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Introducing Digital Health in Post Conflict Mozambique: A Historical Perspective

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Abstract: Implementation of digital health in low- and middle-income countries is susceptible to influences of several institutional dynamics, through interactions of technological artefacts, political and other environmental conditions. These dynamics may lead to contradictions, not always obvious nor easily acknowledgeable. History can be valuable to understand and pursue explanations around why and how a technology gets adopted and institutionalized or not in particular settings. This study is part of a project focusing on a longitudinal case, where history is reconstructed over twenty years, in three phases: introducing digital health in post conflict Mozambique (2000-2007), disruption of initial efforts to introduce District Health Information Systems (DHIS) platform (2008-2014) and, adoption and scaling up of DHIS2 nationally (2015-2021). For the purposes of this paper, we conduct analysis to the initial period, with institutionalist lenses, aiming to identify the set of contradictions raised within the context of study and discuss implications for the future.

Keywords: Historical reconstruction, institutional dynamics, institutional change, institutional contradictions.

1. Introduction

Studies around the implementation of Information Systems (IS) continue to gain interest, with several authors focusing on IS in low- and middle-income countries (LMICs) [30, 49], including stories of failures [22, 64] and successes [2; 49, 31]. While most studies have focused on stories over the short term [2; 63, 31], a limited number of them have focused on long term implementations, spanning more than thirty years [5, 59, 62]. A common analytical focus is on the implementation dynamics and their ongoing implications. In turn, a historical analysis provides the potential to investigate large amounts of existing data, to discern underlying patterns and how they change over time [12].

History provides a valuable tool to reconstruct processes, which helps to explain contemporary occurrences [12] and “allows one to look to the past as a source of alternatives for the future” [23]. Such an analysis helps “provide answers to institutional questions” [23], drawing upon the lens of institutional theory. Several concepts and methods inherited by this theory have been developed along the years and are increasingly being used in research. Concepts such path dependency and historical frameworks have been used to explore evolutionary trajectories and unveil patterns embedded in institutional change phenomena [58].

In this paper, we pursue building a historical understanding of the processes of change around the introduction of digital health systems in post conflict Mozambique. We reconstruct the history around the introduction of the technological artefact DHIS (District Health Information Software) around its initial implementation over the period 2000-2007, within the framework of a global Health Information System Programme (HISP) R&D initiative, coordinated by the University of Oslo (UiO) in Norway. The specific research question to address is: “*how institutional dynamics raise contradictions during IS implementation and what are the unfolding implications?*”. In the next section we introduce some related literature, followed by the methods section. The case study and analysis are presented in sections 4 and 5 respectively. Finally, we discuss key contributions and conclusions.

2. Related Works

Institutional theory has its origins from the 1950s, and has drawn from multiple disciplines of economics, political science, sociology, and organization theory [26, 53, 48, 60]. The more recent history includes the development of a new institutionalism, and the emergence of other debates focusing on *institutional change*, *institutional logics* and *contradictions* [26, 60, 65], which provides the basis for the theoretical approach adopted in this paper.

Studies using Institutional theory has been applied in a multidisciplinary basis across domains of such education, health, commerce, markets, among others, either in commercial or public domains, [5, 34, 51, 61]. Within IS, scholars have used this theory to examine several phenomena around the processes of adoption and institutionalization [57], institutional change [5, 46, 47; 49, 62], institutional logics [4, 50, 17], institutional contradictions [44, 56, 52], institutional work [51]. Various concepts have guided these analysis including *institutions, institutionalization, actor, social action, processes, time, context, behavior, patterns, values, meanings, logics, culture, power, political and economic situations, conflicts* [23, 26, 54, 43, 65], among others. These are perceived, interpreted, and defined differently in accordance with the perspective adopted.

The concept *institution* is central, representing a *social order* or *pattern* that has attained a certain state or property; and *institutionalization* “denotes the *process* of such attainment” [26]. In the literature this concept has been used interchangeably with the term ‘organization’, which despite being related are different. The concept of organization refers to a group of individuals, gathered under the same designation and with same purposes [32]. Whereas the concept of institution reaches a broader scope. Thornton & Ocasio [60] describe institutions as “*supraorganizational patterns* of activity” that *follow a specific order within the society*, viewed as an “*inter-institutional system*” [60]. Avgerou [5] suggests that information technology innovations and organizational practices may be considered institutions, as both possess own mechanisms and legitimate elements, although at different institutionalization stages.

Thornton et al. [61] presents the concept of *institutional logic* as “the socially constructed, historical patterns of cultural symbols and material practices, including assumptions, values, and beliefs, by which individuals and organizations provide meaning to their daily activity, organize time and space, and reproduce their lives and experiences”. This brings together three complementary and essential dimensions of institutions, namely: structural (coercive), normative and symbolic (cognitive), which enable further understanding on how their logics operate [60].

According to Thornton & Ocasio [60], a better understanding of the societal phenomena is attained by exploring the interrelations between its different constituents. They conceptualize *society as a multilevel inter-institutional system* based in three interconnected levels: “*individuals* competing and negotiating, *organizations* in conflict and coordination, and *institutions* in contradiction and interdependency” [60]. Suggesting that, while individual behavior and organizational dynamics are influenced by specific logics inherited by the institutions in place, the latter is social constructed by the interplay of actions from the first two levels. Furthermore, within this process, institutional logics in contradiction may *resist to change* or *cause institutional changes* to occur [55].

In turn, Schreyögg & Sydow [52] highlights the importance of looking to the overall phenomena over time. These authors refer to the concept of path dependency and the argument behind it, which states that past events exert significant influence on future actions and decision-making. And, considering the hard nature of the institutions, this also applies to explain why and how institutions resist or even change, in specific conditions [52].

Although existing institutions may change over time [33] it does not occur in only one direction [65]. Jepperson [26] presents four distinct types of institutional change. He posits these types of changes in terms of transitions in between stages, triggered by particular conditioning designated as *contradictions*. Suggesting that these conditions can be raised by the *environment* where these institutions play a role, result from the *interplay of different institutions* or even arise after basic *social actions*. In this sense, according to [26]:

- “*Institutional formation* (or establishment) is an exit from social entropy, from nonreproductive behavioural patterns, or from reproductive patterns based upon ‘action’”;
- “*Institutional development* (or elaboration) represents institutional continuation rather than an exit – a change within an institutional form”;
- “*Deinstitutionalization* represents an exit from institutionalization, toward reproduction through recurrent action, or nonreproductive patterns, or social entropy”;
- “*Reinstitutionalization* represents an exit from one institutionalization, and entry into another institutional form, organized around different principles or rules”.

For long, several scholars have been discussing the complexities around social embeddedness [26, 15, 60]. To better understand this, Seo & Creed [55] proposes the adoption of a dialectical perspective. They suggest a view of these interplay as non-regular cycles, where multilevel institutionalization processes evolve over time, when institutional arrangements in place are challenged, creating a historical context for institutional change.

Seo & Creed [55] conceptualize *institutional contradictions* as “various *ruptures* and *inconsistencies within and among* institutionalized systems of meaning, forms of organization, and logics of action”. They suggest that the rise and development of this results from the “*ongoing social construction of institutional arrangements*” and the challenges ascending from their legitimization processes, from internal and external sources [38]. Some *external factors* include: introduction of new technologies, management innovations, changes in political policies, major political disturbances, social reforms, economic crises or dislocations, and shifts in cultural beliefs and practices; while *internal factors* are related with specific features defining the organization (“such as organizational mission, structure, resources, operations, and social relations”) or arguments and motives for “change/stability” within the organization [38], *macro* and *micro interdependencies*, and the existence of multi-institutional systems that intersect and overlap [53].

In turn, the interplay of *multiple actors* carrying own interests and objectives may result in *conflicts*, interfering with the interventions in place [65]. Scholars also refer to the potential intervention of individuals (*institutional entrepreneurs*) with both access to resources and the intention to assemble collective actions enabling institutional change [60]. This collective action, also designated as “*praxis*”, is considered an “*essential mediating mechanism*” linking “*institutional embeddedness, contradictions, and change*” [55].

Some scholars associate the sources of contradictions with *legitimacy, adaptation, intrainstitutional conformity, and isomorphism* [15, 44, 55, 56]. Seo & Creed [55] argues that this happens when “legitimacy undermines *functional inefficiency*”, “adaptation undermines *adaptability*”, “intrainstitutional conformity creates *interinstitutional incompatibilities*”, and “isomorphism conflicts with *divergent interests*”. While in the midst of this challenges, Novalia et al. [44], suggest strategies and mechanisms to attempt a mediation through interventions like: “*short-term fixes, elimination, decoupling, moderation, and forging durable identities and finding complementarities*”.

Examples of these debates in the context of Low- and Middle-Income Countries (LMICs) are described next from the perspective of six cases, from Africa, Latin America and Asia.

Piotti et al. [46] discusses institutional change in the context of ongoing reforms in Mozambique. They argue that inflexibility in adaptations of formal rules to accommodate informal constraints from the setting may limit the intended outcomes. In addition, limited overlap between formal and informal dimensions of institutions in place may suggest a need to enhance and enforce the mechanisms to enable changes in future implementations.

While Hayes & Rajão [21] discuss the concept of contradictions, looking in particular to how **competing institutional logics**, emerging along the process of introducing a GIS system in Brazil’s Amazon region over time, contribute or not to achieve a particular developmental goal. They establish a relation between design and use of ICTs and emergence of conflicting logics, arguing that future implementations need to consider historical events and context to anticipate and enable the potential of digital solutions. Wanderley & Soeiro [64] describe an unsuccessful implementation of a Balanced Scorecard (BSC) system in an electricity company in Brazil, to explore the role of **praxis** in the processes of change. In turn, Volkow [62] uses a framework of institutionalism to pursue understanding of institutional dynamics through a **multilevel approach**. Suggesting that the social context may be better “visualized at a macro level” by observing the interplay of “social institutions” and “at a micro level” through “human actions”, where both levels are intrinsically connected.

Sahay et al. [49] uses the theory to explore institutional pressures constraining or enabling the introduction of technological innovations, suggesting that values and meanings underpinning the IT innovation “can influence its adoption and implementation contributing to organizational change (or not)”. Nawab et al. [37], exploring their case in the context of Pakistan, brings out the dilemma of the culture of silence, where people do not engage on challenging or disagreement of others point of view. They suggest that this context is not favourable to identify and resolve contradictions, and, while contradictions may trigger “opportunities for organizational renewal”, they argue that “unrecognized contradictions are opportunities lost”.

In the current study, we find support in these debates for several reasons. First, we perceive the setting as an inter-institutional system, influenced by several institutional orders. Secondly, we understand the importance to discuss these influences from different perspectives in a multilevel context. Thirdly, we understand that historical development of events and processes over the years create opportunities to explore institutional dynamics, different contradictions in place and pursue insights around their implications to the setting.

Along the study we also investigate the phenomena from the perspective of technology as an institution. One of the examples we take as a reference is a study conducted in Mozambique by Nhampossa [42]. This author explores the concepts of technology transfer and translation and draws his arguments around the pilot of DHIS within the setting. Other studies taken, that explore the influences of technology to the emerging institutional dynamics in the same setting, include Chilundo [13], Mosse [35] and Muquingue [36].

To conduct our study, we followed a methodology, as we describe in the next section, and build our analysis around the concepts described previously. In our framework of analysis, we consider: three *historical contexts* (moments), the *processes* and *institutional arrangements* in place and the *contradictions* that emerged around them. Having the *institutionalization processes* in mind, we attempt to explain how these institutional contradictions arise during the period in study.

3. Methods

3.1. Data Collection

The current study is part of a longer-term research initiative of a process spanning 20 years concerning Mozambique’s engagement with the introduction and implementation of digital health systems. This study focuses on the first phase. This 20-year history is interpretively reconstructed over 3 phases summarized in the table 1 below.

Table 1. Timeline of the Historical Reconstruction project

Digital Health Implementation in Mozambique: Historical Phases (2000-2021)				
Phase 1: Initiation (2000-2007)	Phase 2: Disruption (2008-2014)	Phase 3: Establishing Continuity (2015-2021)		
Health Information Systems Project (HISP) initiation	Disruption of HISP	Adoption	Scaling up	Institutionalization process

Data collection was done primarily between 2019-2021 to understand events that had taken place during 1999 until 2007. Multiple sources of data were used, summarized in the table 2 below.

Table 2. Data collection sources

Research, methods	Data sources
Secondary data	Research articles, 7 PhD and 4 Master thesis Documentation from the MoH website and government archives
Interviews	1 Project Manager (HISP) 2 Former Project Manager (UEM and WCU) 7 Former PhD Students (UEM) 6 Former International Master Students (UiO-UEM) 1 Former consultant (MoH) 3 Former and 1 actual Executive staff (MoH) 2 Data Officers (DIS – MoH) 2 members from the external support team 1 Executive staff and 1 Data Manager from Provincial level 1 Medical Doctor from the setting
Field visit	Selected districts in 5 provinces: Gaza, Inhambane, Niassa, Maputo province and Maputo City
Observations	Headquarters of the MoH (DIS) 3 Provincial Directorate of Health
	1 Health facility at Provincial level 5 Health facilities at District level (near and distant from Districts headquarters) 1 Program Officers Meeting (Province level) 1 Validation and 1 Statistical Meeting (District level)
Survey	20 Statisticians from the Nucleus of Statistics from District and Province

3.2. Data Analysis Process

Data analysis followed a sequential process involving the following steps:

1. **Transcribing and organizing data collected:** All data gathered was collated, translated (from Portuguese to English), transcribed and a **data corpus** [11] was developed to enable analysis.
2. **Data analysis through building themes:** Both authors independently read the transcribed data and identified themes [14]. These were then jointly discussed to develop consensus around relevant themes for further analysis, which included: *processes, context, time, actors, social action, political and economic situations, conflicts, power, values and meanings.*
3. **Relating themes to theoretical concepts:** The identified themes were then related to relevant themes drawn from Institutional theory context [5, 65]. Using these concepts, a narrative of the case study is developed, at both the macro (donors, ministry) and micro (districts and health facilities) and their inter-linkages [62].

4. Case Study

We start by presenting the political-institutional context of Mozambique, including events leading to its independence from Portugal, the subsequent civil war until the peace agreement in 1992, and the early efforts to introduce computers in the health sector. These events had a significant bearing on the initiation of the HISP initiative in 2000.

4.1. The political-institutional context of Mozambique (1975-2000)

Mozambique represents a post-conflict setting scarred by colonial rule and civil war, with key events depicted in the figure 1 below.

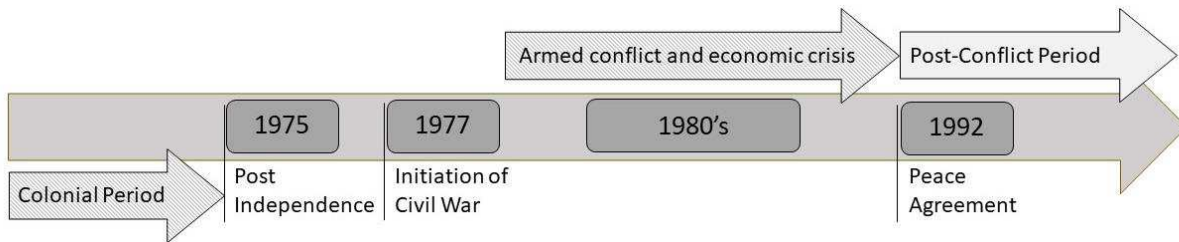


Figure 1. Timeline between independence and peace agreement: 1975-1992

Events in this period had three key implications on digital health systems, which we now discuss.

Disruption of health personnel post-independence:

The year 1975 was significant when Mozambique achieved independence from Portugal, with citizens given the option to stay in the country or leave for Portugal. This led to a massive drain of skilled people, and the health sector was particularly badly affected. In 1974, the country had around 550 doctors [36], a doctor-citizen ration of 1 to 17349 habitants, with more than half of the health workers concentrated in the capital [7], which dwindled by 85% following 1975 [20, 36]. Less than two years post-independence sparked a bitter armed 16-year long civil war involving rival groups with different political interests, which led to death of hundreds of health care workers [19]. To address this huge void, the government sought to establish agreements to receive health personnel from foreign countries, such as Cuba, China, former East Germany, the Soviet Union and from several African countries. In addition, around 10,000 people received training from 1975 to 1990 [36].

Destruction of health infrastructure with the civil war:

Mozambique was one of the poorest countries in the world, contributed to by the post-independence brain drain and the destruction and death caused by the civil war which ended in 1992 [19]. During civil war, existing infrastructure, including industries, health facilities, schools and others were vandalized, destroyed, and even abandoned. The existing 113 Hospitals in 1975, were reduced to 39 in 1977, and only 43 functional hospitals remained in 1997 [24]. The civil war led to large-scale loss of life and economic instability contributing to an increasing level of donor dependency [18, 25, 39] and the consequent loss of sovereignty. The increasing attention of the International Monetary Fund (IMF) and the World Bank on Mozambique opened space for external aid [18, 19], particularly in health and education sectors, a trend which continues today.

These contextual influences shaped the initiation of digital initiatives in the country.

4.2 Initiating digital health in post-conflict Mozambique

Despite early adhoc efforts by the Ministry of Health post-independence, it was only in 1992 that the first computerized system designated SIS-Prog was introduced, limited to the central and provincial levels [Almeida, 2007]. The figure 2 provides a chronology of the different systems introduced in the country during this period.

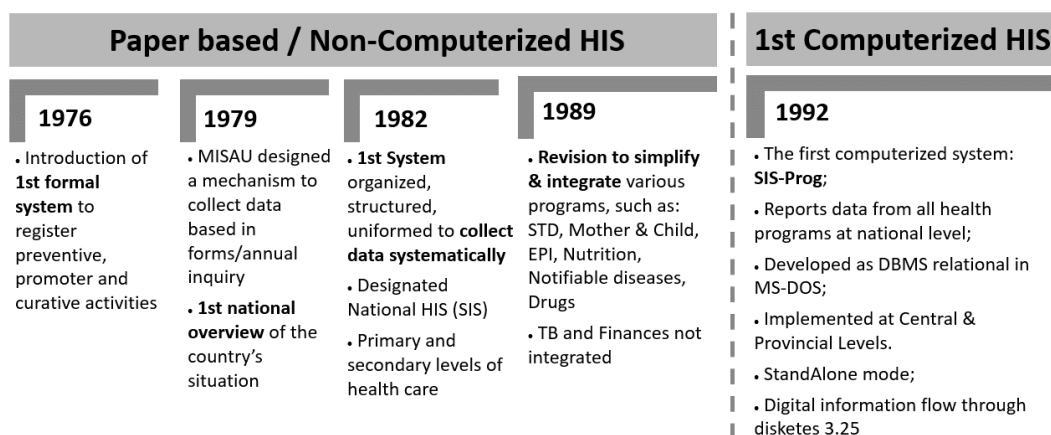


Figure 2. Main achievements of the MoH in terms of Health Information Systems in the period 1976 – 1992

The obvious limitations of SIS-Prog opened space for new developments, including the introduction of the HISP initiative and their software called DHIS 1.3 (District Health Information Software, Version 1.3). Key events around this initiation are now described.

Building relationships and partnerships: 1998-1999

The HISP project in Mozambique initiated in 1998 within an academic setting, providing opportunities to strengthen the tertiary education capacities in conjunction with HIS building efforts. HISP's entry in Mozambique was built upon a decade of high political visibility and success in post-apartheid South Africa [49], where the DHIS software attained the status of a national standard and attracted the attention of other African countries. The Norwegian pioneers of HISP in South Africa met some officials and researchers in Mozambique, and slowly started to build a network of partnerships, as depicted below in figure 3.

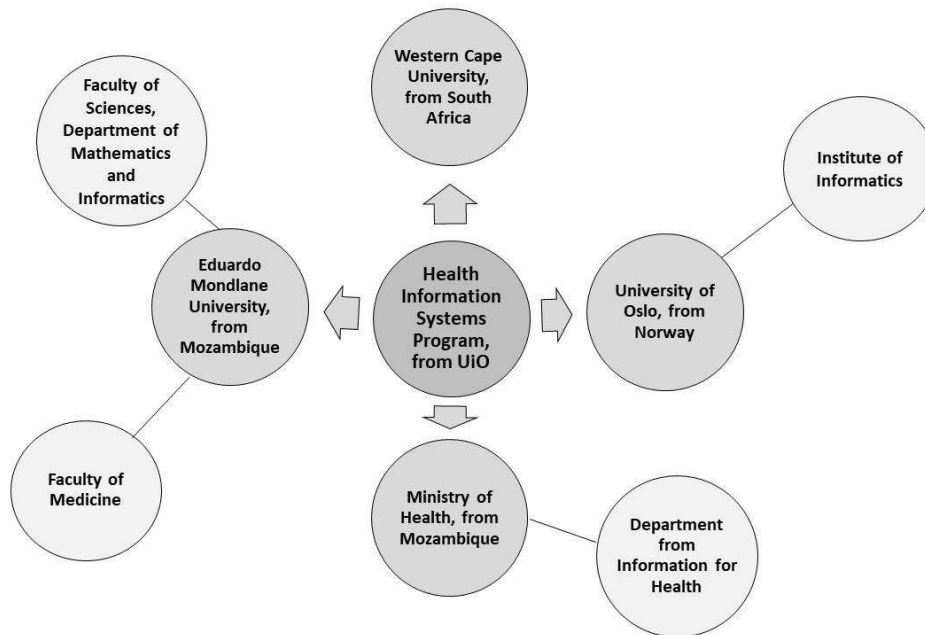


Figure 3. Organizations involved in the first phase of DHIS implementation in Mozambique

Initial conversations were established between the **HISP** coordinator and a local national university **UEM**, through the **Faculties of Medicine and Sciences**. Together, this team commenced conversations with the **MoH**, which at the time was very receptive to the ideas presented, given their engagement in various health sector reforms [13, 36]. These conversations led to the inclusion of other researchers from UEM and members from the Department of Information for Health (DIS) at the MoH, financially supported by the Norwegian Government [9].

A first step in the growing network was the conduct of **an assessment of the current situation** starting with selected districts in three provinces. This assessment contributed for the MoH in developing its **first strategic plan for the sector** and for HISP to develop a more operational project plan for the HIS implementation. This was submitted, approved and a Memorandum of Understanding (**MoU**) was signed between Oslo, UEM and the MoH in 1998, which envisaged a pilot of DHIS in selected sites across three provinces (Gaza, Inhambane and Niassa) [42]. Selected districts were existing training sites for medical students from UEM [13]. The results of the assessment were presented as research in progress in a meeting in Zimbabwe by 1999, and as a complete research paper published in 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 former foreign consultant from MoH)

“We did not have trained and specialized personnel, the base was the health workers themselves... doctorates, masters, licentiates, they were a drop of water.” (A former local senior manager from the MoH)

“The first step was the introduction of a master course in Mozambique... and enrol PhD students...” (A former project coordinator from HISP)

The HISP planned to take the DHIS application developed in South Africa, and through a process of “technology transfer” customize and adapt it to Mozambique’s needs using the capacities of the identified UEM researchers. The capacity building of these researchers was inspired by the Scandinavian tradition of action research [10]. Simultaneously, a multi-disciplinary International Masters program in Health Informatics at UEM, and students from

informatics and community health, from both Mozambique and other countries (Ethiopia, Malawi, Tanzania and India) were enrolled during the early years.

Capacity building strategies and interventions: 2000-2007

In 2000, professors from HISP-UiO and another from Western Cape University (WCU) came together and created a **multidisciplinary task force**, including the local researchers to design the **International Master program** [8, 28] to help strengthen HIS capacity in the country. This program included two core components (1) the health information systems as part of the academic course work; and (2) a research component with mandatory fieldwork and thesis in the same area. This structure promoted a form of action research, where students were encouraged to address existing priorities of the MoH, while learning from this experience to write their thesis. The projects worked on included the pilot implementations identified in the MoU and were supported also by the enrolled PhD students. During the period, a significant number of professionals, from the Health Sector and Academy, enrolled to the International Master Program, and by 2007 already 38 master students had been graduated. The program in Mozambique ran for three editions (2001, 2003 and 2005) before the split into 2 new Master Programs in 2006, in Informatics and Public Health [16, 27]. This Masters programmes can be seen as a success, as it continues till today, although in a modified form.

In 2000, as part of the MoU, six UEM faculty members, 3 each from medicine and informatics, enrolled for the UiO doctoral program, of which 5 ultimately graduated. These students received training on DHIS in South Africa and jointly participated in the customization of the DHIS for the Mozambique context. With the start of the formal studies at UiO, the students were expected to both provide practical implementation support to the projects in the districts, while also doing their course work in Oslo. They were thus operating in split locations, following different objectives, which proved to be a source of contradictions for them, with adverse implications on project outcomes.

“...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 former PhD student)

However, the ultimate completion of 5 PhDs, in a country where no informatics PhDs existed by 2000, can be seen as a huge success towards building tertiary education capacity.

In-service training efforts

Both masters and doctoral students were involved with in-service training activities in the selected provinces for the pilot. During this period, MoH introduced two new institutional entities called Nucleus of Statistics, at provincial and district levels, responsible for supporting all the data management functions. However, on the ground, the health workers, with very limited skills and capacities, were responsible for conducting the everyday work, including training other staff. In 2001, the first 10-day course on the technical aspects of DHIS directed to the health workers was launched in Gaza province, including 20 staff drawn from the three pilot provinces.

The quality of training was however constrained by the relative inexperience of the trainers, particularly in understanding diverse information needs of medical doctors, nurses and other technicians. Often, the dominant technical focus of the trainings, failed to develop a sound social-systems perspective to understand the HIS related challenges.

“...the training to use data entry and analysis began. That's where we began to face difficulties...” (A former local project coordinator)

However, these initial efforts helped create a favourable environment to initiate HISP in Mozambique, with opportunities for MoH to get tools and resources for supporting their health sector reforms, and for UEM to build their tertiary and education capacity within a multidisciplinary framework.

We next describe how the project implementation process developed and the underlying contradictions experienced, which impeded project progress ultimately leading to its closure.

4.3 The project implementation process

The introduction of DHIS (version 1.3) commenced in 2000, amidst excitement and expectancy, which slowly dwindled over time because of various implementation challenges, which we related to the process of initiation of the pilots, which led to different contradictions.

The process of initiation of the pilots

The piloting interventions were organized mainly by the local HISP coordinator, with support from the technical team from South Africa and the UiO faculty. The baseline software used had been developed in and with South African requirements, in Microsoft Access. As a first step, the application needed to be translated to Portuguese. The PhD and Masters students, all Portuguese speaking, were responsible for this process. However, this was extremely tedious and problematic. Although the team knew Portuguese language, they lack on translation expertise and, while also, often unfamiliar about specific technical terms used, required clarifications from other sources, including South Africa. Many issues and concepts got lost in translation,

*“Terms like **backup**, **zoom**, and **data mart** do not have 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.” 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 in order to keep a reasonable layout and distributions of the buttons” [40]*

This process of getting the software ready to initiate pilot implementation was fraught with delays, contributed also by the part time nature of involvement of the PhD students, which dampened some of the initial expectancy. The MoH and the HISP team tended to blame each other for the delays:

Contradictory objectives of project “resource persons”

The MoU promised full commitment from all parties involved in the project, which however unfolded differently during implementation. While agreeing in principle, in practice MoH never gave explicit instructions to the changeover from SIS-Prog to DHIS. At same time, HISP team could not dedicate full time to the implementation work, because of their simultaneous study commitments. This led to long project delays, with both sides blaming each other for the same. These delays opened the space for other HIS applications to be introduced. The MoH opted to select a tool developed by one of the resident consultants, designated SIMP (*Sistema Integrado de Monitoria e Planificação*) from 2002 onwards, in parallel to DHIS. The HISP team opposed this choice, feeling that the MoH was indifferent and uninterested in the pilot project. This led to further delays and the escalation of the blame game.

Afterwards, unhappy with the progress of the pilots, the MoH hired in 2004 an external consultant from South Africa to evaluate the situation. His report came with several recommendations both to MoH and HISP team, suggesting that their demands were possible to attain and could be included shortly in an improved version of the software. However, in response, a Belgian consultant working in the MoH responded extremely critically to this report. For example, he wrote in this response:

“My overall impression of the report is similar to my impression of the consultancy done... A lot of statements, theories... suggestions and recommendations. All with the overall aim of selling the Hisp product... nothing seems to be a problem... everything seems to be relatively easy. But what certainly lack’s in the consultant’s approach is rapid response and practical solutions... 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... too much credibility has already been lost. We have to solve our urgent problems first.” (Excerpt from a letter with comments on the consultancy report)

The HISP team addressed their protests, including other interpretations from the occurrences at the time. In parallel, attempted to initiate developments towards introduction of a GIS application [Aanestad et al, 2005]. Despite that, simultaneously the foreign consultant initiated own development of another application, designated Módulo Básico, which afterwards was implemented by the MoH, later in the same year.

“DHIS 1.3 was not adapted to Mozambique... Politics, donors, and the Ministry behind with the ambiguity to decide what system to use... Process of change of DHIS2 started from there, but in 2006-2007 was terminated in Mozambique. (A former project coordinator from HISP)

Technological contradictions in the process of DHIS “technology transfer”

DHIS was developed in South Africa, with both code and interfaces presented in English, requiring extensive translation work to Portuguese. In addition, as Nhampossa [42] describes, the database was initially designed to respond specific purposes of South Africa and were conflicting with expected outcomes in Mozambique. These contradictions came to the fore when the HISP team were entrusted the task of integrating DHIS with the existing SIS-Prog. Some of the key problems included,

*(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” [41]*

*“... **Many of the functions of DHIS were not yet in Portuguese language... a person had to adapt based on the English words, which caused disturbances**” (A former foreign consultant from MoH)*

Despite these technical disturbances, affecting mostly the ones in the data collection and use of the system, the managers at the district level were satisfied with the outcomes on the reporting side. But because there was not a notification to stop the other systems in place, the work load come from the health workers responsible for the data management was increased and contributed to an increased dissatisfaction among them [35]. This had implications on the commitment to use the new system, and in some cases, they did not engage in quality control assuming that it would be a responsibility to the upper levels in the HIS.

Inadequate infrastructure and capacity to support digital health

In general, the existing infrastructural conditions, such as power restrictions, electricity outages, communication limitations, poor transport and road networks, were all not conducive to enable effective implementation of digital systems and their scaling [35, 42].

“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 former PhD student)

“...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. The support should be given ... But they said they went a long time without receiving visits from MISAU...” (A former local master student).

The ministry relied on several sources of funding by external aid. This enabled opportunities for systems development, but also created fragmentation, with different donors supporting specific systems for particular health programs, such as Malaria, HIV and TB. Overall, the country lacked adequate human resources capacity and expertise to provide dedicated technical support in rural settings, with the bulk of capacity concentrated in the country capital [9]. When DHIS was introduced, the MoH had limited in-house capacity, and relied on donor support which often came with divergent agendas from theirs. There was potential to get support from the researchers, but this also was limited.

5. Analysis

In our case study, we described from an historical perspective, the introduction of digital health in a post conflict Mozambique. The MoH is the central institution in the country responsible for the functioning of the health system. Through our case study, we identified three key moments that were responsible for the implementation trajectory of digital health in the period 2000-2007. This is summarized in table 3.

Table 3. Summary of the contradictions identified

Historical moments (Before and during phase 1)	Contradictions
Moment 1 (1992 - 1998): Post-conflict conditions shaping the health systems context	<ul style="list-style-type: none"> - Compromised financial, human, technical resources leads to high levels of external dependencies - Weak institutions to govern digital health, which require new and more proactive institutions
Moment 2 (1998 - 2003): Historically existing inefficiencies in the HIS and supporting institutional arrangements	<ul style="list-style-type: none"> - High levels of fragmented legacy systems driving the need for reform in digital health systems - Demands of new digital health initiatives don't find support from existing context - Divergent interests and power asymmetries, further constrain digital health initiative
Moment 3 (2003 - 2007): Political-institutional context enabling and constraining the DHIS implementation	<ul style="list-style-type: none"> - Multiple stakeholders with poorly aligned and often contradictory interests - MoH provides ambiguous support to DHIS, without clear directives to the sites of pilot implementation - Ambiguity leads to proliferation of multiple systems, heightened the already high workload to field level workers - Contradictions arising from project management, technical and capacity building conditions contribute to the halt of the project - Growth of the doctoral and Masters study programmes

Key moment 1: Post-conflict conditions shaping health system's context

The setting inherited social constraints from the previous armed and political conflicts, that culminated in 1992 with the peace treatment, and the interventions that were attempted to revert the situation. These, were mainly influenced from political and economic situation in place. While the country is adjusting to the new constitution, a Democratic model, where the government is selected by elections, there is a pressure to implement a five-year governance strategic plan. Although, the country is still resenting from the economic crisis that arose in the 80s. The existent limited budget does not provide much space of manoeuvres to advance with new plans before compensating the massive losses in infrastructure and skilled human resources, while at same provide quality services. There was a need to increase partnerships and with that more compromises with the international donors and request for additional aid programs.

In the Health sector in particular, policies and budgets in place did not allow massive hiring for the state. Budgets were mostly directed to support logistic operations and maintain salaries for existing personnel. Although they were facing a shortage in health personnel, for curative interventions and data management, and the dilemma on hiring technical personnel to help with the introduction of new digital systems instead of doctors.

Health programs began to receive funds from international agencies. With each of these, introducing different systems and employing foreign consultants familiar with them to support local interventions on the setting. While some were integrated in the Departments of the MoH others went to work in implementations at Provincial and District levels. Some local health personnel were also employed at different levels through this partnerships and projects supporting the health programs. This contributed to higher levels of external dependencies.

Moreover, while the MoH was working to produce strategic and fundamental documents for the sector, policies for information systems were not a priority. Therefore, they had limited formal instruments to regulate the interventions and institutional arrangements around the introduction of digital health.

Some institutional arrangements in place, like for instance the introduction of training facilities for nurses and health technicians, engagement with the training of medical doctors by local universities, were established and developed, and are still in place nowadays. Others, like the development of the HIS resulted in undesired outcomes, with multiple and rigid vertical Health Programs; fragmentation of systems and centralized use of information.

Key moment 2: Historically existing inefficiencies in HIS and institutional context

Along the years, the accumulation of several contradictions called for urgent action and need for alternative interventions. Although the previous institutional arrangements were still in place, the existing contradictions open space for an opportunity to introduce changes in the setting. The country was in the midst of a transformational period, where the global interventions were converging to common Agendas of Development, and the collaboration South-South was gaining momentum [6; 29]. A new opportunity came with the interest of HISP in introducing a new digital solution in the HIS of the country.

The project designed meet the criteria of the movements at the time, coming as an alternative solution to resolve the inefficiencies and inconsistencies accumulated from the institutional arrangements in place. This initiative included new institutional arrangements: Introduction of capacity building programs reinforced with research; alternative perspectives for collaborative work and mobilization of resources; and a new system with some resources to support it. In addition, it also aimed at developing some existing process and deinstitutionalize others. There were opportunities to standardize and improve data management processes, decentralize managerial functions to Province and District levels, while at same promote empowerment of users of the digital system, empower managers at data use, and appropriation of the system by the MoH.

Despite that, although there were ongoing projects at national level to improve the communication systems (transports and roads), telecommunication and data services, it was still insufficient to extend these resources to provide a significant coverage, they did not reach all the existing districts. The scenario was similar in relation with the introduction of new technologies.

With the initiation of DHIS pilot, new tasks were introduced to a group of health worker that had no experience with computers, had limited data management skills, and were involved also in reporting activities using other systems from different health programs. With the shortages of health workers, the same group of professionals that had been previously trained as nurses and other health technicians, they were assigned other tasks accordingly. They were overload, and it certainly influenced their motivation to learn and to use the new system. Although, there was a partial acceptance of the new digital solution, within the MoH, Provinces and Districts.

Even though, the assumptions of the responsibilities of each intervenient and expectations were not properly aligned. The set of unresolved contradictions was significant, the presence of the multiple actors involved in the process was more visible. The breach between the team was eminent.

Key moment 3: Political-institutional context enabling and constraining DHIS implementation

During the period, the shifts in the government affected the health sector at large extent. There was a new order inside the Health Sector, still aligned with the Developmental Agendas, but with slight shifts in the power structures. These shifts also affected the implementation team, were some members from the MoH were substituted by others that were not involved directly in the previous processes.

The MoH were involved in the pilots, there was an interest to implement the new system to support the implementation of the first strategic plan that was developed after the assessment conducted in 1999. But no formal directive was emitted to stop the existing systems and only focus attention to DHIS. The strategic plan was ready in 2001 and the pressure increased. While the development of the pilots was in place, another system was under development (SIMP) by a foreign consultant and came to be implemented by the MoH in 2002.

Managers at Provincial level, where the pilot was implemented were interested in the new reporting systems, but nor them or the project did not have resources to scale the system to other districts. In addition, the information flow was still the same, the pressure to send the information from the multiple health programs to the upper levels was enormous.

With the introduction of this new system, the already overloaded Health workers experienced increased difficulties to operate with multiple systems at same time, while also experiencing the problems arising from the scarcity of resources to maintain the existing equipment and continue to use the systems.

The software being transferred was in English and the user's working language was Portuguese. There was a pressure to translate, both in terms of configuration and language. The structural differences of the languages raised challenges to adapt the software to the new setting. Also, there was a recommendation from the MoH to integrate this new solution to one that was already in place (SIS-Prog). DHIS database was not adapted to the setting needs at the begging of the pilot and the requirements were difficult to incorporate. The software that was designed with different logics, associated with the translation issues, both in customization and language (English to Portuguese), generated interface and functionalities constraints. All this contributed to delays, disturbances in the use of the system, contributing to the accumulation of contradictions.

The MoH-DIS-Partners partners requests were not completely reflected in the software, requested an assessment, and demanded faster corrective actions. At the time, another development (Módulo Básico) was initiated lead by the foreigner consultant that vocalized the inconsistencies of the new solution, and it was placed to use by the MoH-DIS, despite the ongoing developments in the pilots. The HISP-UEM, had their Action-Research activities ongoing, with some periods of field work in the districts and others associated with the academic programs, they were expecting more involvement from the MoH teams to appropriate the system and compensate their absences in the field, while also expecting a recognition of the research results, but this was not visible.

The Inadequate infrastructure and capacity to support the digital health, resulted in an accumulation of social constraints from the setting that were present since the first historical context. The conditions did not improve significantly, neither to support the ongoing processes nor the scaling intents of the team. The Provinces and Districts, left with the system stopped in the midst of any difficulty, pressure to use several systems and other activities, expecting a support that did not come with the desired frequency, with the absence of formal directives to use on instead of the other, saw their motivation diminished over time.

Despite the scenario described and analysed in this section, it is worth mentioning some of the significant outcomes resulting from phase 1, occurring during the period corresponding to my phase 2 and 3, from 2008 until 2021. Along the following years, the establishment and development of the capacity building initiatives satisfied the correspondent goals of the project. The graduation of 38 master students from Africa and Asia, trained on the International Master offered by UEM-UiO, and the completion of the PhD programs by the Mozambican researchers, was considered a success. These results were also significant to the development and continuity of all the capacity building initiatives established during phase 1.

Furthermore, these graduates played a significant and valuable role in the further development of DHIS to the actual DHIS2, which is currently being used globally and in Mozambique. From 2004 the developments on top of DHIS continued outside Mozambique. The nodes created abroad, in some African and Asian countries, contributed significantly for the changes in the technological artefact. A new version with a significant change, designated DHIS2 was released in 2006, shifting from a standalone to a online operating mode. The potential of this technological artefact as a health information system platform increased and attracted the attention of several countries, including Mozambique.

6. Discussion

First, conceptualizing the setting as an inter-institutional system, influenced by several institutional orders, we noted a set of new orders that we perceive as being common to the setting of LMICs, such as External Aid Policies, Developmental Agenda, Technology innovations but also others that are implicit to the underdevelopment conditionings (like Corruption and Poverty, for instance). We would tag this a note to further investigations on the institutional orders influencing these settings as way to further explore the implications deriving from this.

Secondly, we understand the importance to discuss the different influences from the perspectives of the existing multilevel context, where we identify a multiplicity of actors and organizations at play and being influenced by multisource institutions. As we saw from the analysis, the establishment of new process (institutionalization of the education/training initiatives) in our case succeeded and prevailed in the entire phase 1. Although the social constraints were also present, they did not influence conflicting results sufficient to undermine their continuity.

Thirdly, because we understand that the historical development of the events and processes over the years created opportunities for different types of responses in terms of institutional changes, motivated by different contradictions in place in different moments. Although, the other processes suffered from the accumulation of several contradictions, as we could see emerging from the environment (mostly in moment 1); but also, because of the conflicting interplay between the interconnected levels of the inter-institutional system (mostly in moment 2) and the differences in the logics of actions (mostly in moment 3).

Lastly, because engaging within these debates creates opportunities to explore whether these institutional dynamics contributed or not to changes, and the subsequent implications of the outcomes to the setting. We perceived that the contradictions not well mediated accumulate and may indeed contribute to resist to change (overall implementation of

DHIS was not successful), create opportunities to change (as with the establishment of the training initiatives), generate unintended results (as happened in the case of the institutionalized processes in moment 1).

7. Conclusion

The current study is part of an ongoing project that intends to conduct a research based in a longitudinal case study of the reconstruction of the institutional history of the HIS in Mozambique, over the last twenty years, based in the implementation of a technological artefact designated DHIS2 (District Health Information System version 2). This, to support the analysis of the interplay between technical, institutional, and human factors involved in the process, and its evolution over time. We attempt such an analysis around the efforts to adopt the DHIS2 software by the Ministry of Health in Mozambique since 2000, and subsequent action toward its institutionalization. At this point, we were able to identify four types of institutional pressures playing determinant roles in the implementation of a technological artefact: conflicts, power relations, social actions, and resources. Thus, playing different roles along the time and contributing for changes within the HIS. We believe that a deeper analysis on their institutional dynamics can provide good insights to future implementation processes and help to further understand how they support initiatives while building ownership, self-reliance, and sustainability of implemented technological artefacts, within the LMICs context.

We perceived from the current study that certain interventions may trigger different outcomes and influence the institutional dynamics that take place during an implementation process. These influence both the technological artefact and the setting where the implementation take place, promoting development of technology and practices around the processes of adoption and institutionalization of technological artefacts within an established HIS.

Although an initial contribution lies in the reconstruction of DHIS2 piece of history, helping to build awareness of the evolution of this technological artefact in a specific setting, it generates important insights to a broader spectrum of technological artefacts as well. This is, because we acknowledge the importance of long-term evaluations to gather an overall picture of the different factors triggering processes of change, spanning from user experiences, implications to organizations where they are being implemented and the practices arising around the implementation of the artefact itself. The case shows clearly how certain levels of pressure, arise from different sources within the setting, generating conditions and influencing the processes of adoption and institutionalization of DHIS. It allows us to see how it creates space and provides insights for further developments and adaptation to a multiple settings context. In turn, to enable this continuity of changes over the time, alongside the process a compromise of different interests coming from the field, donors and owners is needed and denoted to be critical.

The current study contributes both with theoretical and practical insights. The theoretical contributions include the discussion of the institutional orders influencing the LMICs analysis and discussions. In practice, we present a rich case study from the introduction of digital health in a post conflict period within a LMIC country. In addition, from this historical analysis and discussion, we contribute with several insights from the perspective of the contradictions, which may emerge triggering opportunities to either change or resist to changes.

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