the institutional context involving DHIS2 (2.13) during Phase 2 and the re-institutionalisation of MB-SIS through MB-SIS Anexo, an extended version with new functionalities. IE2, in Phase 3, was well-positioned to provide advice, exert influence, and

take strategic actions. His involvement was crucial in securing resources, including financial and external technical support, which bolstered the potential for collective action engagement.

The initial strategies aimed to integrate components of organisational practices into the software. The information cycle was customised to ensure that system usage was deeply embedded within the health sector's routines. This included configuring the calendar for routine reporting cycles in the country and determining the timings for data capture, validation, discussion, and reporting. Leveraging available resources and technical support was key to implementing and consistently replicating these routines. The budgets for these activities were incorporated into national plans, benefiting from donor financial support. Limited technical assistance was expanded through joint efforts by HISP-UiO, HISP Mozambique (including UEM researchers and Saudigitus), and MOASIS.

Strategic interventions also emphasised educational approaches to demonstrate the capabilities of DHIS 2.16 to health workers. The MoH incorporated capacity-building activities for health information management staff into both their short and long-term plans. Beyond formal channels like technical or tertiary education, in-service training was enhanced with DHIS2 academies. Three critical actions during this phase were pivotal: ‘Diversifying to Strengthen Capacity’, ‘Building Networks of Support, Resources, and Legitimacy’, and ‘Embracing Platform Coexistence While Bridging Interests’.

Diversifying to Strengthen Capacity:

The MoH continued to develop capacity-building through education, merging conventional formats (formal courses at universities, schools, or institutes) with new regional training and in-service training initiatives. Reinforcing training was deemed vital to strengthen practices and system usage. In-service training helped health workers redefine their practices and ensured continuity of services during team transitions, until new health workers could fortify the team. The proximity of involved universities (UEM and UiO) rejuvenated previously established relationships. Additionally, the local-level support provided by DHIS2 Academies was crucial in fostering aspects of ownership and self-reliance.

***Building networks of support,* resources and legitimacy**

The introduction of a new system necessitates time for continuous adaptations. While some users may draw on previous experiences, others might be quick learners or may need a longer period to overcome issues hindering their progress. The historical narrative has shown that the role of entrepreneurial actions was instrumental in addressing persistent institutional

contradictions, paving the way for adoption and institutionalisation. This overall process demanded engagement from the MoH and a collective effort involving users at all levels to establish support networks. The Department of Information for Health played a pivotal role in ensuring the integration of all support teams across various levels, including program heads and the Statistics Nucleus at the provincial, district, and hospital levels. Their involvement was key throughout the entire information cycle, with these actors taking on more proactive support roles at their respective levels. Enhancing system usage monitoring, facilitating interactions to share experiences, and strengthening monitoring and evaluation processes were also crucial aspects.

It is common for new systems to impose specific demands on the supporting infrastructure. A portion of the financial resources mobilised for entrepreneurial actions aimed at institutionalisation was allocated to investing in and improving infrastructure, equipment, and connectivity, as well as supporting related training activities. This was vital to mitigate the impacts of persistent institutional contradictions. Improving communication across different levels was essential, not just for operational efficiency but also to promptly address issues arising at all levels. For instance, system administration issues became more apparent at the central level, necessitating adaptations to the HMIS; issues like Internet and computer malfunctions due to software viruses caused delays in data submission, requiring solutions such as the development of the SIS-Compact station.

These improvements also addressed existing challenges in hiring and retaining IT professionals, thereby extending the health sector's technical capacity by integrating legitimate external support from local organisations. The MoH formed agreements with external entities operating alongside universities, such as MOASIS and Saudigitus, which represented internal actors. The support from these external organisations included skilled and expert human resources that contributed to maintaining and enhancing the HMIS. While some of these resources were allocated to support teams at the provincial level, others were deployed at local health facilities. This approach was crucial for timely response to local demands and integrating new functionalities into their work.

Embracing platform coexistence while bridging interests

In the national setting, fragmentation has increasingly become a prevalent issue over the years. Various government sectors, including health, education, and justice, have operated in silos, hindering the establishment of consistent data exchange among them. The common approach to resolving sector-specific issues has been the adoption or development of specialised systems,

informed by shared experiences with national and international partners and donors. The development of a national government interoperability framework was critical in facilitating initiatives between sectors and mitigating fragmentation where possible.

In the health sector, the challenge of fragmentation was particularly noticeable. Despite established practices and routines associated with the new system, challenges persisted due to legacy systems introduced over the years by health programs and partner organisations. Fragmentation within the HMIS remained a significant challenge over time. However, there were notable improvements in integrating some health programs that had previously operated in isolation, such as Malaria, TB, the Extended Program for Immunisation (EPI), and Community HIS. The MoH adapted to the multiplicity of systems in place, ensuring they facilitated communication and data sharing/exchange within the HMIS. This approach also reinforced data ownership and addressed information gaps through technical means of integration and interoperability.

To address the 'plurality of actors effects', the MoH implemented a strategy to bridge interests. With the diversity of actors in the health sector came a variety of systems. The MoH worked to establish communication links and routines for accessing data from these systems. Similarly, the MoH initiated collaboration with other government organisations to enable data exchange between their repositories. For instance, while the MoH registers all births at the hospital level, the Ministry of Justice records all children born in the country. These two ministries collaborated to create an interoperability interface between their systems.

The MoH followed certain patterns of actions throughout the HMIS implementation processes over time, which I summarise in Table 30.

Table 30. Patterns of action followed by the MoH along the three historical moments identified from the case study.

Patterns of actions	**Related historical moment**
Running pilots	- In 2000, ran DHIS Pilot alongside SIS-Prog and SIMP - In 2014, ran the pilot of SIS-MA alongside MB-SIS.
Technical consultancy	- In 2004, they hired an external consultant from South Africa to evaluate DHIS Pilot and adopt MB-SIS afterwards. - In 2008, they hired an external Consultant#1 (ITECH) to evaluate MB-SIS and opted for a hybrid solution (maintain MB-SIS while developing SIS-MA with DHIS2). - In 2013, they hired an external consultant (HISP) to evaluate the new system developed (pilot of SIS-MA with DHIS2) and opted to halt the implementation (maintaining MB-SIS operational)

Fostering relationships and collaboration with the academy	- In 2000, related to UEM researchers - In 2008, related to MOASIS (an initiative led by one researcher from UEM involved in DHIS 1.3 pilot) - In 2013, related to UEM as a privileged partner and source of expert human resources (hiring one researcher from UEM involved in the DHIS 1.3 pilot).
Regulative reinforcement	- In 2000, introduced the first Health Strategic Plans (PESS 2000 – 2005), the Health Information System Development Program (2003-2005), and the Restructuring and reorientation of the Health Information System Plan (2006-2008) - In 2008, implemented the Health Strategic Plans (PESS 2007 – 2012), continued the implementation of Restructuring and reorientation of the Health Information System Plan (2006-2008), and introduced the Health Information System Strategic Plan (PESIS 2009-2014) - In 2015, implemented the Health Strategic Plans (PESS 2014 – 2019)
Receptivity to technological initiatives	- In 2000, DHIS 1.3 was introduced by HISP, - In 2004, MB-SIS was introduced by the Internal Consultant - In 2008, SIS-ROH and MB-SIS Anexo were introduced by MOASIS/ Jembi - In 2014, SIS-MA developments were taken up by the MoH with integrated external support (local consultants working inside the MoH) - In 2018, introduced POC with SIS-Compact stations
Consultancy, collaboration, and external technical support	- In 2000, relied on DIS (with foreign consultants), HISP, UEM and WCU researchers - In 2008, relied on DIS (with foreign and local consultants), MOASIS /Jembi - In 2015, relied on DIS (with local consultants), HISP, MOASIS /Jembi and UEM
External support in the vertical health programs and other initiatives	Donors were providing financial support and introducing digital initiatives to support health programs.
External support to implement digital initiatives	Examples include the NORAD, CDC, and Global Fund in the three historical moments.

Institutionalisation as an incremental and continuous historical process

The historical narrative demonstrated that the institutionalisation processes were initiated following the successful interventions of institutional entrepreneurs and specific entrepreneurial actions. These efforts helped to counteract and leverage existing institutional contradictions. Integrating organisational practices with the HMIS implementation as an incremental and continuous historical process was vital for the MoH. The ongoing reinforcement of entrepreneurial actions within the organisation's practices facilitated gradual and steady progress. This approach ensured the continuity of HMIS developments, even after the institutional entrepreneurs vacated their leadership roles.

Over time, the MoH gained increased control over HMIS developments. In Phase 2, following the end of the contract with IE1 (the internal consultant), MOASIS provided support and

module upgrades for MB-SIS.Anexo, ensuring the continuous operation of MB-SIS. This system was eventually replaced in Phase 3 with the introduction of SIS-MA (DHIS 2.16), under the guidance of IE2 (the deputy director). IE2 spearheaded the institutionalisation of this system, a process that was continued by successors from 2019 onwards. Alongside its institutionalisation, SIS-MA experienced ongoing evolution, incorporating developments from its supporting technological artefact (DHIS). These advancements did not pose impediments or constraints to HMIS implementation, thanks to the integrated efforts of the MoH's local support teams (MOASIS and Saudigitus) and the global DHIS2 network.

8.5 Explaining DHIS institutionalisation

Institutionalisation represents a stage in institutional transformation and is best understood as a process. In discussing the introduction of DHIS, I delineate this process across three distinct periods.

Prior to any efforts to introduce DHIS, various institutional contradictions were evident. Issues such as infrastructure and technical capacity limitations continued to impede HMIS development. The governance instruments for HMIS were evolving slowly, in stark contrast to the rapid introduction of technological innovations and the proliferation of fragmented legacy systems. Moreover, the shortage of skilled health personnel for data management functions remained a challenge, counterbalanced by the increasing responsibilities of health personnel in supporting the HMIS.

A pivotal entrepreneurial action during this period was the integration of research, education, and practice. This included (1) launching an International Master's course at UEM and enrolling UEM researchers in a PhD program at UiO, and (2) engaging students and researchers in training, software development, and research. These initiatives were crucial in making the first attempt to pilot DHIS 1.3. Additionally, this institutional process aimed to disrupt the existing SIS-Prog system. This attempt, however, encountered various tensions and conflicts (as described in section 8.2), which were subsequently addressed by IE1 (the internal consultant). IE1 developed MB-SIS and spearheaded its adoption. The ensuing processes involved disrupting SIS-Prog and SIMP, and the termination of the DHIS 1.3 pilot. Figure 20 in the document illustrates these institutional processes.

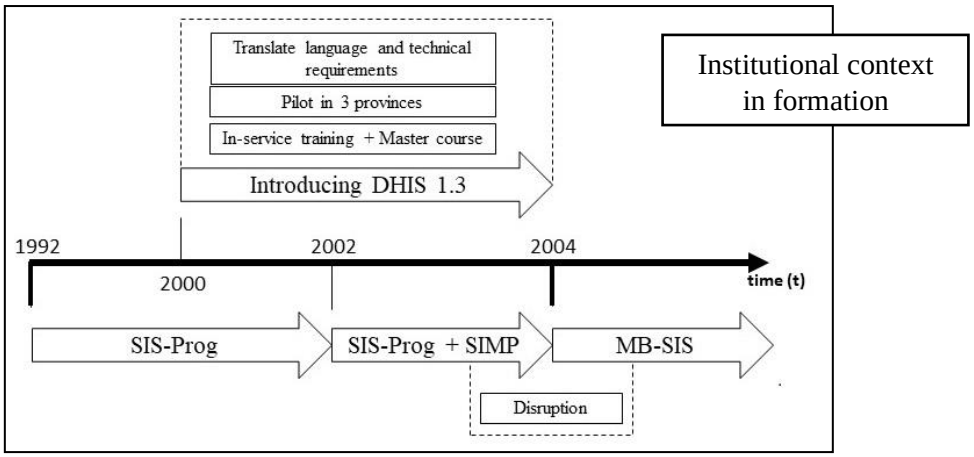


Figure 24. First attempt to introduce DHIS (version 1.3) in the setting.

The second attempt to introduce DHIS, this time with version 2.13, also faced challenges due to institutional contradictions. These issues were addressed by IE2 (the deputy director), who played a pivotal role amidst changes in MoH leadership. This individual steered significant shifts in the ongoing institutional process. Consequently, the developments were halted, and a new institutional process was initiated. Figure 21 in the document illustrates these institutional processes.

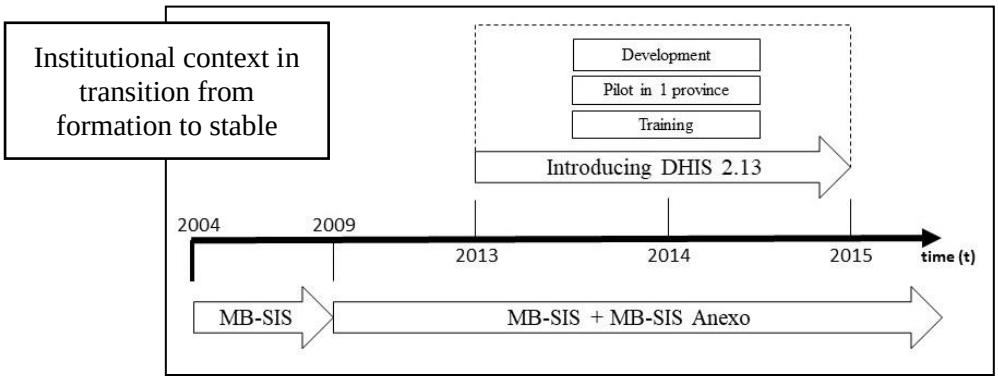


Figure 25. Second attempt to introduce DHIS (version 2.13) in the setting.

The third attempt to introduce DHIS was led by IE2. This individual successfully rallied support from influential entities (MoH and the Global Fund) and UEM to implement DHIS 2.16. The triumph of this institutional process hinged on more profound collective action and engagement. After developing the new system with DHIS 2.16, IE2 employed a bold and somewhat risky strategy by replacing MB-SIS with DHIS 2.16. A key factor in this process was the successful integration of the new system within the existing installed base. This integration was further bolstered by the introduction of 'tailored technological innovations for extended support'. Additionally, three other actions played a crucial role in this phase: 'diversifying to strengthen capacity', 'building networks of support, resources, and legitimacy',

and ‘embracing platform coexistence while bridging interests’. Figure 22 in the document illustrates these institutional processes.

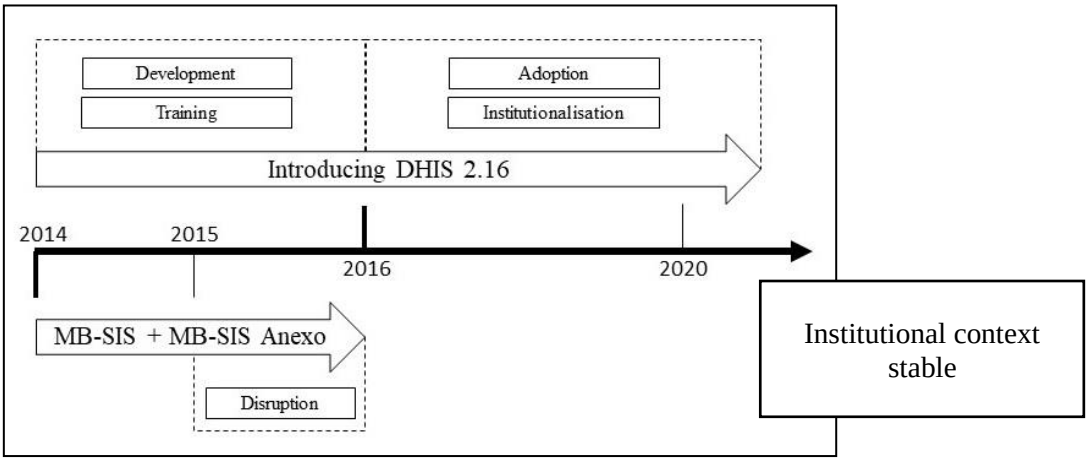


Figure 26. DHIS adoption and institutionalisation (version 2.16) in the setting.

Having outlined the events of the three HMIS implementation processes and considering the development of DHIS in the setting, I now aim to provide some explanations. A key question is why DHIS was not implemented in the setting during phases 1 and 2, but was successfully implemented years later. One plausible explanation is the variation in the institutional context across these phases. Figure 23 in the document illustrates this scenario. The changes in context are largely exogenous, arising from environmental elements that constitute the institutional setting. In phase 1, the institutional context was more conducive to the introduction of SIMP and MB-SIS, representing formal changes. During this phase, the MoH issued directives to implement SIMP and MB-SIS, but none to adopt the DHIS pilot. Other changes in the institutional context can be categorised as informal changes, such as the health workers’ readiness to accept the new software (MB-SIS). These changes occurred as a result of the training that accompanied the DHIS pilot.

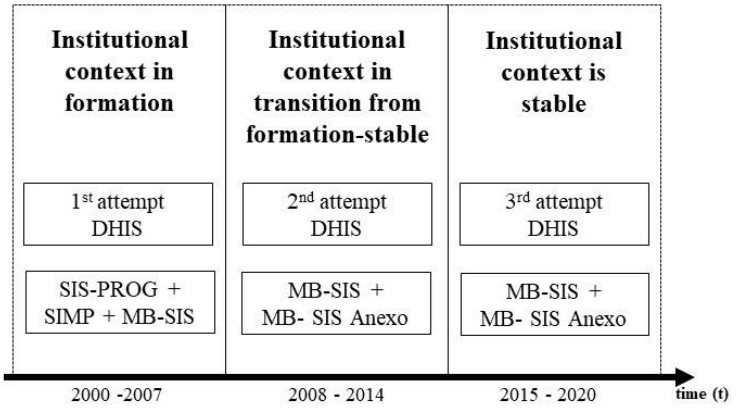


Figure 27. The first explanation for the institutional changes that occurred over time.

Another explanation for the varied outcomes in DHIS implementation relates to the evolution of DHIS over the years, as reflected in the different versions introduced in each phase: DHIS 1.3 in phase 1, DHIS 2.13 in phase 2, and DHIS 2.16 in phase 3. Figure 24 in the document illustrates this progression. These advancements are considered endogenous, signifying internal transformations within the technological artefact. The most recent version, DHIS 2.16, proved to be more suitable for customisation and adaptation to the setting than its predecessors. The involvement of IE2 was pivotal in this evolution. This was partly due to IE2's prior experience with the earlier versions of the technological artefact and a comprehensive understanding of its functions. Additionally, IE2's knowledge, social skills, and ability to mobilise necessary support and foster collective action were crucial in implementing the needed transformation. The adoption of DHIS 2.16 marked a formal change, as it was a decision made by the MoH.

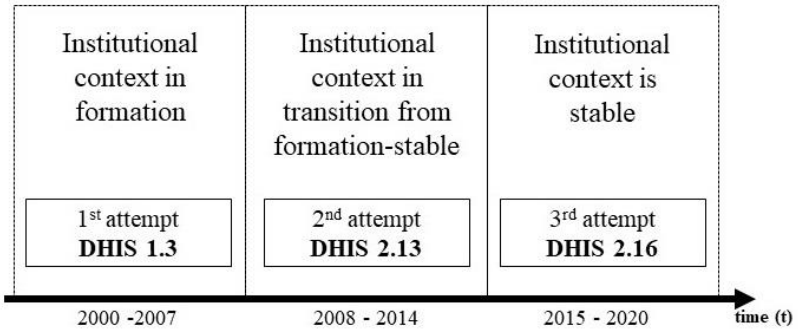


Figure 28. The second explanation for the institutional changes that occurred over time.

Beyond these two explanations for the resistance and eventual adoption of DHIS in the setting, the historical analysis offers a critical set of evidence explaining how DHIS was institutionalised. Over the 20 years analysed, DHIS maintained a constant presence, continually supported through ongoing education activities initiated with the pilot. These included in-service training, Master's courses, PhD programs, and subsequent initiatives like DHIS2 Academies. The initial resistance to adopting DHIS in the early 2000s and later in the 2010s helped inform health sector participants about their needs and expectations for the developing HMIS. By the time IE2 joined the MoH, DHIS was no longer an unfamiliar technological artefact, as its history and reputation had preceded it. This prior recognition significantly contributed to its legitimacy in the setting. Another factor was the growing international recognition of DHIS2. Its further developments abroad were aligned with the requirements of international organisations (such as the World Health Organisation) and donors (including the Global Fund and CDC) that support health initiatives in LMIC countries. The entrepreneurial

actions (discussed in sections 8.3 and 8.4) further reinforced DHIS's potential to support the HMIS and ensured its institutionalisation in the setting. In the next chapter, I will discuss these results in the context of similar studies and other relevant literature.

Chapter 9 : Discussion

This thesis contributes to research in the ICT4D and Health Information Systems implementation domains and seeks to add to the body of knowledge in IS research on implementation. In this chapter, the results are discussed from a historical perspective, underscoring the contributions and their implications for both theory and practice. The chapter articulates four key contributions, which are elaborated on in the subsequent sections.

Section 9.1 crafts a historical narrative based on the implementation of the HMIS in the LMIC context of Mozambique. Section 9.2, building on this historical analysis, presents contributions that challenge the prevalent failure literature in IS implementation research. This section analyses the mutual shaping process between technological artefacts and their implementation contexts. In Section 9.3, the focus shifts to the interplay among three institutional concepts, which helps develop the notion of emergence of institutional entrepreneurs. Section 9.4 is devoted to examining entrepreneurial actions and shedding light on their practical implications. The chapter concludes with Section 9.5, which synthesises the key themes and discussions presented in this chapter.

9.1 Developing a historical reconstruction and analysis process

This thesis advances the development of a historical narrative, which responds to Walsham's (2017) call for an analysis of the complex relationship between technological artefacts and their implementation environments. This detailed historical narrative holds significance for ICT4D research, addressing issues like the mutual influence of technology and societal and contextual contexts, and builds a critique of models of technology transfer and diffusion. For instance, Avgerou's (2000) research on IT and organisational change, which draws upon Volkow's (2003) examination of systems informatisation in modernising a state company in Mexico, develops such a narrative. Avgerou used this longitudinal study to conceptualise IT innovations and organisational practices as evolving institutions, shedding light on processes of institutional change over time. In the health domain, historical data and analysis are relevant, supporting retrospective clinical studies (Klebanoff & Snowden, 2018) and aiding in managing future uncertainties (Harvey & Kattuman, 2020).

This historical narrative also complements multiple studies conducted in Mozambique concerning the introduction and evolution of the DHIS-based HMIS. These studies, spanning from 2000 through till about 2015, examined the adoption of DHIS in Mozambique from diverse angles. They include research by master’s and PhD students from the International

Master at UEM[47] and PhD programs at UiO (UiO, 2022b). Examples are Nhampossa's (2006) examination of technology transfer in the DHIS pilot; Mavimbe and Bjune's (2007) exploration of standardisation versus localisation; Mosse's (2005) insights into socio-political challenges of DHIS implementation; and Chilundo's (2004) focus on HMIS integration challenges within complex health sector structures in LMICs.

My thesis integrates insights from these studies to present a more comprehensive view of the implementation story within a historical perspective. For example, earlier research labelled the initial pilot implementation efforts as a 'failure,' which overlooks how the system eventually resurfaced and thrived. Additionally, my analysis includes the evolving roles of individuals in the implementation process, such as the emergence of institutional entrepreneurs. While snapshot studies are valuable for capturing specific time-bound dynamics, a historical perspective is crucial for understanding the shaping of the institutionalisation process.

While my study is focused on Mozambique, its findings are also pertinent to research conducted by on HIS implementation by Health Information Systems Programme (HISP) researchers and also others in LMIC contexts. A substantial body of work, encompassing both master's and PhD students affiliated with HISP at the University of Oslo (UiO, 2022b), has examined the challenges of implementing software in diverse settings, including Mozambique. For example, the introduction of DHIS2 in Ghana and Liberia in 2011, following its successful deployment in Kenya, capitalised on the improved Internet infrastructure across Africa (Poppe, 2012). This study included a historical dimension but focused primarily on a comparative analysis of the three-year implementation in these two countries. In Ethiopia, HISP's involvement began in the early 2000s with a DHIS pilot described by Lagebo and Mekonnen (2005). Subsequent reports by Gizaw (2014) and Fossum (2016) discuss the discontinuity of DHIS2 in Ethiopia and their contributions to further software developments in global settings Gizaw et al.' (2022) study offers a summary of this history and the progress of DHIS2 in Ethiopia following its reintroduction in 2015. This particular research underscores the significance of a historical perspective in enriching analysis and providing a comprehensive understanding of the country's context. While most related studies span 4 to 5 years, my research synthesises existing literature and extends the examination over a 20-year period. In doing so, it offers a supplementary viewpoint to global-scale research on DHIS evolution conducted over the years (Adu-Gyamfi et al., 2019; J. Braa et al., 2023; Dehnavieh et al., 2019; Nicholson et al., 2022; Nielsen & Sæbø, 2016; Roland & Sanner, 2017). This analysis is crucial

[47] Included as Appendix 4 in this thesis.

as it helps identify patterns in software implementation, which can be instrumental in future projections across different country contexts.

Adopting a temporal analytical focus within the public sector of a LMIC context offers a significant contribution to the limited body of research on historical analysis in ICT4D. Bureaucracies in government, particularly in the public health sector, often prolong project timelines, impacting their effectiveness. A longitudinal perspective is practical for analysing the impact of such interventions. While this approach has typically been used in high and upper-income countries, there are notable exceptions, including research by (Walsham & Sahay, 1999), (Krishna & Walsham, 2005), (Madon, 2006) in the Indian context, Volkow (2003) in Mexico, and Bernardi et al. (2019) in Kenya. For example, Madon (2006) conducted longitudinal studies over 17 years on governmental reforms in Gujarat, India. An initial study in 1992 reported limited success of a rural reporting system implementation after almost ten years. The follow-up studies in 1995 and 2003 showed varied outcomes, including improved staff participation and data usage in the first, and later, a surprising regression despite technological improvements.

The methodology for this historical analysis in my thesis combined several approaches, responding to calls for innovative research methods within the IS and ICT4D domains (Bryant et al., 2013b; Porra et al., 2014; Soden et al., 2021; Williams & Pollock, 2012). It examines the contemporary phenomenon of HMIS implementation processes retrospectively. The three-step methodological process includes preliminary analysis, development of a historical narrative through thematic analysis (Braun & Clarke, 2006), and a theoretically informed synthesis. A variety of techniques were used for data collection, including desk research of archival and digital documents, semi-structured interviews, questionnaires, and non-structured observations during field visits and surveys (Yin, 2018). A snowballing strategy (Parker et al., 2019) helped identify and reach individuals no longer connected to the HMIS in Mozambique and abroad.

Temporal bracketing was employed to divide the study period into three distinct phases, facilitating the organisation and analysis of the extensive collected data, both primary and secondary (Langley, 1999; Mills et al., 2010b). This approach enabled thematic analysis and the development of a theoretical synthesis of the themes. The process is further detailed below.

9.1.1 A strategy for temporal bracketing

The concept of temporal bracketing, which I employed in my research, draws inspiration from Anthony Gidden's structuration theory and has been further refined by scholars such as Barley (1986) and Langley (1999), as noted by Mills et al. (1999, p. 691). Barley recognised the

challenge of examining mutual changes in processes that occur simultaneously over time and suggested dividing these processes into subsequent phases to simplify the analysis. Mills et al. (2010b, p. 2) define temporal bracketing as "an analytical strategy for dealing with diachronic process data", which refers to the study of how something develops and evolves over time ('Oxford Reference', 2010). Simplified, a process is a "sequence of events" ('Oxford Reference - Process', 2016), and data is "information in any form" ('Oxford Reference', 2016). Mills et al. (2010b, p. 2) further add that "diachronic process data" deals with "case study data that are composed of detailed event histories over time". However, this definition might be too narrow, considering Yin's (2018) distinction between case studies and historical studies in terms of collecting and analysing process data. A broader definition might be: "diachronic process data deals with information in any form that describes sequences of historical or contemporary events unfolding over time".

Langley (1999, p. 691) notes, "…process data are messy. Making sense of them is a constant challenge". Indeed, analysing diachronic process data collected retrospectively presents both opportunities and challenges. It can include data from the studied phenomenon and its various contexts, potentially involving an extensive amount of data from the past and present from multiple sources. Challenges may arise regarding the availability, accuracy, and reliability of these sources and their potentially convergent or divergent perspectives. Hirschheim and Klein (2012, p. 191) emphasise that history is essentially a narrative of the past, shaped by historians and is thus an interpretation of past events. While this may be seen as 'subjective' or 'biased,' it is acceptable within the interpretive research domain. As Soden et al. (2021, pp. 9–10) advise, "just as working with quantitative or qualitative data requires methodic considerations", engaging with historical sources demands a specific methodological approach, a thorough examination, and a rigorous assessment of the evidence forming the basis of analysis.

Soden et al. (2021) caution against the risks of presentism, which occurs when past events are analysed through the inadequate lens of present-day understanding. While their focus is on the study of science and technology, they emphasise that each field has its own unique history that has shaped its current state. To mitigate the risks of presentism, they propose three strategies: "1) understanding historical trajectories of change, continuity, disuse and revival; 2) investigating histories of the designer, the user, the participant, the non-user, and their historical traces; and 3) drawing on the past as a source of design knowledge and experience." (Soden et al., 2021, pp. 2–3). They argue that novelty can be better understood when contrasted against historical continuities and that these continuities should be examined and valued, rather than dismissed as obsolete (Soden et al., 2021, p. 4). These scholars advocate for cultivating a

historicist sensibility among the research community and their focus on "analyses of continuities and discontinuities in technologies, organizations, and practice" (Soden et al., 2021, p. 12). The temporal bracketing strategy I employed in my research aligns with and supports this approach.

This strategy involves breaking down process data into sequential periods to delineate interventions (actions) and their effects (outcomes) (Langley, 1999; Mills et al., 2010b). It facilitates the observation of factors influencing the process, enabling changes or resistance, and examines their implications on subsequent periods, helping to analyse both continuities and discontinuities. My research design echoes and builds upon the notion that "institutions always have a history, and they have to be understood within the historical process in which they were produced" Van der Blonk (2002, p. 29). This perspective is integral to the development of the theoretical framework, which is discussed in the subsequent subsection.

9.1.2 Adaptation of Seo and Creed's framework

My thesis contributes to the literature on institutional theory by adapting and expanding Seo and Creed's (2002) framework. This adaptation helps to elucidate the interconnections among three institutional concepts: institutional contradictions, institutional entrepreneurship, and institutionalisation. The refined framework was instrumental in guiding the theoretical synthesis of my research.

Originally, this framework posited that institutionalisation processes are entrenched within and evolve as a result of social dynamics in an institutional context. These processes can lead to either harmonious evolution or disruptions, culminating in institutional contradictions. Potential change agents may perceive these contradictions as opportunities to challenge the existing institutional setup. These agents, termed institutional entrepreneurs, are capable of mobilising collective action, support, and resources to enact changes. Their interventions may encounter resistance or lead to modifications in the institutional context. Recognising the gradual nature of these processes, I first adapted the framework to include a historical dimension, enhancing understanding of the development and evolution of these processes. This perspective considers institutional contradictions, entrepreneurship, and institutionalisation processes as products of historical development, allowing my analysis to trace the evolution of these processes over time. While the original framework acknowledged the role of institutional entrepreneurs, my extension emphasises the role of technology in mediating institutional contradictions.

Research in organisational studies has primarily identified four sources of institutional contradictions: “(1) legitimacy that undermines functional inefficiency, (2) adaptation that undermines adaptability, (3) intrainstitutional conformity that creates interinstitutional incompatibilities, and (4) isomorphism that conflicts with divergent interests” (Seo & Creed, 2002, p. 226). My analysis identified additional sources of contradiction specific to the context of a public health organisation in an LMIC setting. Thus, engaging with the examination of macro (socio-political and technological interventions) and micro dynamics (projects, human relations and actions) within the setting, particularly affecting the HMIS implementation, as part of the influential factors and sources of institutional contradictions. For instance, my historical analysis, highlighted how the effects from the prior colonial rule and the 16-year civil war, significantly affected the developments within the research setting. Despite the recovery plans and reforms in place, the developments in the post-conflicts period revealed to be slower and disjointed from the investments taking place across sectors, including health and education. Thus, fostering the emergence and the development of institutional contradictions in the setting.

Despite high aspirations, such as digitalisation goals, public health organisation often face limitations in resources, finances, and human capital. Addressing these asymmetries is a long-term endeavour, extending over years rather than days or months. They typically comprise extensive structures across multiple levels, aiming to provide timely, quality health services with a focus not on profit, but on public welfare. Consequently, these organisations are heavily dependent on external conditions and government budgets. This challenge is particularly pronounced in LMICs, characterised by constrained resources and a heavy reliance on donor funding. The implementation of Health Management Information Systems (HMIS) in these settings inherits institutional contradictions from their institutional contexts, along with evolving socio-technical-political challenges (Khubone et al., 2020).

In my research, I have identified additional sources that give rise to institutional contradictions, namely: 1) 'Scarcity hindering readiness for technological innovations', 2) 'Plurality of interests promoting misalignments', and 3) 'Expectations constrained by technological and financial challenges'. The study reveals that although these sources of contradictions were recognised early in the Health Management Information Systems (HMIS) implementation, they proved challenging to overcome. Consequently, they were perceived alternately as opportunities and barriers at different stages, further illuminating ongoing tensions throughout each implementation phase. For instance, the issue of 'scarcity hindering readiness for technological innovations' during Phases 1 and 2 led to local tensions between organisations introducing

technological artefacts and their recipients. This necessitated several adaptations to the technological artefacts to align with expectations, challenged by either the existing technical conditions (Phase 1) or the approaches adopted (Phase 2). Additionally, the historical analysis shed light on the interdependence of the three identified sources of institutional contradictions. It shows that certain strategies adopted by governments in LMICs to address resource scarcity led to external dependencies, thereby increasing the influence of diverse groups with varying perceptions and interests.

As indicated by the analysis using the original framework, institutional contradictions may arise and persist without causing obvious changes in the institutional context. Nawab et al. (2021) examined a case in Pakistan, underscoring the 'culture of silence' as a dilemma where people refrain from challenging or disagreeing with others' viewpoints. This context was deemed unfavourable for identifying and resolving contradictions. They argued that although contradictions might present "opportunities for organizational renewal", these opportunities could be missed if the contradictions are not acknowledged (ibid, p. 1-3). Their accumulation might be seen as a chance to question the existing institutional context and initiate mediation mechanisms. Seo and Creed discuss this process in terms of the emergence of potential change agents, namely, the institutional entrepreneurs. In my adapted analytical framework, I consider both the roles of institutional entrepreneurs and the impact of technology.

> "Institutional contradictions may not only trigger the shift in actors' collective consciousness but also may provide alternative logics of action and psychological and physical resources to be mobilised, appropriated, and transposed in the process of institutional change."(Seo & Creed, 2002, p. 231).

My study underscores the intricate interconnections among institutional contradictions, institutional entrepreneurs, and institutionalisation, demonstrating how they emerge and evolve over time. The analysis of the two identified institutional entrepreneurs focused on their strategic positioning, actions, and contributions. Their role was pivotal in fostering collective action, essential for the adoption and institutionalisation of two technological artefacts: MB-SIS (in Phase 1) and DHIS (in Phase 3). The historical analysis revealed five key entrepreneurial actions, which are further discussed in section 9.4.

Each of the three phases outlined in the historical narrative underscores different Health Management Information Systems (HMIS) implementation processes associated with a focal technological artefact, including the DHIS pilot, its reintroduction, adoption, and institutionalisation. The historical analysis deepened the understanding of the mutual shaping

process between the technological artefact and its implementation setting, which I will discuss in the next section.

9.1.3 Evolution of technology over time

More than two decades ago, Orlikowski and Iacono (2001) examined the way the Information Technology (IT) artefact was studied within IS research. They noted that many studies treated the IT artefact as "stable, discrete, independent, and fixed," often "taken for granted" and "assumed to be unproblematic" (Orlikowski & Iacono, 2001, pp. 121–122). Recently, Nielsen and Sahay (2022) reviewed the engagement of research in the field, particularly in digital health, noting a significant gap in the centrality of technology and its contextual use.

In my analysis, I consider the transformations in the institutional context across different phases, alongside corresponding changes in technology. This approach enhances research studies that have recognised technology's material role in shaping implementation, as seen in works by Walsham and Sahay (1999), Madon (2006), and Bernardi et al. (2019), and Nielsen and Sahay (2022), by explicitly incorporating the temporal dimension.

The introduction of GIS in India, as analysed by (Walsham & Sahay, 1999), was considered partially successful. The application was adopted (fulfilling the intention of its introduction) but not extensively used, possibly because a map-driven culture was not deeply ingrained in the setting. My analysis suggests that even when user requirements are successfully integrated into a technological artefact, these features may remain underutilised. Technological artefacts, purposefully designed with transformational potential to improve performance and outcomes, rely on the conditions (social-political-economic, technical) within their institutional context for full utilisation and operational transformation (Volkow, 2003).

Madon's (2006) study highlights the interplay between two types of systems implemented by the government in the public sector in India. While back-end systems were developed to enhance governmental administrative tasks, front-end systems aimed to improve services for citizens. The study underscores the crucial roles and interdependencies of both systems. Strengthening back-end systems was vital for the success of front-end systems, which, in turn, played pivotal roles in initiating administrative reforms impacting the back-end systems. These findings are in line with those of Bernardi et al.'s (2019, p. 1178), who argue that certain technologies can redefine "information flows and processes of participation and governance", thereby playing significant roles in change processes.

Nielsen and Sahay (2022) discuss the rise of various technologies in the health sector and their contextual impacts. They observe that 'when technologies introduce new possibilities, they may change users' tasks and roles, alter collaboration forms, and reorganise the way work is structured' (ibid, p. 1). For example, the expansion of mobile technology has influenced the digital context across sectors, including health (Avgerou et al., 2016; David et al., 2020). The advent of cloud technology, facilitating storage and data exchange, has raised issues around data ownership and security (Sahay et al., 2017).

My historical analysis concentrates on the evolution of DHIS, initially a standalone software that gradually transitioned to a web platform, contributing to its national institutionalisation. This perspective enabled an examination of the mutual transformations between the technological artefact and its institutional context. Designed in South Africa, DHIS carried features and values specific to that context, leading to compatibility challenges in new environments. Examples include language translation needs from English to Portuguese, adapting databases with South African specificities to Mozambique's health sector, and incorporating GIS in settings with limited digital infrastructure. Although DHIS2, now institutionalised in the study context, has improved technical support for GIS, this feature remains underutilised. Health workers often resort to manually drawn maps, indicative of the challenges in accessing and maintaining digital resources (e.g., computers, printers). Early training in DHIS use was beneficial, as it heightened awareness and equipped health workers to use other systems. Discussions and challenges in the setting prompted a shift to a web-based architecture for DHIS, influencing its development trajectory abroad. When DHIS2 was reintroduced, it was no longer perceived as foreign technology.

My analysis underscored how institutional contexts have evolved over time, influenced by technological advancements aimed at fostering the country's digital inclusion in global trends. These advancements also yielded local benefits, particularly in the implementation of Health Management Information Systems (HMIS). For example, national investments in digital infrastructure gradually mitigated the institutional contradictions identified in Phase 1. A notable illustration of this is the expansion of the mobile market, characterised by increased device availability at affordable prices and improved technical support, alongside enhanced national Internet service coverage during the third phase. Additionally, the technological artefact itself underwent transformations, integrating more versatile features that allowed for customisation to different contexts. For instance, the integration of the Tracker module in DHIS enabled the system to be easily configured for patient data management, supporting health programs requiring treatment follow-ups, such as tuberculosis (TB) programs.

In conclusion, the temporal bracketing strategy employed in this study facilitated the organisation of diachronic process data and the examination of the interplay between the technological artefact and its setting across the three phases. The historical narrative supported the analytical framework, allowing for an in-depth analysis of various evolving factors and their cumulative impacts over time.

9.2 Arguing against the 'failure' discourse in IS research

My thesis challenges the prevailing narrative of failure that dominates research in ICT4D and IS. Scholars like Heeks (2002) and Nhampossa (2006) have reported on failures in the ICT4D domain, while Nelson (2008) has summarised many others within IS. The IS literature often focuses on identifying determinants of failure and success, primarily based on technical aspects, thereby frequently overlooking the intangible side effects and long-term developments that stem from such initiatives. Dwivedi et al. (2015) examined various perspectives on success and failure, ultimately underscoring that "context matters when researching IS implementation outcome…". They identified several key positions that my thesis reflects or addresses: 1) "success and failure is a question of judgment"; 2) "implementing IS involves more than just operating an IT artifact"; 3) the importance of expanding IS research to new settings, especially the "public sector" (Dwivedi et al., 2015, p. 152). My study responds to these calls by seeking a deeper understanding of the implications following the introduction, evolution, or termination of digital initiatives (Langley et al., 2013).

As researchers strive to pinpoint determinants, mistakes, and best practices in IS implementation outcomes, they often categorise their subjects as either successes or failures (Dwivedi et al., 2015; Nelson, 2008). However, such categorisation is inherently subjective, particularly due to the diverse interests involved in the projects (Heeks, 2002). While some stakeholders focus on the technological artefact itself (its adoption, usage, scalability, or abandonment), others concentrate on the conditions facilitating its functionality (infrastructure, capacity-building, support, understanding of needs and values).

IS implementations have frequently been examined through 'snapshot' analyses that evaluate single technological artefacts at single sites over short periods (Williams & Pollock, 2012). Although these studies can offer valuable contextual insights and identify factors influencing implementation processes, they may inadvertently limit the scope of further research and practical analysis. Studies that rely on episodic approaches often miss opportunities to explore the institutional dynamics that influence both the setting and the artefact itself. Williams and Pollock (2012) illustrate this with an example from their research, where an enterprise solution

that was successfully implemented led to organisational transformation only years later. They acknowledged that their snapshot approach constrained their ability to perceive these transformations, concluding that "stability and change could occur around the same technology, albeit over an extended period of time" (ibid, p. 4). Madon's (2006) study, as mentioned earlier, demonstrates that organisational change is not linear and that various factors and conditions over time contribute to either desirable or undesirable outcomes. In Volkow's (2003) historical study, for instance, these conditions were linked to the social and cultural aspects of the setting, which were not always reflected in the technical system and the organisational practices they enabled.

While the DHIS pilot in Mozambique was reported as a failed project by some (Kimaro & Nhampossa, 2005), others have highlighted positive aspects from the same process that contributed to the development of this technological artefact (Staring & Titlestad, 2008). Declaring an IS implementation as successful or failed requires assessing a range of factors beyond merely whether the technological artefact was implemented or whether it met stakeholders' goals. The narrative of IS failure often finds support in project surveys, evaluations, and analyses that emphasise statistical data and financial investment losses (Heeks, 2002; Nelson, 2008).

Dwivedi et al. (2015, p. 144) reference the taxonomy of DeLone and McLean, which identifies "six interrelated variables to define IS success: System Quality, Information Quality, Use, User Satisfaction, Individual Impact, and Organizational Impact". An important observation is that these variables primarily focus on organisational, technical, and economic dimensions and are largely market-driven. They align with the benefits commonly cited in literature, such as improvements in "profitability" and "organizational performance", and at the individual level, "efficient and effective business processes or working routines" (Dwivedi et al., 2015, p. 143).

In LMIC contexts, it is recognised that "the benefits of information technology come at a high price and are not always manifested quickly" (Krishna & Walsham, 2005, p. 123). However, studies employing a historical perspective have shown that besides measurable gains, there are also 'invisible' benefits that support the argument for IS success. For example, Krishna and Walsham' (2005) study in the Indian state of Andhra Pradesh from 1995 to 2002 highlights significant long-term investments in training and infrastructure, leadership development, and the collective "ability to learn from mistakes and persist" as key benefits across the projects (ibid, 2005, p. 138). My thesis presents multiple HMIS implementation processes in Mozambique that coincided with technological developments, yielding shared 'invisible benefits'. For instance, alongside the DHIS pilot, capacity building and normative instruments

were also developed. Although DHIS was not immediately adopted, these technical and social conditions facilitated the adoption of MB-SIS. This suggests that beyond technical and economic dimensions, other benefits are often embedded in the implementation setting. Thus, even if one system fails, health stakeholders at all levels learn from the process, the context is transformed, and this may pave the way for the successful implementation of other systems.

These 'learnings' are acknowledged in the failure literature, especially concerning managerial functions (Nelson, 2008). In the health sector, this perspective has been applied to health workers as key actors in Health Management Information Systems (HMIS) implementation (Mukherjee, 2017). Mukherjee (2017, p. 9) emphasises 'participation and capability' as crucial factors shaping the institutional context and driving 'human agency interaction', contributing to the 'invisible' gains in ICT4D projects within LMIC contexts. My thesis aims to bring these benefits to light by treating HMIS implementation processes as a continuous 'becoming' (Cloutier & Langley, 2020).

In my study, where HMIS implementations were analysed as processes unfolding over time, I demonstrate that even when a technological artefact was not adopted, it led to various learnings that could be viewed as successes. For instance, while some participants initially perceived the HMIS implementation as a failure, this view overlooked the successful elements introduced with the District Health Information System (DHIS), such as enhanced capacity-building and infrastructure improvements. A second observation from my study is that DHIS eventually was adopted and institutionalised in a different 'space' and 'time'. The potential of DHIS was recognised early in the 2000s, but its tangible benefits took a considerable time to materialise, emerging in a different institutional context than where the pilot was initially conducted. Although the technological artefact itself was not immediately adopted, the efforts to operationalise it resulted in other positive outcomes. These included improvements in the institutional context, transformation of organisational practices, and promotion of collective and individual skill development. The development and political legitimisation of DHIS also played a crucial role, facilitating its advocacy by those involved in the HMIS implementation processes.

9.3 The becoming of an institutional entrepreneur

This thesis makes a significant contribution by deepening the understanding of institutional entrepreneurs. It explores pertinent questions about these actors, such as 'who' they are, 'where' they come from, 'why' and 'when' they intervene, and 'how' they operate within their institutional context. While existing research (Bruton et al., 2010; Fligstein, 1997; Greenwood

& Suddaby, 2006; Maguire et al., 2004) provides valuable insights into these questions, there remains a gap in comprehensively explaining the emergence, development, and positioning of institutional entrepreneurs. My work addresses this gap by adopting a process-oriented and dynamic perspective.

Previous studies have explored the role of institutional entrepreneurship in mediating institutional contradictions (Burns & Baldvinsdottir, 2005; Seo & Creed, 2002). My analysis conceptually illustrates how institutional contradictions emerge, develop and persist over time. In turn, these potentially trigger opportunities for entrepreneurial actions that initiate processes of change (or attempts at change). In Phase 1, for instance, the limited number of health workers with skills in data management and the unmet expectation with the existing legacy systems contributed to creating an opportunity to introduce DHIS, through action research projects led by HISP (entrepreneurial actions). In Phase 2 and 3 the efforts to overcome the shortage in skilled technical personnel supporting the HMIS restructuration led to other entrepreneurial actions, such as the introduction of technological innovations led by MOASIS to minimise technical interventions in remote areas and the combined efforts from Saudigitus and MOASIS to extend technical support at the MoH.

My thesis extends previous studies by demonstrating that institutional entrepreneurs do not emerge abruptly; instead, they gradually become potential agents of change through various roles, interests, and skill development over time, influenced by their prior experiences and learnings in diverse institutional contexts and circumstances. In my analysis, I have identified two institutional entrepreneurs who successfully intervened in HMIS implementation processes, one with an ICT background (IE1) and the other with a medical background (IE2). The first, working as a consultant, was effectively positioned as both an insider and an outsider. As Volkow (2003, p. 243) noted,

> "Consultants, as outsiders, can have a privileged position" for understanding the political rationale because they are not immersed in the closed ideological system of the organization. However, they have to be aware of the rational values that are institutionalized in each specific case. Local conditions should not be addressed with a judgmental attitude, but should seek to understand the values, practices, social dynamics, and political positions of people in their social setting and how this can influence the development of a project."

IE1, a foreign individual, as a consultant was providing necessary assistance funded by an international donor and assumed key roles in defining the HMIS implementation. His skills,

experiences and relations developed allowed privileged knowledge to be made available to the MoH. As an internal actor, he gained legitimacy and was instrumental in driving the change process during Phase 1 and the subsequent introduction of the MB-SIS.

IE2, the medical doctor developed his health informatics skills through various exposures: his participation in the DHIS pilots, his role as a lecturer in the International Master program, and his doctoral studies in information systems. When he took on the role of Deputy Director in the Ministry of Health (MoH) post his doctoral studies, he was an outsider positioned inside. His combined profile, evolving in tandem with the technological artefact, fortified his legitimacy to guide the HMIS implementation, and take crucial decisions in this regard. His hybrid positioning proved crucial in the adoption and institutionalisation of DHIS in the context.

The literature emphasises the importance of identity (Bernardi et al., 2019; Mosse & Byrne, 2005) and power (Mosse & Byrne, 2005; Sheikh, 2015) in shaping the outcomes of Health Management Information Systems (HMIS) implementations. Bernardi et al. (2019) argue that as actors 'become change agents', they draw on their developed identities – both professional and organisational ('who they are'), and social ('what others expect them to be'). These identities influence the roles they adopt in challenging or influencing change processes. (Creed et al., 2010) posit that roles can be perceived as valuable resources enabling agency. Sheikh (2015) discusses the crucial role of power in institutionalisation processes, considering it a crucial resource.

Denis et al. (2001) examine roles in the context of strategic leadership. Through a longitudinal case study, they investigate how health managers develop their roles and enact strategic leadership, emphasising that actions conducted by strategic leaders are more crucial than individual traits. They view strategic leadership as a collective, processual, and dynamic phenomenon, where effective transformations result from contributions by various individuals. This collective understanding of strategic leadership suggests that leaders mobilise diverse groups, employing tactics and strategies to influence organisational transformation and trajectory shifts.

Strategic leadership, viewed as a dynamic phenomenon, implies that “participants, roles, and influences evolve over time” (Denis et al., 2001, p. 810). Denis et al.'s study facilitates a deeper understanding of the 'dynamic construction, de-construction, and reconstruction' of roles by individuals participating in various processes over time. They highlight the importance of defining strategies, allocating resources, and influencing structural decisions. A key aspect of

their discussion is the positioning of these actors and the extent of their influence. Consequently, they propose that these actors engage in decision-making as part of a network, where individuality merges into the collective, yet they extend their influence beyond the organisation, adopting a hybrid role as both internal and external actors.

Entrepreneurial actions manifest in diverse ways, such as addressing significant shortages of health workers to bolster HMIS capacities. Siribaddana et al. (2019) discuss this in the context of Sri Lanka. Similarly, my thesis demonstrates that constraints in human resources in the health sector extend beyond healthcare provision. The historical narrative in my study shows a shortage of data management and digitally skilled professionals to support the HMIS implementation. In LMICs, medical doctors often undertake multiple roles simultaneously, which, while appearing as a performance constraint, can be crucial for enabling HMIS implementation. This is echoed in Siribaddana et al.' (2019) study, which introduces the concept of 'hybrid doctors' in Sri Lanka, developing a new profile of medical doctors trained in health informatics to transform the health sector.

My thesis further illustrates that the evolution of an institutional entrepreneur is a gradual process. These individuals develop their identities and build legitimacy, taking on various roles to gather support and resources from influential actors. These processes reveal to be crucial for engaging in collective action and leveraging strengths to develop strategies and catalyse institutional transformation. For instance, in the case of IE2 all the roles assumed over the years, enabled the space to be listened, influence decisions, and enable collective support. Obtaining donor support was vital for implementing educational strategies, familiarising health workers with DHIS 2.16, and investing in the communication infrastructure necessary for the digital system. This aspect is particularly significant when leading processes aimed at institutionalising specific practices, as these need ongoing reinforcement and strengthening.

In conclusion, my thesis builds upon existing literature to illustrate how institutional contradictions were identified and perceived as opportunities, catalysing institutional entrepreneurship that mediated these contradictions and facilitated institutionalisation within specific contexts. This section has highlighted individuals who gradually developed the necessary skills and profiles to become institutional entrepreneurs. While individual skills are vital, the thesis demonstrates that these skills become significantly more impactful when utilised as enablers of collective action. These previous experiences and roles of these individuals were seen to substantially contribute to their key positioning at specific moments. Institutional entrepreneurs rely not only on their skills, empathy, and understanding of their institutional context to devise strategies but also on the collective efforts of various groups to

transform their institutional environment. This study reinforces the notion from existing literature that strategic leadership is a collective, processual, and dynamic phenomenon.

9.4 Practical contribution: Entrepreneurial actions

The theoretical framework adopted for this study, which elucidates the interconnections among various concepts, provided a solid foundation for exploring the historical narrative and conducting an in-depth historical analysis. This thesis makes a significant contribution by enhancing the visibility of long-term learnings and advancing the understanding of their practical implications.

The historical narrative and analysis in this study present evidence that institutional contradictions can be mediated through entrepreneurial actions. For example, the contrast between the setting's readiness and the urgency to revitalise the digital HMIS constituted an institutional contradiction, ripe with opportunities for change. This study highlights the role of five entrepreneurial actions that emerged during the adoption and institutionalisation processes: (1) capacity building approach – integrating education, research and practice, (2) tailored technological innovations for extended support, (3) diversifying training to strengthen capacity, (4) building networks of support, resources and legitimacy, and (5) embracing platform coexistence while bridging interests.

9.4.1 Capacity building approach – integrating education, research and practice

The recognition of limitations within the setting, which were not conducive to the introduction of digital solutions, led to the integration of capacity building as a key entrepreneurial action alongside the HMIS implementation. My thesis focuses on the long-term investments in capacity building and highlights its pivotal role in the institutionalisation processes of HMIS, as well as in fostering institutional entrepreneurship. Previous studies, such as those by Kaasbøll and Macome (2002), Muquingue (2009), and Kaasbøll et al. (2018), describe early and ongoing capacity-building initiatives in the country. My work demonstrates how these initiatives facilitated the emergence and development of institutional entrepreneurs and their actions, building their legitimacy to challenge and navigate institutional contradictions over time. Additionally, the thesis shows how this initiative influenced the gradual creation of robust instruments for regulating the sector and HMIS.

Education was provided to a group of professionals to enhance their research and development skills, equipping them to support the digital intervention and reinforcing capacities in the tertiary education sector. Concurrently, these professionals engaged in in-service training,

participated in the adaptation of the technological artefact, and contributed to related research. The outcomes of this integrated approach were favourable to the subsequent HMIS interventions.

9.4.2 Tailored technological innovations for extended support

Throughout the different phases of the HMIS implementation, a variety of initiatives were introduced. My thesis illustrates how these digital initiatives were deployed as a means to address the existing constraints within the institutional context. For example, the introduction of the SIS-compact unit—a computer with a built-in screen encased in a locked box, running only the District Health Information System (DHIS) as its sole application—served as a mediation mechanism. This design was intended to shape user behaviour and reduce the need for technical support in remote areas. Limiting the computer to a single application aimed to keep health workers focused, while disabling flash drive access prevented virus infections, potentially prolonging the device's lifespan. Parts for these computers were imported from South Africa, with the assembly completed by local technicians. While some of these units are still operational, their maintenance has proven to be costly, especially given the need to import certain parts and the logistics involved in repairing them.

Although such tailored technological innovations have supported the HMIS, their sustainability heavily relies on external funding and technical assistance. However, the improving technological landscape and growing capacity within LMIC settings hold the promise of reducing this dependency through the development of local innovations.

9.4.3 Diversifying training to strengthen capacity

The strategy to diversify training included investments in various educational opportunities, tailored to maximise available resources and cater to the varying needs of health professionals. This approach was crucial for building self-reliance and minimising technical dependencies, particularly relevant in LMIC settings where budget constraints often limit human resource hiring and training opportunities. The formal capacity building was varied, encompassing technical, professional, and tertiary-level courses targeted at the health workforce. Over time, these efforts proved beneficial in enhancing engagement with the technological artefact implemented in the setting and in developing local support to reinforce the sustainability of the HMIS.

Training has long been recognised as a key element in supporting IS implementations (Madon, 2006; Walsham & Sahay, 1999). However, traditional training formats have been challenging to maintain consistently, especially due to logistical constraints and the need to involve

geographically dispersed participants. This challenge is particularly acute in the health sector in LMICs, where there is often a shortage of health personnel. In-service training emerged as a solution to these challenges, offering more inclusive training opportunities. Recent research has underscored the importance of online and blended training methods (combining face-to-face with online tools) for expanding capacity-building opportunities in LMIC contexts (Chrysantina et al., 2019, 2022; Siribaddana, 2016). Yet, the adoption of these methods is still hindered by factors such as the digital divide (Lythreatis et al., 2022).

My thesis shows that in-service, online, and blended training models with DHIS2 were also incorporated alongside the HMIS implementation. While in-service activities continue traditionally (face-to-face and as part of the annual plan), they are contingent on financial resource availability. Online and blended DHIS2 academies, despite offering more accessibility, incur registration and other costs, limiting participation due to budget constraints. Nevertheless, when organised, the Ministry of Health (MoH) ensures representation from all provinces. These representatives are then tasked with replicating the training at provincial, district, and facility levels, as feasible. This model has significantly bolstered the capacity of the health workforce and has been instrumental in sustaining HMIS operations.

9.4.4 Building networks of support, resources and legitimacy

The literature acknowledges the heightened complexities involved within the health sector. Denis (2001, p. 810) describes this sector as,

> "…a classic pluralistic domain involving divergent objectives (individual patient care, population health, cost control) and multiple actors (professionals, administrators, community groups, and politicians) linked together in fluid and ambiguous power relationships…"

My thesis highlights the complexities influencing the emergence of sources of institutional contradictions, specifically the plurality of interests promoting misalignments. Scholars have recognised the importance of developing networks to align interests and objectives (Denis et al., 2001; Walsham & Sahay, 1999). Networks of support are also crucial for overcoming technical constraints and securing extended support from peers, other users, and developers of similar digital solutions (Braa et al., 2004, p. 338). However, creating and maintaining these networks is challenging. For example, Walsham and Sahay (1999) encountered difficulties in sustaining a support network around GIS implementation in India.

The network supporting DHIS benefitted greatly from two entrepreneurial actions: the integrated capacity-building approach and diversification of training opportunities (Siribaddana, 2016). The introduction of online training through DHIS2 academies was a strategy to extend training opportunities and include developers and implementers in various geographical locations. My study shows that the HMIS implementation in the research setting also gained from these opportunities, which expanded local capacity and reinforced ongoing in-service training.

9.4.5 Embracing platform coexistence while bridging interests.

Another challenge in the health sector is the plurality of actors with divergent or misaligned interests, often resulting in uncoordinated interventions and increased system fragmentation. Interoperability is seen as a solution to reduce system fragmentation and enhance communication between different systems (Hodapp & Hanelt, 2022). However, achieving interoperability is complex, considering its technical, organisational, semantic, and legal dimensions, as well as economic and political dependencies (ibid). In the research setting, interoperability has been progressively adopted to maximise efforts by different ministries and within the health sector, serving as another strategy to ensure the sustainability of existing digital systems.

Over the years, various solutions have been introduced at different levels within the health sector, handling different data types (aggregate or individual) and serving varied needs (planning, management, or healthcare). The lack of technological integration historically led to limited data sharing and communication, constraining planning, analysis, and other benefits. For instance, when different health programs collect similar data, it not only leads to data duplication but also exposes disparities in figures. Such discrepancies are exacerbated when fragmentation extends to a governmental level, as seen when ministries like justice and health, handling vital data, fail to communicate and consolidate their data. An interoperability solution addressed this issue. The thesis also demonstrates that system integration, while challenging, is achievable, as evidenced by the integration of the MoH human resources system with the ministry's public administration system (Waters et al., 2016). These successful examples highlight how efforts within the health sector positively influenced other governmental sectors, promoting broader engagement in the process.

In summary, my practical contribution draws from the theoretical and historical analysis, focusing on the entrepreneurial actions introduced over time. These actions encompass an integrated approach to capacity building, diversification of efforts to foster sustainability, bridging systems and interests, and tailoring interventions to suit the setting. The maintenance

of these initiatives is crucial for replicating institutional arrangements and reinforcing the institutionalisation of both the technological artefact and the accompanying organisational practices.

9.5 Conclusion

This thesis underscores the significance of historical studies in ICT4D and IS research domains. Adopting a historical perspective allowed for an in-depth investigation of the HMIS implementation as an institutional process unfolding over time. In this chapter, I have discussed my results in relation to existing literature and identified four key contributions.

The first theoretical contribution is the emphasis on the value of historical narrative and analysis in IS implementation studies, and the development of systematic methods and concepts for conducting such analyses. The second contribution relates to the research project's format, where I combined various strategies and techniques to provide a consistent methodology, including a temporal bracketing strategy. This involved engaging in historical reconstruction and analysis as a concurrent process, through three essential steps, and adopting a multilevel approach to analyse societal levels (institutional, organisational, and individual) over time.

As a second theoretical contribution, my study demonstrates how long-term retrospective investigations offer a broader range of opportunities to illustrate and explain the evolution of IS implementation and its various forms of success. This includes increasing health workers' awareness and readiness, improving physical and supportive infrastructure, and providing insights for parallel developments. These factors are valuable for introducing, developing, and institutionalising processes such as technological innovation and organisational practice in the setting.

The third theoretical contribution relates to the institutional theory literature. I identified three sources of institutional contradictions within the public health sector in an LMIC context. These contradictions were analysed to show how they create opportunities out of tensions and challenges, thereby preparing health professionals to become potential agents of institutional change. This chapter discusses how individuals gradually develop skills and profiles, assuming various roles that enable them to become institutional entrepreneurs. Therefore, they rely on collective efforts from various groups to transform their institutional context, reinforcing the idea from existing literature that strategic leadership is a collective, processual, and dynamic phenomenon.

Finally, as my practical contribution (fourth), I discuss five entrepreneurial actions introduced in the setting that significantly impacted the HMIS implementation, leading to system adoption and institutionalisation. These actions include an integrated approach to capacity building, efforts to diversify for sustainability, bridging systems and interests, and tailoring interventions to the setting. The continual maintenance of these initiatives is essential to replicate the institutional arrangements and strengthen the institutionalisation processes.

Chapter 10 : Concluding Remarks

This chapter presents the conclusions of my thesis, including the key findings, limitations, and suggestions for future research. Section 10.1 summarises the key findings, while section 10.2 discusses limitations and the potential for future research.

10.1 Key findings

My thesis responded to several calls to analyse the intricate relationship between technological artefacts and their implementation settings, as noted by Walsham (2017). It also embraced innovative research methods within the IS and ICT4D domains, as encouraged by Bryant et al. (2013), Porra et al. (2014), Soden et al. (2021), and Williams & Pollock (2012). Specifically, it addresses a call for IS researchers to develop a historicist sensibility, focusing analytically on the "continuities and discontinuities" of "technologies, organizations, and practices" (Soden et al., 2021, p. 12). Additionally, the thesis responds to the call by Dwivedi et al. (2015, p. 152) to broaden IS research into the public sector and deepen understanding of "success and failure."

Research on HMIS implementations within Low- and Middle-Income Countries (LMICs) has provided significant insights into the nature of challenges and approaches to addressing them, from both research and practical perspectives. However, many of these studies were conducted over relatively short periods, in single sites, and focused on a single technological artefact adapted to local conditions. While these studies offer valuable insights into implementation dynamics within defined temporal and spatial domains, they fall short in understanding how the past informs the present and possibly the future. Considering that HMIS implementations in LMICs often unfold over years, if not decades, a historical analysis is crucial for comprehending the 'how' and 'why' of the implementation narrative. My thesis primarily contributes to these questions within the context of Mozambique's public health system. Integral to this historical analysis were concepts from institutional analysis, which are particularly well-suited for long-term process studies.

By conceptualising HMIS implementation as an evolving process, I analysed the continuities and discontinuities from a historical perspective, supported by concepts from institutional theory. My contribution includes developing a methodological approach for this historical analysis, comprising three steps: a preliminary analysis, narrative development based on a temporal bracketing strategy and thematic analysis, and a multilevel analysis with a synthesis across all phases, guided by institutional theory. The incorporation of a snowballing strategy to identify participants was invaluable, helping to piece together primary and secondary data

that supported the research design definition. The thesis demonstrated the potential of both the temporal bracketing strategy and thematic analysis in organising extensive data sets.

The early recognition that an HMIS (Health Management Information System) implementation consists of multiple evolving subprocesses was essential. These subprocesses include transformations of institutional and organisational contexts, individual roles and interventions, and the practices and artefacts related to technology. Given the varying speeds and conditions of these subprocesses' developments, it was logical to temporally bracket the institutional context. The three identified phases were considered 'stable' to facilitate observation and description of how other processes unfolded 'continuously' within and across these phases. This approach was crucial for understanding their mutual influences and their relation to the institutional context. The three concepts emerging from the empirical data underscored this understanding.

Institutional dynamics in the study's setting were influenced by historical and contemporary institutional arrangements within and beyond the health sector. The study revealed how historical events significantly affected cultural, technical, and political decisions, impacting the sociotechnical context of HMIS implementation. Three institutional contradictions, rooted in the historical armed conflict background of the setting, were identified and persisted during the research period. These include: ‘Resource scarcity hindering readiness for technological innovations’, ‘Multiple stakeholders with poorly aligned and often contradictory interests’, and ‘Governance expectations contrasting existing technological and financial challenges’.

The historical analysis highlighted human action and the role of technology in mediating these contradictions. It allowed me to track individuals involved in the HMIS implementation over time, understanding their activities, roles, and positioning within and beyond the health sector, and identifying them as potential agents of change and institutional entrepreneurs. Five key institutional entrepreneurial actions, crucial in HMIS implementations, emerged from this acknowledgement: (1) a capacity-building approach integrating education, research, and practice, (2) tailored technological innovations for extended support, (3) diversified training to strengthen capacity, (4) building networks for support, resources, and legitimacy, and (5) embracing platform coexistence while bridging interests. Simultaneously, while the technological artefact demands certain conditions to operate, it also fosters parallel efforts within the implementation setting, mediating some institutional contradictions. The DHIS (District Health Information Software) pilot introduced new organisational practices at various levels, such as digital data capture forms, development of technical support capacity, enhancement of digital and data management skills, computing in remote areas, and strategic

and instructional instruments for both short and long-term. These outcomes addressed the institutional contradiction of resource scarcity hindering readiness for HMIS development. Furthermore, they supported the introduction, adoption, and scaling of another technological artefact in the setting, with the development of workforce and support capacity and organisational awareness being vital for these unfolding developments.

The current study was conducted within an LMIC (Low- and Middle-Income Country) context, specifically in a selected country. While there are apparent differences between this research setting and other LMIC countries, owing to their varied historical backgrounds that influence their cultural, socioeconomic, and political structures, including health systems (Bernardi et al., 2019), commonalities exist. These similarities, particularly in relation to longstanding and emerging challenges hindering the "adoption and use of HMIS" (Health Management Information Systems), are shared across LMICs (Bernardi et al., 2019, p. 1178; Khubone et al., 2020). Consequently, I believe there is potential for generalising the findings presented in this thesis. This thesis illustrated examples of HMIS implementations in various LMIC settings with similar patterns. The political, economic and cultural challenges and the variations in the outcomes identified over time in the Mozambican HMIS implementation were also acknowledged in other LMICs, see Gizaw (2022), Volkow (2003), Madon (2006). My thesis supports the argument that long term retrospective observations have the potential to uncover patterns of actions that are hidden from short term studies. Investments in education and ICT infrastructure are long term investments, and the positive outcomes are better evaluated from a process perspective within long periods. Examples of similar insights are reported in Krishna & Walsham (2005), Mukherjee (2017) and Siribaddana et al. (2019). It is critical to acknowledge and uncover those successes as they impose gradual and significant transformations in human agency and implementation settings, with direct implications to the technological artefacts and HMIS they support. The recent Covid-19 pandemics, the local and global political and economic instability, the extreme natural phenomena have highlighted those connections, particularly impacting the LMIC context. As the Human Development Report (UNDP, 2022) notes, our world is constantly changing and we need to consider how those past, present and continuous events promote uncertainties and instabilities that impact our future.

10.2 Limitations of the study and future work

In this study, I employed a multilevel analysis to examine the institutional dynamics that shape the processes of HMIS implementation at both organisational and individual levels. However, it became necessary to focus primarily on the predominant software used in the country and

the participants involved in these processes. My data collection centered specifically on the phenomenon of the DHIS (District Health Information Software) implementation and its associated dynamics. As such, specific practices and concerns related to data use and quality received less research attention than they warranted. Future research could further explore these aspects, considering the results from earlier DHIS implementation studies and more recent research. A historical perspective might be valuable in assessing improvements in these areas over time and could offer insights into the roles of managers, users, and the system itself in those processes.

Although Mozambique was selected as research setting, data collection was restricted to four predefined provinces, where DHIS was piloted in 2000. Despite that I was able to visit each site and interact with managers and data officers at the province level, I could not delve deeply into the current localised projects and activities involving partner implementers. Nevertheless, I was able to observe site dynamics and gather enough information to understand, for example, how they engage with discussions about the data collected and available in the system. There is potential for further studies to explore how the system has gradually aided in improving healthcare and respective health indicators, as well as enhancing system usage, promoting standardisation, and reducing system fragmentation among the various systems operating under each health program.

I recognise the importance of expanding beyond the approach used in this study and exploring the HMIS implementation process from various perspectives. Given my fieldwork experiences and interactions with provinces and districts, there appears to be potential for investigating the implementation processes from their viewpoints. Applying a multilevel analysis at different organisational levels within the health sector could yield diverse insights into how daily practices influence HMIS implementation outcomes. This includes understanding the impact of national-level decisions on activities at lower levels. For instance, during my fieldwork, I observed potential for exploring entrepreneurial actions at the provincial, district, and community levels. The dynamics within the daily routines of healthcare workers are distinct and examining their practices could provide significant insights. This is particularly relevant for tailoring digital policies and fostering more integrated development across all levels.

The African oral tradition, recognised as a valuable source of historical heritage that supports scientific and cultural developments (Leite et al., 2014), plays a significant role in Mozambique and many other African countries. Here, indigenous knowledge is often transmitted generationally through oral sources. Throughout this project, I realised the importance of oral sources as relevant scientific evidence, noting the limitations of paper and digital written

sources. My data collection was comprehensive, involving interviews, official websites, online document repositories, and physical archives at organisational headquarters. However, some information was unreferenceable, inaccessible, lost, or simply not found. I recognised that while archival processes supported by digital systems have the potential to be enduring and expansive, a lack of structure can significantly hinder archival integrity and access to valuable information over time. Conversely, valuable information might be lost when it is solely spoken and not recorded or documented. The constraints in accessing missing, lost, untold, or unwritten information limited the scope of my historical narrative, potentially omitting valuable insights. Future research could explore this phenomenon to enhance human-technology interactions in this domain and provide ethical guidance on these issues and alternative approaches.

Within the thesis, language is discussed in various instances, both as a cultural aspect influencing the development of the technological artefact and as a source of tension between the artefact and its users. Both language and ICTs (Information and Communication Technologies) can carry embedded assumptions that shape their roles (Urquhart, 2016). In my methodological description, I identified language as a non-critical limitation of the research process. My mother tongue is Portuguese, which is also the official language of the research setting. This greatly facilitated communication with participants during fieldwork and throughout the data collection process. Despite this advantage, I was concerned that some meanings might have been lost in translation when incorporating quotes into my historical narrative, as the thesis is written in English. While English serves as a 'lingua franca' and broadens the reach of my work to a wider audience, this language barrier is undoubtedly a limitation for many health sector beneficiaries in the research setting. As part of the process of giving back to the research community, I see potential in conducting related research in Portuguese.

In conclusion, I believe my study will be of broad relevance to both ICT4D (Information and Communication Technologies for Development) and IS (Information Systems) research. Understanding the positive impacts of technological implementations is best achieved from a retrospective and longitudinal perspective. The public health sector in an LMIC (Low- and Middle-Income Country) provides a particularly complex institutional context for implementation, with specific institutions (like external dependency) significantly influencing HMIS (Health Management Information System) implementations. Therefore, investigating HMIS implementations is enriched by considering the mutual and temporal shaping processes

between the institutional context (as the implementation setting), actors and agency (both individual and collective), and the material role of technology.

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Appendixes

Appendix 1 – Data collection instruments

Interview Guide

Interview Guide

Researcher profile presentation:

Name, place of work, training program, supervisors

1. **Interviewee profile in relation to the HIS implementation process**

   Name, role/ place of work, other relevant information

2. **Beginning of the HISP Project (introduction of DHIS) within the Health Information System in Mozambique**
   a. Project initiation
   b. Description of the process
   c. Actors involved
   d. Other relevant elements
3. **For the purpose of the study, I attempt to divide the 20 years period in Phase 1 (2000-2007), phase 2 (2008-2012) and Phase 3 (2013-2019)**
   a. Positioning/ Role of the interviewee
   b. Period involved in the implementation process
   c. Type of the interventions done
   d. Intervention sites
   e. Objectives and results
   f. Enablers and constrains
   g. Personal experiences in relation to the process
   h. Knowledge regarding other phases
4. **Internal and external factors influencing the implementation of DHIS and the Health Information Systems in general**
   a. In the country, the Ministry, the provinces (implementation sites)
   b. External (Infrastructure, resources availability – financial, human, technological, and others)
5. **Constraints**
   a. In the country, the Ministry, the provinces (implementation sites)
   b. External (support, infrastructure, resources availability – financial, human, technological, and others)
6. **Present and future challenges**
7. **Referrals to others that can provide useful information**
   a. Ministry
   b. Provinces

Survey

Survey (English)

Profile of the participant

Province
District
Name of the health sector
Role of the participant
Academical level of the participant
Years of service

Profile of the work sector

The location of the health unit (Province/District)
Location within the health sector (Province/District/Facility)
Does your sector have computers?
How many computers?
From the existing computers, how many work?
How do you use the computers?
Does your sector have tablets, smartphones, or phones? How do you use them?
Do you have your personal tablets/smartphones/phone?
Do you use any social network applications at work (WhatsApp or other)? With whom?
Can you mention how many computers were provided by the Ministry or by the partners?
The equipment provided by the partners is used for which purpose?
Do you have the means to communicate? How do you report to the upper levels?
Do you have Internet access?
Who provides the Internet?

Process: Data Capture

How is event data collected? Who collects?
How is data entered into SISMA (DHIS2)? By whom?
When and how do you interact with SISMA? For what purpose is it used in your sector?
What kind of activities are frequently carried out at SISMA? Others?

Process: Data Analysis

Do you often use indicators? Which? Created by who? Are they calculated in the system? How often?
What analysis tools do you usually use?
How is data analysis performed in your sector?
How is the analysed information shared?
Do you use any panels in SISMA? How many and which ones are available? Created by who? How often?
Do you have permission to create dashboards?
Do you follow any procedures/protocol manuals?
Are you able to comment or interact with other users through panels?

Process: Data Validation

How is the information entered and removed from SISMA validated?
How many and which indicators are used per program?
What activities are done to ensure data quality? what is periodicity?

What is the perception of stakeholders in the sector in relation to the information taken from the System?
Do program managers support data entry in SISMA?

Process: Data Use

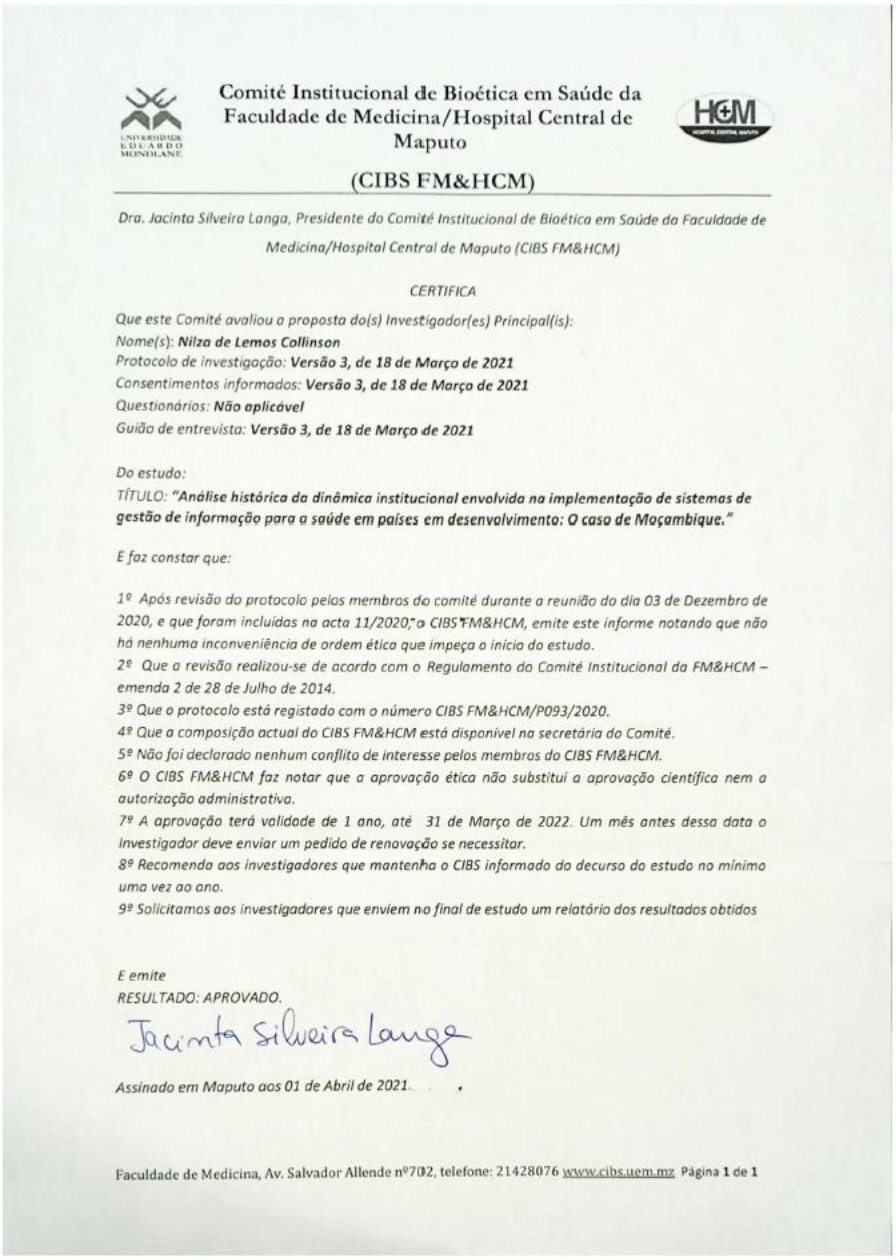
How often is the System information used to solve real and current problems in the region?
How often do you use the system to extract and query data for reports? (1 – low; 5 – high)
How often is reporting done? (Weekly, Monthly, Quarterly, other)
How do you get information from SISMA? In what format?

Process: Use of the System

What are the biggest challenges encountered while using the system?
How relevant is the System to your work?
Have you been trained to use SISMA? (Yes/No)
How do you report your concerns and receive support?
How often do you participate in training (eg. DHIS2 Academies)? How relevant is this to your work?
What is the difficulty level of using the system? (1 – easy; 5 - difficult)
What are the main difficulties you encounter when using the System?
What are your main expectations regarding the System?
How can we improve the use of this System?

Appendix 2 – Ethical Documentation

Approval from the Institutional Committee on Bioethics in Health of the Faculty of Medicine/Central Hospital of Maputo



Comité Institucional de Bioética em Saúde da Faculdade de Medicina/Hospital Central de Maputo

(CIBS FM&HCM)

Dra. Jacinta Silveira Langa, Presidente do Comité Institucional de Bioética em Saúde da Faculdade de Medicina/Hospital Central de Maputo (CIBS FM&HCM)

CERTIFICA

Que este Comité avaliou a proposta do(s) Investigador(es) Principal(is):
Nome(s): ***Nilza de Lemos Collinson***
Protocolo de investigação: ***Versão 3, de 18 de Março de 2021***
Consentimentos informados: ***Versão 3, de 18 de Março de 2021***
Questionários: ***Não aplicável***
Guião de entrevista: ***Versão 3, de 18 de Março de 2021***

Do estudo:
TÍTULO: ***"Análise histórica da dinâmica institucional envolvida na implementação de sistemas de gestão de informação para a saúde em países em desenvolvimento: O caso de Moçambique."***

E faz constar que:

1º Após revisão do protocolo pelos membros do comité durante a reunião do dia 03 de Dezembro de 2020, e que foram incluídas na acta 11/2020, o CIBS FM&HCM, emite este informe notando que não há nenhuma inconveniência de ordem ética que impeça o início do estudo.
2º Que a revisão realizou-se de acordo com o Regulamento do Comité Institucional da FM&HCM – emenda 2 de 28 de Julho de 2014.
3º Que o protocolo está registado com o número CIBS FM&HCM/P093/2020.
4º Que a composição actual do CIBS FM&HCM está disponível na secretária do Comité.
5º Não foi declarado nenhum conflito de interesse pelos membros do CIBS FM&HCM.
6º O CIBS FM&HCM faz notar que a aprovação ética não substitui a aprovação científica nem a autorização administrativa.
7º A aprovação terá validade de 1 ano, até 31 de Março de 2022. Um mês antes dessa data o investigador deve enviar um pedido de renovação se necessitar.
8º Recomenda aos investigadores que mantenha o CIBS informado do decurso do estudo no mínimo uma vez ao ano.
9º Solicitamos aos investigadores que enviem no final de estudo um relatório dos resultados obtidos

E emite
RESULTADO: APROVADO.

Jacinta Silveira Langa

Assinado em Maputo aos 01 de Abril de 2021.

Faculdade de Medicina, Av. Salvador Allende nº702, telefone: 21428076 www.cibs.uem.mz Página 1 de 1

Comité Institucional de Bioética em Saúde da Faculdade de Medicina/Hospital Central de Maputo

(CIBS FM&HCM)

Dra. Jacinta Silveira Langa, Presidente do Comité Institucional de Bioética em Saúde da Faculdade de Medicina/Hospital Central de Maputo (CIBS FM&HCM)

CERTIFICA

Que este Comité avaliou a proposta do(s) Investigador(es) Principal(is):
Nome(s): ***Nilza de Lemos Collinson***
Protocolo de investigação: ***Versão 2, de 14 de Dezembro de 2020***
Consentimentos informados: ***Versão 2 e de 14 de Dezembro de 2020***
Questionários: ***Versão 2 e de 14 de Dezembro de 2020***
Guião de entrevista: ***Versão 2 e de 14 de Dezembro de 2020***

Do estudo:
TÍTULO: ***"Análise histórica da dinâmica institucional envolvida na implementação de sistemas de gestão de informação para a saúde em países em desenvolvimento: O caso de Moçambique."***

1º O CIBS FM&HCM APROVA o pedido da Primeira RENOVAÇÃO do protocolo com Versão 2, de 14 de Dezembro de 2020, com o referência CIBS FM&HCM/093/2020.
2º O CIBS FM&HCM informa que prorroga o prazo do protocolo e a validade do mesmo passa para o dia 30 de Março de 2023 .
3º Um mês antes dessa data o Investigador deve enviar um pedido de renovação se necessitar.
4º Recomenda aos Investigadores que mantenham o CIBS FM&HCM informado do decurso do estudo na base semestral até o término do estudo.

E emite
RESULTADO: ***APROVADA A PRIMEIRA EXTENSÃO AO PROTOCOLO***

Jacinta Silveira Langa

Assinado em Maputo aos 29 de Março de 2022

NSD Assessment

Sikt

Notification form / Historical analysis of the institutional dynamics surrounding the i... / Assessment

Assessment of processing of personal data

Reference number	Assessment type	Given
420105	Standard	15.12.2022

Project title
Historical analysis of the institutional dynamics surrounding the implementation of health management information systems in developing countries: The case of Mozambique

Institution responsible for processing
University of Oslo / Faculty of Mathematics and Natural Sciences / Department of Computer Science

Project manager
Nilza de Lemos Collinson

Project period
10.12.2018 - 31.12.2023

Categories of personal data
General

Legal basis
Consent (Privacy Regulation art. 6 no. 1 letter a)

The processing of personal data is legal as long as it is carried out as stated in the registration form. The legal basis applies until 31 December 2023.

Notification form

Comment
BACKGROUND
Based on information given in the notification form and correspondence with the project leader, we understand that the processing of personal data has started. We understand that data collection has been carried out and that the collected personal data will be processed until 31.12.2023.

The personal data have a low degree of sensitivity, and the processing has been based on consent. Due to the project not being notified to us, the project has however not had documented legal grounds until now, in noncompliance with the principle of lawfulness, fairness and transparency, cf. GDPR art. 5 a. Information provided to participants is sufficient to document informed consent, but does not include all information required in GDPR art. 13, such as contact information to the University's Data Protection Officer (DPO) and the planned end date.

We find that risk to the rights and freedoms of data subjects is low, based on the above. The breach is not of a nature that needs to be notified to the Norwegian Data Protection Authority.

RESPONSIBILITY OF THE DATA CONTROLLER
Please note that it is the data controller, the University of Oslo, that has the responsibility to ensure that personal data are processed in accordance with data protection legislation. The University of Oslo is responsible for making sure that correct knowledge is transferred to its students and employees. Data Protection Services is available to provide guidance if there is a need for further data protection training.

ABOUT OUR ASSESSMENT
Data Protection Services has an agreement with the institution where you are carrying out research or studying. As part of this agreement, we provide guidance so that the processing of personal data in your project is lawful and complies with data protection legislation.

We have now assessed the planned processing of personal data in this project. Our assessment is that the processing is lawful, so long as it is carried out as described in the Notification Form with dialogue and attachments.

IMPORTANT INFORMATION
You must store, send and secure the collected data in accordance with your institution's guidelines. This means that you must use online

Approval from the Ministry of Health

REPÚBLICA DE MOÇAMBIQUE

MINISTÉRIO DA SAÚDE
DIRECÇÃO DE PLANIFICAÇÃO E COOPERAÇÃO
Departamento de Informação para saúde

À
Sra. Nilza de Lemos Collinson
Maputo

N/Ref. Nº 1416 /DPC/DIS/2021 Maputo, 16 /Abril/2021

Assunto: Recolha de dados

Em relação ao assunto em epígrafe a Direcção de Planificação e Cooperação é de parecer favorável a realização de recolha de dados para efeitos de investigação na área de sistema de informação com o tema "*Analise histórica da dinâmica institucional envolvida na implementação de sistemas de gestão de informação para a saúde em países em desenvolvimento: O caso de Moçambique.*" No entanto a Direção de Planificação e cooperação propõe uma apresentação dos resultados obtidos no fim do estudo.

A Directora

Sãozinha Paula Agostinho
/Médica Especialista Assistente/

Appendix 3 – Documents sent with the invitation to participate in the study

Consent Form

Consent to Participate in Research

These interviews are parts of a PhD research project at UiO being conducted by Nilza Collinson, as the main researcher, with the involvement of Sundeep Sahay (main supervisor), Petter Nielsen (co-supervisor) and Emilio Mosse (co-supervisor).

The overall aim of the research is to conduct an analysis of the institutional dynamics influencing the implementation of HMIS, enabling or constraining its adoption and institutionalization processes relating to building ownership, self-reliance and contributing to sustainability, within a developing country context. We attempt such analysis around the efforts to adopt DHIS2 software by the Ministry of Health in Mozambique since 2000. The questions in the interview will revolve around this topics.

The duration of the interview will be about one hour, conducted in Portuguese and transcribed to English. The interview will not be recorded, unless the interviewee accepts to do it. All the data collected will be securely stored and used only for the purpose of this study.

Please fill the following space with Yes or No: _____ I autorize the recording of the interview.

Voluntary participation

Your participation in this research is voluntary, and you can withdraw at any point, also after the interview has taken place by contacting the main researcher by email. On your request, all data from your participation will be deleted.

Anonymity

Data from the research may be used in publications published in scientific conferences and journals and in DHIS2 related forums. What you say during the research activities will not be linked to your name, and data is thus anonymized. However, your role in the process and typical work tasks may be used to put the data into context in publications. Therefore, depending on the reader, this could lead to you being identified. If you are not comfortable with this, you should not take part in the research. If we are using direct citations from interviews, they will be presented for you.

Your rights

As long as you can be identified in the collected data, you have the right to:

- access the personal data that is being processed about you
- request that your personal data is deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and

1

- send a complaint to the Data Protection Officer or The Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?

We will process your personal data based on your consent.

Where can I find out more?

If you have questions about the project, or want to exercise your rights, please contact:

- Nilza Collinson by email: nilzac@ifi.uio.no, nilza.collinson@uem.ac.mz .

_____

Signed, researcher

Consent

I have read, understand and agree on the information above. I will hereby participate in the research project.

_____ _____

Place and date *Signature*

Project Description

Historical analysis of the institutional dynamics surrounding the implementation of health management information systems in developing countries: The case of Mozambique

Introduction

The implementation of Health Management Information System (HMIS) is susceptible to several institutional dynamics influences, raised by technological artefacts themselves or political and cultural conditions in place. These dynamics, not always obvious and easily acknowledgeable, sometimes appear intrinsically merged or hidden within the context, being only perceptible through patterns along periods in time with particular lenses. In those cases, history is valuable to understand and pursue explanations around why and how technology gets adopted and institutionalized or not, those being valuable while planning future efforts. We attempt such analysis around the efforts to adopt DHIS2 software by the Ministry of Health in Mozambique since 2000.

Main Objective

Analysis of the institutional dynamics influencing the implementation of HMIS, enabling or constraining its adoption and institutionalization processes relating to building ownership, self-reliance and contributing to sustainability, within a developing country context.

Method

As this study intends to conduct a research based in a longitudinal case study over the last twenty years, history is reconstructed in terms of three main phases: DHIS initiation in Mozambique (2000-2007), disruption of the Ministry of Health with DHIS (2008-2012), adoption and scaling up nationwide (2013-2019). The setting selected includes the first three provinces where DHIS was first introduced. The initiation of this reconstruction will find support in the work done by the researchers involved in Doctoral Programs through University of Oslo, which focused in the referred implementation and parallel processes, along this period. In the following stages, referees suggested by this main group of interviewees will be contacted and additional documentation will be also consulted.

Results & Contribution

From this historical reconstruction, we expect to be able to identify some institutional pressures that played determinant roles in this implementation. Thus, aiming to understand how different institutional and other conditions in the setting affect sustainability and self-reliance with respect to HMIS implemented over the time, while also contributing to build new and relevant knowledge around a HMIS implementation in a developing country context, and more broadly to the domain of ICT4D.

Appendix 4 – Dissertations published as part of the International Master program - from the period 2000-2009

Nr.	Year	Name	Topic
1	2009	Patrick Albert Chikumba	Application of the Geographic Information System (GIS) in the Drug Logistics Management Information System (LMIS) at the district level in Malawi: Opportunities and Challenges
2	2009	Joshi, Dibyadhar	Presentation of health data and user acceptance of a District health information system
3	2009	Kim Anh Thi Vo	Challenges of Health Information Systems Programs in Developing Countries: Success and Failure The cases of Thua Thien Hue province and Ho Chi Minh city, Vietnam
4	2009	Ole Kristian Hustad	Challenges of Open Source Software Capacity Building among DHIS2 developers in India Master thesis 60 credits
5	2008	Thorseng, Anne Asmyr	Managing complexity through flexible scaling : a case study of the expansion of a health information system in Botswana
6	2008	Hilland, Elise Cathrine	PD i HISP Zanzibar: Møte mellom teori og praksis
7	2008	Anders Bjarne Skjelten Gjendem	Recruitment, training, communication and Open Source: A case of health information systems
8	2007	Store, Margrethe	Explore the challenges of providing documentation in open source projects
9	2007	Marlen Stacey Galimoto	Integration of Health Information Systems: Case Study from Malawi
10	2007	Nguyen, Thanh Ngoc	OSS For Health Care in Developing Countries : Comparative Case Studies of DHIS2 and Patient Based Systems In Ethiopia And Vietnam
11	2007	Edwin Nyella	Challenges and Opportunities in the Integration of HIS: Case Study from Zanzibar
12	2007	Caroline Ngoma	Cultivation Strategies in the Implementation of Health Management Information System in Zanzibar: An Action Research Study
13	2007	Sandvand, Jon	Organizational Strategies for improving Health Information at district level - a field study of Management Implemented Support Structures in Malawi
14	2007	Hamre, Gro Alice	Motivation and demotivation among health staff at facility and districts level : A case study of the national Health Management Information system of Malawi
15	2007	Abrha, Sofia	Evaluating challenges and opportunities for sustainability of computer-based information system : case study from Addis Ababa
16	2007	Brucker, Øyvind F	Internationalization and localization - A case study from HISP
17	2006	Heldre, Thor Helge	Study of a Health Information System pilot project in Tanzania

18	2006	Jacobsen, Petter	Design and development of a global reporting solution for DHIS : Performing action research in Vietnam
19	2006	Nordal, Kristian?	The challenge of being open : building an open source development network
20	2006	Egil Øvrelid	Patient treatment as enactment: Knowledge sharing across professionally divides
21	2006	Hafsal, Karen	Building Participatory Networks for HIS in a Developing Country Context : A Case Study from India
22	2005	Teresa Hang Nguyen?	Internationalisation in Health Information System Project Research in Vietnamese Language
23	2006	Gjerull, Nils Fredrik	Open Source Software Development in Developing Countries : The HISP Case in Ethiopia
24	2005	Sheikh, Yahya Hamad	Improving routine health information management at health districts : an action research study
25	2005	Olsen, Gøran Klepp	Comparison of different Model Driven Development approaches : a mobile Meal Ordering System for the healthcare sector
26	2005	Syahrir, Irwan	Software Development Practices in Global Software Work : Developing Quality Software
27	2005	Shidende, Nima H.	Challenges and approaches to the integration of HIS : case studies from Tanzania
28 e 29	2005	Hirut Gebrekidan Damitew And Netsanet Haile Gebreyesus	Sustainability and Optimal use of Health Information Systems: an Action Research Study on Implementation of an Integrated District-Based Health Information System in Ethiopia.
30 e 31	2005	Birkinesh Woldeyohannes Lagebo And Selamawit Molla Mekonnen	Challenges and Approaches to Scaling and Standardizing Health Information Infrastructure in Developing Countries: Case Studies from Ethiopia
32	2005	Saugene, Zeferino Benjamim	Challenges, opportunities and strategies for using geographic information systems for public health management : an action research study from Mozambique
33	2005	Lewis, John	Design and development of spatial GIS application for primary healthcare sector : case studies from India and Mozambique
34	2005	Mangset, Lars	DHIS-2 - A Globally Distributed Development Process : Performing Action Research In Vietnam
35	2005	Ginger, Lúcia Joaquim	Introducing geographical information systems for health care in developing countries : challenges and approaches - a case study from Mozambique
36 e 37	2005	Andresen, Trond; Vik, Lars Gunnar	Application of Open Source GIS in District Health Information Systems
38	2005	Damitew, Hirut Gebrekidan	Sustainability and Optimal use of Health information systems : An action research study on implementation of an integrated district-based health information system in Ethiopia

39 e 40	2004	Jakobsen, Elisabeth And Johansen, Ann Kristin H.	"All I want is a system that works" : evaluation of the health information system in Cape Town, South Africa – using an information audit to capture views from the grass root level
41	2003	Mukama, Faraja	A study of health information systems at local levels in Tanzania and Mozambique : improving the use and management of information in health districts
42	2003	Fumo, Teotónio Glória dos Santos	Health information systems integration : a data warehouse architecture model for the Ministry of Health in Mozambique
43	2003	Lungo, Juma Hemed	Data flows in health information systems : An action research study of reporting routine health delivery services and implementation of computer databases in health information systems
44	2003	Macueve, Gertrudes Adolfo	Drugs logistics management information system in Mozambique : challenges and opportunities