An Enterprise Architecture Approach for Data Quality Management within Namibian Health Information Systems

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By

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ABSTRACT

A Health information system (HIS) is regarded a key pillar in any healthcare sector. Yet, for many developing countries, challenges with data quality management have affected the adequate use of HIS. Resilient and well-functioning HIS systems contribute to the delivery of high-quality healthcare services, enhanced operational efficiency, informed decision-making, and the advancement of public health systems. Efforts to improve the quality of data in HIS has recently been a research interest in healthcare literature. This study investigates the use of Enterprise Architecture (EA) principles as an approach to data quality management in the context of Namibian Health Information Systems (NHIS). The study focuses on the principles outlined in The Open Group Architectural Framework (TOGAF) EA framework.

This study followed a Grounded Theory Methodology (GTM). The themes from literature and data were used to form a conceptual model. Themes that emerged from the data include governing laws, standardization, data quality assessment and data quality assurance. The findings highlight the use of EA principles in Namibian HIS (NHIS) and showed that the standard out-of-the-box implementation of EA may not be suitable for use within a healthcare setting. The results, however, indicate that EA implementation should be informed by healthcare laws and policies particularly those pertaining to patient privacy. Furthermore, data quality challenges and some of the contextual conditions were discussed in depth and found to be similar to the findings in literature.

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LIST OF ACRONYMS AND ABBREVIATIONS

HIS	Health Information Systems
DQ	Data Quality
NHIS	Namibian HIS
MOHSS	Ministry of Health and Social Services
DHIS	District Health Information System
EPMS	Electronic Patient Monitoring System
EDT	Electronic Dispensing Tool
WHO	World Health Organization
PTRACKER	Prevention of Mother to Child Transmission (PMTCT)
MIMS	Multisectoral Health Information System
E-DEATH	Electronic Death Notification system
E-BIRTH	Electronic Death Notification system
PMIS	Pharmaceutical management information system
LMIS	Low middle-income countries
HMN	Health Metrics Network
NDHIS	National Level District Health Information System
DQA	Data Quality Assessment
RHIS	Routine Health Information System
IS	Information System
GT	Grounded Theory
GTM	Grounded Theory Method

CHAPTER 1: INTRODUCTION

1.1 Background

The quality of data in Health Information Systems (HIS) is a fundamental requirement for a well-functioning public and private healthcare sector (Moyo, 2017). The World Health Organization (WHO) has established that HIS is one of the key components of a health system (Dagnew et al., 2018). HIS is an information system that stores data on clinical operations, administrative, financial, and patient data (Iwelunmor et al., 2015 as cited by Teshnizi et al., 2021). It aims to collect health data supporting health-related decision-making (Shama et al., 2021). As such, the benefits of HIS include better decision-making, financial benefits, and improved patient care quality (Dehnavieh et al., 2019).

Characteristics that govern the reliability of data are regarded as data quality (Thulare et al., 2020). These characteristics include accessibility, accuracy, usefulness, completeness, validity, reliability, timeliness, and confidentiality, according to the World Health Organization (WHO) ((Endriyas et al., 2019). One of the crucial uses of Health Information Systems (HIS) data is ensuring proper decision-making concerning public health (Hamunyela & Nekongo-Nielsen, 2015). Data quality management has been a major challenge for many developing countries despite all efforts to improve data quality. Some of the key challenges include fragmented HIS, which has been identified as negatively impacting the use and efficiency of the system (Mjelva, 2017). Secondly, data collection methods contribute to poor data quality in healthcare HIS (Dehnavieh et al., 2019). This is due to the inconsistency and disorganization of the data collection methods applied. Further emphasis on these challenges will be discussed in detail in chapter two of the paper.

Enterprise Architecture (EA) is a discipline that aligns business interests with information technologies to create an integrated perspective of business processes and IT systems (Dang & Pekkola, 2017). It serves as a representation of an organization's business processes, IT systems, their interrelationships, and their connection to the external environment (Gunawan & Liejaya, 2020). EA provides a framework for streamlining business processes, data management, and technical development to support an integrated

Health Information System (HIS) (Higman et al., 2017). Guided by EA principles, organizations achieve consensus on EA maintenance, development, and implementation, bridging the gap between operations and strategy (Larno et al., 2019). For organizations to achieve targeted architectural outcomes, the implementation of relevant principles is crucial. These principles serve as a guiding framework, ensuring design decisions are strategically directed towards the development of capabilities that align with the desired outcomes (Haki & Legner, 2021). EA Principles are defined as a set of philosophies that provide guidance to the organization's architectural development (Haki et.al., 2021). This study investigates the use of architectural principles from The Open Group Architectural Framework (TOGAF) Enterprise Architecture (EA) for managing data quality in healthcare.

1.2 Problem Statement

Data inaccuracy is one of the key issues related to the weaknesses in HIS (Wright et al., 2017). In Namibia, HIS has been operated through segregated systems across 14 regions, including the primary district HIS (DHIS) (Angula & Dlodlo, 2018). However, limited studies reference the use of EA to improve healthcare system integration in Namibia (Dlodlo & Hamunyela, 2017; Shaanika & Iyamu, 2015). At the same time, several studies point out the deployment challenges of EA in Namibia (Higman et al., 2017; Shaanika & Iyamu, 2018; Adenuga et al., 2015). For example, Shaanika et al., (2015) highlight the challenges of EA implementation in Namibian public healthcare. These include communication, collaboration, organizational culture, skills, and power dynamics. The primary focus of these studies is centered on the challenges associated with the implementation of Enterprise Architecture (EA) frameworks, rather than emphasizing the use of EA principles in the context of data management.

Several studies have highlighted limitations associated with a rigid, out-of-the-box application of Enterprise Architecture (EA) methodologies. (Kotusev, 2018) identifies challenges such as maintaining complex documentation, managing poor-quality documentation, and fostering isolated EA practices that lack integration with broader organizational processes. While the academic literature on EA often explores its value, benefits, and applications, a critical gap exists in understanding its internal workings (Kotusev et al., 2022). Research tends to focus on the external aspects of EA, such as overall

impact and stakeholder viewpoints, neglecting the specific activities and processes involved (Dang & Pekkola, 2017). This necessitates targeted research on how EA principles can be effectively applied in specific sectors including public health.

Therefore, this study focuses on the application of EA principles for managing data quality in healthcare. EA principles act as a bridge between an organization's strategic goals and its operational practices (Dumitriu & Popescu, 2020). In practical terms, these principles serve as guidelines for governing the design and ongoing development of the organization's architectural landscape (Haki & Legner, 2021).

1.3 Research Questions

This study is guided by the main research question and is subdivided into the sub questions listed below.

RQ How do principles of Enterprise Architecture (EA) influence data quality management within Namibian HIS (NHIS)?

- What are the data quality management challenges within NHIS?
- What are the major causes of data quality management challenges within NHIS?
- What are the contextual conditions influencing data quality management within NHIS?
- How do EA principles influence data quality management?
- How can EA principles mitigate data quality management challenges in NHIS?

1.4 Research Objectives

The objective of this research is to examine the use of Enterprise Architecture (EA) principles for managing data quality within the Namibian Health Information System (NHIS). To accomplish this goal, the study aims to identify and analyze the specific EA principles that significantly impact data management practices within the NHIS, while also investigating the underlying challenges inherent in NHIS data management.

This paper is comprised of 5 chapters. Below is a breakdown of each chapter which

outlines the chapter's contribution to the overall project.

Chapter 1 briefly introduces the study's background, including key concepts and the research problem.

Chapter 2 is the literature review. It provides a detailed discussion of the topics highlighted in chapter one as it pertains to the research problem. It also considers the contributions of other authors in the field of study. The chapter contains the theoretical consideration which covers the introduction of the initial conceptual model.

Chapter 3 provides the research methodology. This chapter covers research purpose and philosophical stance, research approach and strategy, a conceptual theoretical model, data collection tools and methods that will be adopted.

Chapter 4 is the findings and analysis chapter which constitutes of the presentation of the research results and discussion of the findings.

Chapter 5 contains the final remarks and draws key conclusions from the findings in chapter four.

Chapter 6 Highlights limitations in the overall study including contributions and suggestions for future studies.

CHAPTER 2: LITERATURE REVIEW

The literature review chapter is structured as follows:

Section 2.1 Describes the phases of literature review

Section 2.2 – 2.4 Highlights health information systems in Namibia

Section 2.5 – Deals with data quality management

Section 2.6 – 2.11 Gives a background of Enterprise architectures (EA) as a discipline and EAs in healthcare

Section 2.12 Includes a proposed initial conceptual model based on the themes discovered in literature.

2.1 Phases of Literature Review

Since the research methodology follows a Grounded Theory (GT) approach the literature will be conducted in three phases as proposed by Thornberg & Dunne (2019). The first phase is the initial literature review which happens before data collection. The second phase involves an ongoing literature review during data collection and analysis whereby the researcher will seek to find themes in the literature that relate to the findings in the data. The final phase involves the researcher seeking to provide a contextual view of the constructed GT with theoretical ideas to compare against the data collected (Thornberg & Dunne, 2019).

2.2 Health Information Systems

Healthcare is the foundation of human wellness and contributes to the economic progression of a nation (Thulare et al., 2020). HIS systems predominantly contain data related to disease surveillance, healthcare personnel, patient encounters, financial systems, commodities, and various other health-related information (Nsaghurwe et al., 2021). Thus, HIS enables better decision-making by providing key roles of communication, compilation, generation, synthesis, and use of data (Alipour & Ahmadi, 2017). The data stored in HIS enables healthcare providers to plan, prioritize resources, and identify gaps. For example, decisions such as the number of medications or the type of vaccinations required in a geographical region are typically driven by data collected from the HIS systems. On the

contrary, poor healthcare delivery is partly imputed to HIS systems that are not up to standard (Iwelunmor et al., 2015; Kagoya et al., 2020).

2.3 Namibian Health Information Systems (NHIS)

Namibia is considered a high middle-income nation with a population of 2.5 million as of November 2022 (Amupanda, 2019). The Namibian population is sparsely disseminated, which means that the quality of health services is limited by the widespread geographical population (Mabirizi et al., 2018). With part of population living in the rural areas, access to adequate healthcare services through digital technology remains one of the major challenges.

The Namibian Health Information System (NHIS) lies under the governance of the Ministry of Health and Social Services (MohSS) (Angula & Dlodlo, 2018). MohSS is currently the primary service provider for public healthcare services (Amukugo et al., 2016). Namibia's healthcare sector comprises of services provided by both public and private providers. MohSS renders public health services on national, regional, and district levels (Nuuyoma & Ashipala, 2020). The current information flow in NHIS is bottom-up approach illustrated in figure 2.1.

Figure 2.1 shows how data flows within the NHIS landscape starting at healthcare facilities, clinics, and health centers. The data then goes to the district level DHIS, which then flows into national and regional level DHIS. At the National DHIS level the data is extracted and used for decision making and policy formulating (Nengomasha et al., 2018). NHIS integrates data from different sources including health administrative records, patient data, population surveys and censuses (Nengomasha et al., 2018).

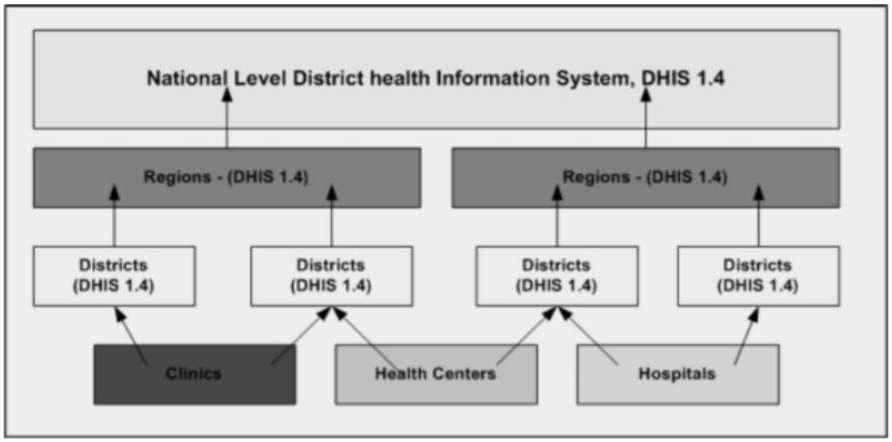

Figure 2.1: Data flow diagram (Source: Kapepo & Yashik, 2018)

2.3.1 Namibian Health Facilities and Centres

Namibia has a total of 433 public health facilities countrywide consisting of health centers, hospitals, regional, district health offices, clinics, voluntary counselling, and testing centers (VCT). Of the 433 health facilities in Figure 2.3, 290 are clinics. The rest includes 27 hospitals, 37 health centers, 3 intermediate hospitals, 14 regional health offices, and 38 district health offices spread across 14 regions country wide. Figure 2.2 shows the structure of all the health facilities by type. According to the most recent statistics from the Ministry of Health and Social Services (MoHSS) Namibia Master Health Facility List (MHSS, 2023), clinics constitute the largest proportion of health centers across the country.

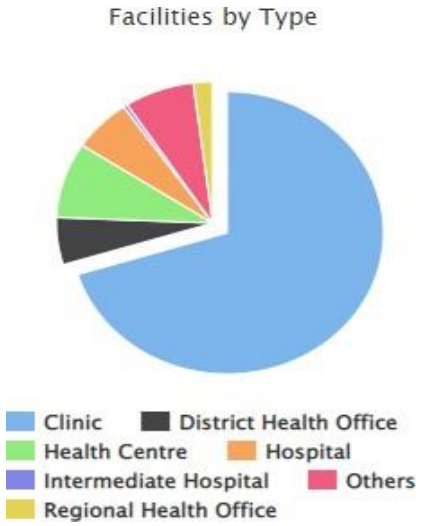

Figure 2.2: Health Facilities by Type (Source: https://mfl.mhss.gov.na/)

Facilities By Type And Ownership

Types	Faith Based Organisation	MOD	NGO	Police	Private	Public_MoHSS	Unsure
Hospital	7	1	0	0	8	27	0
Health Centre	6	0	7	0	10	37	1
Clinic	13	0	112	1	80	290	0
Regional Health Office	0	0	0	0	0	14	0
District Health Office	0	0	0	0	0	38	0
Intermediate Hospital	0	0	0	0	0	3	0
Others	1	0	11	13	2	24	0

Figure 2.3: Health Facilities by Ownership (*Source:* https://mfl.mhss.gov.na/)

2.3.2 NHIS platforms

MohSS has several NHIS systems that were developed in partnership with various international organizations to strengthen the healthcare system in Namibia. For example, ePMS Quantum, PTracker, e-Birth/e-Death were all developed as standalone systems for different projects.

i) ePMS Quantum

The Electronic Patient Monitoring System (ePMS) also known as Quantum was developed with capabilities to support HIV epidemic control by improving data management and reporting (Intrahealth, 2022). MohSS collaborated with IntraHealth international organization to implement the system, one of Namibia's biggest HIV surveillance systems (Mahalie et al., 2022). The system was implemented in 2007 (Corbell et al., 2012). It provides statistics on patient's antiretroviral therapy by gathering data that illustrates highly impacted HIV districts across the country.

ii) District Health Information System (DHIS)

DHIS is open-source system specifically designed to facilitate data integration, analysis, and the dissemination of information (Koumamba et al., 2020). Since the year 2010, an increasing number of countries have embraced the DHIS platform as a valuable tool. Currently, this platform is actively used by 23 organizations and 47 governments across the

globe (Hazel et al., 2018). The use of DHIS has been growing exponentially in Sub-Saharan Africa (Higman et al., 2017). In 2017, Namibia launched its second DHIS system versioned DHIS2 used to report on regional and district level data (Nengomasha et al., 2018). The DHIS2 has various modules used for different purposes within the ministry. These modules include MohSS Aggregate Module, Multisectoral health information management system, Inpatient Module and Covid-19 Vaccination Registry.

iii) Namibia's PTracker

Mother to child transmission has continued to be the main infection cause for HIV in children (Munkhondya et al., 2021). PTracker was implemented in 2002 to support the Prevention of Mother to Child Transmission (PMTCT) program and is used to monitor and record data on HIV infected pregnant women (Mutasa, A., 2017). The PTracker application was developed in partnership with Global Programs to aid Namibia in eradicating the transmission of HIV from mother to child (Global Programs, 2022).

iv) e-Birth / e-Death

E-Birth system is linked to Home Affairs and is used to monitor every new birth in the country. The system allows for generation of a registration numbers used to obtain an official birth certificate (Mutasa & Iyamu, 2022). E-birth system provides timely birth statistics to promote efficient governmental planning, decision-making, and efforts towards reaching Sustainable Development Goals (Shilamba et al., 2022). Similarly, the e-Death system records Namibia's deaths and is linked to Home Affairs.

v) Pharmaceutical management information system (PMIS)

PMIS, a pharmaceutical management information system was implemented to provide timely data to MohSS for the National Antiviral Therapy (ART) program. The system contains integrated information tools such as Facility Electronic Stock card, Electronic Dispensing Tool (EDT), Pharmaceutical Management Information Dashboard and EDT National Database which manages the flow of antiviral therapy data at the national level (Mabirizi et al., 2018). The integrated PMIS system was launched in 2017 in 13 Namibian regions. Since the launch, more hospitals have been introduced to the system. Despite the introduction of the electronic PMIS system, health delivery indicators have remained at

lower rates due to many factors including poor quality data and limited resources (Kibuule et al., 2020).

vi) EDT

The Electronic Dispensing Tool (EDT) is a system that holds patient information and other data necessary for the allocation of medication (Hafner, 2017). EDT manages the disbursing of antiretrovirals drugs at the service delivery points located at different health centers (Mabirizi et al., 2018).

2.4 Contextual conditions impacting NHIS

Within a Namibian context, HIS initiatives and acquisitions are primarily driven by various partners and donors resulting in uncoordinated HIS that are not integrated (Dlodlo & Hamunyela, 2017). Notably so, other conditions impacting data quality in NHIS is the manual or partially electronic patient management systems that is non-standardized and fragmentated which puts a burden on health workers and therefore impacts on quality reporting (Dlodlo & Hamunyela, 2017) The fragmented systems result in the absence of unique patient identification numbers (Nengomasha et al., 2018).

2.5 Data Quality Management

Data serves as a representation of real-world objects, capable of storing, processing, and retrieving information through network communications and software processes (Batini, 2006 as cited in Cichy & Rass, 2019). As the demand for data increases, effective data management becomes crucial for any organization. Data Quality Management (DQM) ensures that collected data meets adequate standards of quality and reliability (Bernardia et al., 2022). Assessing data quality characteristics is crucial in DQM processes (Daneshkohan et al., 2022) which also includes quality assurance, control, and improvement measures (Kaloyanova et al., 2021). The quality of data hinges on various attributes such as usefulness, completeness, validity, legitimacy, accuracy, reliability, accessibility, and confidentiality (Koa et al., 2018). However, data quality management in developing countries faces numerous challenges stemming from low levels of data quality (Alipour & Ahmadi, 2017). Inevitably, public health facilities require data that is on time, complete and accurate to detect any early warning signs of disease outbreaks (Njuguna et al., 2020).

2.5.1 Data Quality Management (DQM) challenges

Data use and quality in high income countries rely heavily on the use of technology and have developed approaches in place to improve data source interoperability (Ben-Assuli et al.,2015; Lemma et al., 2020). Table 2.1 highlights some of the common challenges of data quality in health information systems identified in literature.

Challenges	Source
1) Huge workloads	(Moukénet et al., 2021a)
2) Unavailable data reporting tools	(Moukénet et al., 2021a; Moukénet et al., 2021b; Tilahun et al., 2022) (Njuguna et al., 2020)
3) Paper based HIS systems	(Moukénet et al., 2021a)
4) Shortage of healthcare workers	(Moukénet et al., 2021a; Roomaney et al.,2017)
5) Inconsistent reporting across multiple platforms	(Njuguna et al., 2020)
6) Lack of timely reporting	(Njuguna et al., 2020)
7) Lack of data management standards and policies	(O'Hagan, Marx, Finnegan, Naphini, Ng'ambi, Laija, Wilson, Park, Wachepa, Smith, Gombwa et al., 2017)
8) Lack of leadership commitment	(Tilahun et al., 2022)
9) Poor data use culture	(Kebede et al., 2020)
10) Poor infrastructure	(Taye, 2021)
11) Inadequate skills of healthcare workers on managing the data entry and reporting	(Nengomasha et al., 2018)
12) Fragmented HIS systems	(Higman et al., 2018; Meke I Kapepo &Singh Yashik, 2018)
13) Lack of data reporting consistencies (outliers)	(Maïga et al., 2019a)

Table 2.1: Data Quality challenges

2.5.2 World Health Organization Data Quality Criterion

WHO defines the quality of data with the following 8 criteria of measurement (Endriyas et al., 2019):

1. Accurate / Valid is the extent to which data presented correctly portrays the true nature of the intended purpose or object (Laranjeiro et al., 2015).

2. Reliability relates to the collected data that is consistently accurate (Peer et al., 2022). For the data to be reliable, it should return the same result consistently when collecting, processing and displaying the information (Roomaney et al., 2017)
3. Completeness according to Cichy and Rass (2019) is the "The extent to which data is of sufficient breadth, depth and scope for the task at hand" p.4.
4. Legibility is the extent to which all data that is collected is readable (Roomaney et al., 2017)
5. Timeliness refers to how information is readily available when required and is up to date (Ndegwa, 2015). Timely access to data is vitally important for healthcare accountability and governance (Farnham et al., 2020).
6. Accessibility depends on the degree to which information can be acquired easily (Fadahunsi et al., 2021).
7. Confidentiality guarantees that unauthorised users cannot access data (Salman et al., 2019).
8. Usefulness refers to the data collected being useful to fulfil the mandate for which it was intended and is relevant (Roomaney et al., 2017)

2.5.3 Data Quality Assessments and audits

With the increased need for data driven decision making, improving the quality of HIS data has been a major focus. Data quality assessment (DQA) approaches have been proven to improve data quality in Low Middle-Income Countries (LMIC) (Wagenaar et al., 2017). WHO recommends the regular usage of DQA methods to monitor the performance of HIS (O'Hagan et al., 2017). DQA provides healthcare with the opportunity to collect data and develop a view of the overall data quality by assessing the data quality characteristics (Yourkavitch et al., 2019).

Temporal trend analysis is one of the well-known method of accessing data quality cited by several authors (de Sá Pinheiro et al., 2022; Muñoz-Moreno et al., 2019; Ribeiro et al.,2020). The method was applied to a data quality framework in a study by Kahn et al., (2016) and involves comparing the volume of the data over a certain period against a set value. Another method known as database guidelines involve the process of counting the prevalent occurrence of health records over time to identify missing records or differences in the volume of data (Hall et al., 2012 as cited by Ta & Weng, 2019).

2.5.4 Performance of Routine Information System Management (PRISM)

The PRISM framework was developed with the purpose to evaluate and strengthen Health Information systems (HIS) (Saigí-Rubió et al., 2021).

The framework established that absence of proper standards and data management guidelines contributed to the poor level of data quality (O'Hagan et al., 2017). PRISM framework identified factors that influence data quality in three main categories; technical, organizational, and behavioural factors (Shama et al., 2021). The technical factors mainly include the use of technology in HIS and the level of skills and competency (Lemma et al., 2020). The behavioural factors include the low demand for HIS data and poor motivation from healthcare workers while the factors at organizational level are management, governance, culture, and supervision (Hoxha et al., 2020). PRISM framework does not just provide guidelines for data quality improvement but also provides DQA tools such as the Behavioural Assessment Tool (OBAT) (Nawaz et al., 2020). The OBAT tool can validate behavioural factors that include problem-solving skills and workforce motivation.

2.6 Healthcare frameworks for data management

2.6.1 The Patient Demographic Data Quality framework (PDDQ)

The framework was developed by Office of the National Coordinator for Health Information Technology (ONC) of the United States government in collaboration with Capability Maturity Model Integration (CMMI) Institute. This framework is used by healthcare organizations to measure the patient data management capability (Kofi Osei-Tutu, 2020) and to ensure that the adopted standards or processes are effective for handling duplicate patient data records and improving patient demographic data quality (Gillespie, 2024). Patient demographic data refers to all data attributes that uniquely identifies a patient.

2.6.2 Health Level Seven (HL7)

HL7 is the most widely accepted standard for managing health data interoperability (Abril-Gonzalez et al., 2017). HL7 is an organization that develops standards but is not a standard itself.

These standards and specifications are developed to ensure that information contained in electronic health records is structured and communicated in a coherent manner (Boussadi & Zapletal, 2017). One of HL7's initiatives, Fast Healthcare Interoperability Resources (FHIR), simplifies this data exchange by focusing on reducing complexity while maintaining data accuracy. (Boussadi & Zapletal, 2017; Ayaz et al., 2021).

2.7 Enterprise Architecture

Enterprise Architecture (EA) offers a comprehensive toolbox of methods, frameworks, and techniques to support organizations in information system planning (Kotusev, 2019). A core component of EA is the Enterprise Architecture Framework (EAF), which provides a structured set of methods for designing and maintaining an organization's business processes, information systems, and overall structure (Hadaya et al., 2020). Over the past decades, various EAFs have emerged, including prominent frameworks like the Federal Enterprise Architecture Framework (FEAF), The Open Group Architecture Framework (TOGAF), Zachman Enterprise Framework (ZEF), and the Department of Defence Architecture Framework (DoDAF) (Dumitriu & Popescu, 2020b).

Among these frameworks, TOGAF has demonstrated particular value in the healthcare sector (Girsang & Abimanyu, 2021; Handayani et al., 2019) and has been recognized for its advantages over other EAFs (Xia et al., 2021). A key differentiator of TOGAF is its detailed methodology, the Architecture Development Method (ADM), which guides organizations from their current architectural state to a desired future state (Elmir et al., 2015). TOGAF offers several advantages, including cost reduction and enhanced time management, achieved through the integration of information and technology services within a unified framework (Mayakul et al., 2019). Additionally, TOGAF is credited with fostering superior organizational interoperability and agility compared to other frameworks (Liu et al., 2021).

TOGAF's Architecture Development Method (ADM) provides a clear roadmap for the various phases involved in EA development (Handoko, 2018; Vodyaho & Zhukova, 2014). These structured processes streamline architectural development efforts. They ensure consistency and efficiency in creating architectural artifacts across diverse projects and teams, ultimately promoting interoperability.

2.7.1 Enterprise Architecture (EA) artifacts

EA is formed by documents known as EA artifacts (Kotusev, 2019a). EA artifacts assist organizations in documenting both future and current states of the organization's processes and digital landscape (Bischoff et al., 2014; Kotusev, 2019; van de Wetering et al., 2021). EA artifacts include data flow diagrams, policies, guidelines, network diagrams and business process models (Kotusev et al., 2022).

2.7.2 The Open Group Architecture Framework (TOGAF)

The Open Group Architecture Framework (TOGAF) is the most widely used EA framework (Amalia & Supriadi, 2017). It is an open standard and can be used freely by organizations (de Oliveira et al., 2021). The framework contains four main domains illustrated in Figure 2.4. These domains include the Business Architecture, which describes core business processes, strategies, and governance. The Information Systems Architecture domain contains data and Application Architecture as subsets (Malyzhenkov & Ivanova, 2017).

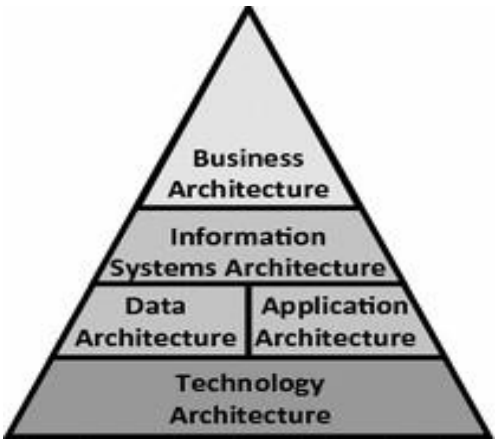

Figure 2.4: TOGAF Architecture (Malyzhenkov & Ivanova, 2017)

Data sources must be centralized and integrated within the data architecture to enable better coordination and accurate data representation (Nama et al., 2017). The application domain, according to TOGAF Open group, describes the structure of applications which provides the necessary business functions and support data assets (TOGAF, 2022). Lastly, the technology domain outlines details on the technical infrastructure of the enterprise (Arman et al., 2018).

2.7.3 TOGAF Architecture Development Method (ADM)

TOGAF Architecture Development Method (ADM) is an iterative process split into 9 phases (Qurratuaini, 2018) illustrated in Figure 2.5. The ADM phases are defined for specific uses (Girsang & Abimanyu, 2021; Kearny et al., 2016; Proença & Borbinha, 2017). ADM begins with the preliminary phase in which the architectural goals are identified, and relevant guidelines are set in place (Proenca & Borbinha, 2017). The preliminary phase provides a base for developing information systems architecture, business, and technology architecture.

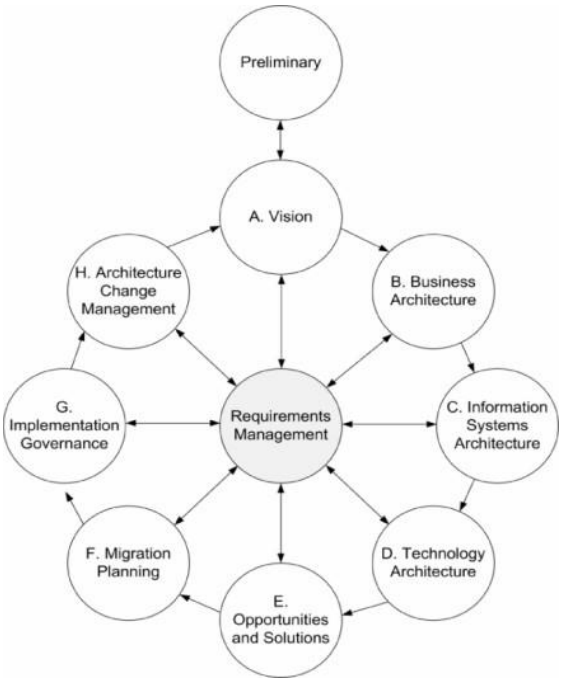

Figure 2.5: TOGAF ADM (Source: Proença & Borbinha, 2017)

- *Architecture Vision* – Sets the tone for ADM stages and defines the elementary stages of ADM including scope, stakeholders involved, necessary approvals and construction of the architectural vision (Darmawan et al., 2020).
- *Business Architecture* – The business architecture is developed following the approved architectural vision (Gebayew & Arman, 2019).
- *Information Systems Architecture* – Includes the Application and Data architectures (Sari et al., 2019).
- *Technology Architecture* – Includes the IT infrastructure which entails the architecture of the technology domain (Azizi & Sumitra, 2019).
- *Opportunities and Solutions* – This phase is concerned with the gaps identified in the previous phases (Girsang & Abimanyu, 2021).
- *Migration Planning* – This phase details the plan for the target architecture. At this stage the plan will highlight the activities from the AS – IS state to the TO - BE state and how that will be implemented (Darmawan et al., 2020).
- *Implementation Governance* – This is the governance phase that provides the necessary controls for delivery of projects (Negara & Emanuel, 2020).
- *Architecture and Change Management* – The change management phase describes the nature of changes and how those changes will impact the organization (Girsang & Abimanyu, 2021).

2.7.4 Data Architecture

Data architecture is part of the TOGAF ADM phase under Information Systems Architecture. Data architecture is not necessarily a logical design or design of physical storage systems but describes data entities significance to the organization (Gebayew & Arman, 2019).

2.8 Enterprise Architecture Principles

Architecture principles regulate the processes impacting enterprise architecture use within an organization (Qurratuaini, 2018). The TOGAF principles found in literature are highlighted in table 2.2with the relevant sources.

EA Principles	**Sources:**
Data Architecture	
Data Accessibility	(Nama et al., Nov 2017; Olavsrud, 2020)
Data is Shared	(Eskaluspita & Sumitra, 2020)
Data Security	(Qurratuaini, 2018) (Noranita et al., 2021)
Data Trustee	(Setiawan & Yulianto, 2018)
Data Asset	(Handayani et al., 2019)
Data Definitions and common language	(Setiawan & Yulianto, 2018) (Olavsrud, 2020)
Application Architecture	
Technology Independence	(Handayani et al., 2019)
Ease of use	(Guntara et al., 2020; Handayani et al., 2019)
Business Architecture	
Position of Intellectual Property	(Negara & Emanuel, 2020)
Compliance with the Law	(Handayani et al., 2019; Noranita et al., 2021)
Business Continuity	(Qurratuaini, 2018; Sofyana & Putera, 2019)
Information Management is everyone's Business	(Negara & Emanuel, 2020)
Technology Architecture	
Requirements Based changes	(Eskaluspita & Sumitra, 2020)
Interoperability	(Qurratuaini, 2018)

Table 2.2: EA Principles

2.9 EA Principles and HIS Data quality standards

High quality health data is required for various reasons including planning, monitoring performance, justifying financial support, and decision making. Table 2.3 displays a correlation between TOGAF 9.2 data principles and the WHO data quality principles.

TOGAF Data Principles and definition (TOGAF, 2021) (Qurratuaini, 2018; Palupi et al., 2018)	**WHO Data Quality Principle Definition** (*World Health Organization*, 2015)
Data Accessibility - Data must be available for users to carry out daily mandates.	***Accessible*** - Data is readily available for official use or patient care (Bloland & Macneil, 2019)
Data is Shared - Data is shared across the institutions and users have timely access to accurate data	***Complete*** - All required data should be available and should include all pertinent documentations ***Timeliness*** – Data is recorded at the observation time (Roomaney et al., 2017; Cheti, 2019)
Data Security - Data must be safeguarded against unauthorized use	***Confidential and security*** - Both are necessary to safeguard patient's data and for legal purposes (Bloland & Macneil, 2019)
Data Trustee - A trustee is responsible for the quality of data including elements such as data accuracy	
Data Asset - Data is valuable to the institution and adds real measurable value aiding in decision making	***Accurate*** - The proximity to the measurement or the actual value of what is intended to be measured (Roomaney et al., 2017) ***Useful*** - Data is used for decision making ***Valid*** – Data is free from systemic errors ***Reliability*** – Data is consistent and coherent (Bloland & Macneil, 2019)
Data Definitions and common language - Common data vocabulary is used across the enterprise	***Legibility*** – Data is readable (Roomaney et al., 2017)

Table 2.3: TOGAF and WHO Data Principles

2.10 EA in Healthcare

Several studies have identified how EA frameworks were applied to HIS. Table 2.4 summarises the studies that have looked at EA in health care.

Author	Title	Points of contribution	Source Databases
(Higman et al., 2017)	Designing interoperable health information systems using Enterprise Architecture approach in resource-limited countries: A literature review	- Data exchange facilitated by EA improves data accuracy and availability by Data comparability - Interoperability - Provides quality healthcare service	ProQuest
(Handayani et al., 2019)	Health Referral Enterprise Architecture Design in Indonesia	- EA implemented for a Health Referral System in Indonesia was based on TOGAF 9. - EA was used to guide healthcare providers and regulators in Indonesia	PubMed
(Putra & Hadiana, 2020)	Designing Enterprise Architecture for Public Health Center Based on TOGAF Architecture Development Method	- TOGAF (ADM) was applied to the Curup Timur Health Center based in Indonesia. - The findings in the study produced an architectural framework for Curup Timur Health Center.	Scopus
(Ajer et al., 2019)	Enterprise Architecture in Hospitals: Resolving Incongruence Issues	- EA handles processes related to data integration and standardization. - EA frameworks show potential in managing challenges in HIS related to siloed systems and poor IT infrastructures. - The findings in the paper suggest various challenges related to EA characteristics in contrast to healthcare domain characteristics that need to be addressed to advance EA use in that setting. - The challenges identified in the study include: Clinical vs System knowledge 1)EA involves process standardization whereby Healthcare would be clinical knowledge-based information 2) EA is focused on Data Integration whereby in healthcare it involves sensitive data which entails patient safety vs patient privacy challenge 3) EA is plan driven whereas in a healthcare setting it would be national strategies.	PubMed

Table 2.4: EA in healthcare

2.11 EA implementation in HIS assessment (Based on Table 2.4)

The studies included in Table 2.4 were specifically selected based on their focus on Enterprise Architecture (EA) use within healthcare systems. Higman et al. (2017) conducted a literature review to identify best practices for applying EA to Health Information Systems (HIS). The primary interest was in understanding EA implementation in resource-constrained countries. However, the review had some limitations. First, it mainly focused on EA as an isolated concept, neglecting the various frameworks and approaches within the broader EA discipline. Second, the review primarily addressed the initial stages of EA implementation, without comprehensively evaluating the outcomes of these initiatives.

The second study, titled "Health Referral Enterprise Architecture Design in Indonesia" by Handayani et al. (2019), focused on the implementation of EA in a health referral system based on the TOGAF framework. This study provided an overview of the business, application, data, and technology principles involved. However, rather than delving into an extensive analysis of the use and adaptation of these principles within the architecture of the HIS referral system, the study offered them as foundational guidelines.

Similar to the research conducted by Higman (2017), Ajer et al. (2019) centered on the establishment of an integrated information system at Curup Timur health center.
However, the study primarily presented a broad methodology for implementing the information systems at Curup health center, without providing an analysis of the outcomes resulting from this implementation. Moreover, the study did not address the specific TOGAF architecture principles that would have guided the development process of the integrated information system.

The primary objective of the last study was to investigate the underlying reasons for the limited adoption of Enterprise Architecture (EA) in the healthcare sector. Through the research, four key areas of conflict between EA requirements and the healthcare domain were identified, necessitating reconciliation. These areas were outlined as follows: 1) Patient safety versus patient privacy, 2) system versus clinical knowledge, 3) bottom-up

versus top-down planning, and 4) global versus local arrangements (Ajer et al., 2019). The study emphasized that the challenges identified were contextualized within the scandinavian healthcare system and may not be universally applicable to all health systems.

2.12 Proposed Initial Conceptual Model

The proposed conceptual model in figure 2.6 draws from TOGAF Enterprise architecture principles and indicates how the enactment of these principles influence the healthcare domain. It incorporates EA principles from the TOGAF Architecture Development Method (ADM), consisting of the business architecture, information systems architecture, and technology architecture domains. Under the information systems architecture is the data architecture and application architecture. The model highlights that these principles have influence on the management of data quality within the Namibian Health Information System (NHIS).

Data quality management (DQM) contains various subcategories including data quality management challenges and mitigation strategies. Contextual conditions includes specific public healthcare challenges that have a direct impact on Data Quality Management (DQM) within the Health Information System (HIS) of Namibia. These challenges, along with underlying causes, are effectively addressed and managed within the framework of DQM, ultimately leading to improved healthcare outcomes.

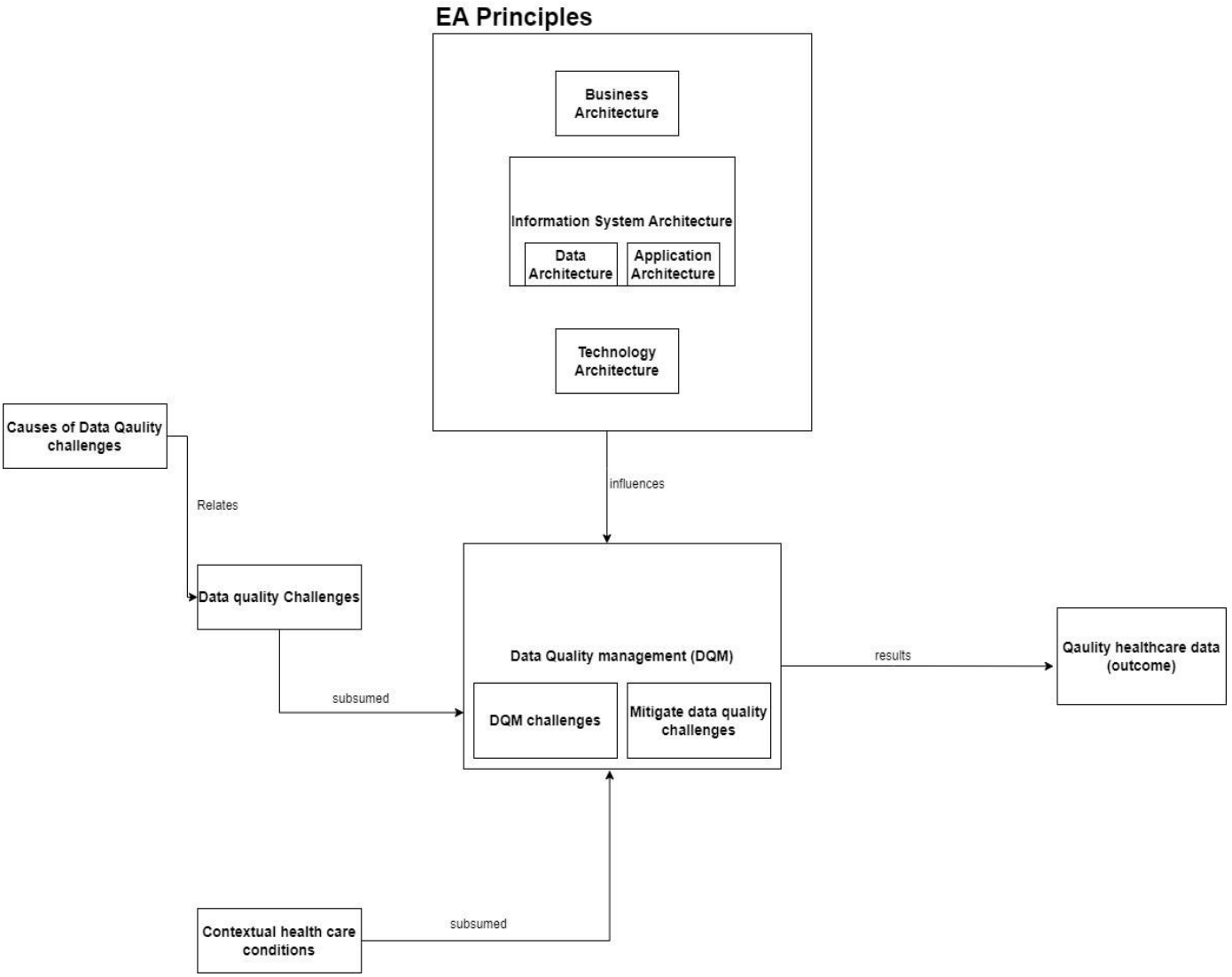

Figure 2.6: Initial conceptual Model

CHAPTER 3: RESEARCH DESIGN

Chapter 3 is subdivided in the following sections:

Section 3.1 Covers the research philosophy of the study

Section 3.2 Includes the research purpose

Section 3.3 Describes the research approach

Section 3.4 Discusses the research strategy

Section 3.5 Describes the research timeline approach

Section 3.6 Discusses the target population

Section 3.7 Discusses the research sample strategy

Section 3.8 Provides an overview of the research instruments used

Section 3.9 Describes the ethics approval process

Section 3.10 Highlights the approach to ensure confidentiality of the participants

Section 3.11 Provides an overview of the overall project deliverables and timelines

Section 3.12 Describes the data collection methods

Section 3.13 Discusses the data analysis steps and approach

Section 3.14 Discusses the reliability and validity approach of the study

3.1 Research Philosophy

A research philosophy refers to beliefs that guide the design and development of a research study (Tamminen & Poucher, 2020). It is what the researcher deems to be truth, knowledge, or reality (Ryan, 2018). The research philosophy considers two philosophical assumptions or paradigms which are ontology and epistemology (Mukhles M. Al- Ababneh, 2020). Ontology refers to the reality element of the philosophy or what currently exist in the real world (Willig, 2019). Ontological philosophical assumptions include realism and relativism. Realist belief that there is only one objective truth whereas relativist focus on the stance that truth is subjective and dependent on individuals (Scotland, 2012). The study aims to examine the influence of EA principles on data management from the subjective experiences of the research participants. Therefore, the study takes a relativist ontological perspective.

Epistemology on the other hand is grounded in knowledge and presents a view of how knowledge is obtained (Al-Ababneh et al., 2020). An epistemological view of the research influences the research methodology selected (O'Connor et al., 2018).

According to Ragab and Arisha (2017), three distinct philosophical paradigms that are commonly employed in research are interpretivism, positivism, and critical theory. Positivism relies on the use of models to predict a plausible outcome that is independent of the researcher's input (Sanchez et al., 2022). Positivist believes that truth should be objective and free from any influence of the researcher's personal beliefs (Ryan, 2018). Critical theory is formed on the idea that knowledge can be derived from a socially constructed reality (Pham, 2018). Critical theorist seeks to find loopholes in social systems with the aim of contributing transformational commentary to the phenomena of study (Rashid et al., 2019). Furthermore, critical research tends to predict or challenge the status quo (Myers & Klein, 2011).

This study adopts an interpretivist approach, aiming to uncover the meaning associated with the use of Enterprise Architecture (EA) for data management. Interpretivism emphasizes the exploration of depth and meaning within the experiences of research subjects (Alharahsheh & Pius, 2020). This approach allows the researcher to delve into the various factors influencing these experiences, including behavioral, cultural, and social

influences (Alharahsheh & Pius, 2020).

3.2 Research Purpose

The research purpose can be interpreted through various methods which are explanatory, descriptive, exploratory, or prescriptive method. Explanatory research is based on an individual's understanding as explanations are prompted by subjective viewpoints (Seidel & Watson, 2020) while descriptive is concerned with presenting an accurate profile of an individual, event, or situation (Mukhles M. Al-Ababneh, 2020). Prescriptive research means that certain variables can be changed or controlled (Seidel & Watson, 2020).
Exploratory aims to uncover new insights (Swedberg, 2020). This research is based on an explanatory approach due to the focus on the subjective views of the research subjects.

3.3 Research Approach

Qualitative analysis can take a deductive or inductive approach (Armat et al., 2018). A deductive approach is when the analysis is based on a theory that already exists (Azungah, 2018). Deductive approach begins with extracting the hypothesis from the theory then testing the hypothesis and finally re-evaluating the theory with the analysis (Woiceshyn & Daellenbach, 2018). This research is based on an inductive approach which involves the observation of a particular area of interest and the development of concepts and theories based on that (Locke, 2007 as cited by Ryder et al., 2019).
Inductive approach is based on the idea that knowledge is derived from neutral observations as opposed to preconceived assumptions (Majeed, 2019). With inductive studies, codes are first identified in the data following a process of constant comparison tocreate themes (Pearse, 2019). The initial conceptual model in this case has been developed from the literature review and has been used to inform the base of the research. Initial conceptual models are used to illustrate the relevance of the study by highlighting the main ideas and the relationships between them (Rocco & Plakhotnik, 2009).

3.4 Research Strategy

Despite significant progress in Namibian health care delivery over the past decade, health indicators remain sub optimal attributed by limited resources and low quality NHIS (Kagoya, H. R. et al., 2020). As a lower-middle-income country with diverse populations and healthcare infrastructure distributed across urban and rural areas, Namibia faces distinct challenges in collecting, storing, and utilizing health data effectively (Kagoya, Harriet Rachel et al., 2020; Karon & Dlodlo, 2017). Understanding how EA can be leveraged to address these challenges in a resource-constrained setting like Namibia can provide valuable insights applicable to similar contexts globally. Therefore, Namibian HIS (NHIS) was selected as an ideal case study for this research.

A case study is a study of a research interest within its physical state (Ebneyamini & Moghadam, 2018). Case studies are generally useful for examining broad and complex research areas that are not properly explored (Keutel et al., 2014). It allows the researcher to focus on the case in the confinement of space and time (Schoch, 2020). The two types of case studies considered are single-case study and multi-case study approaches. In the multi-case study approach, the researcher explores multiple cases to compare and contrast (Gustafsson, 2017).

A single-case strategy selected for this study is based on MohSS as a research focus. To support the case, non-profit organizations such as Global Programs and Intrahealth Namibia were included as partner organizations, offering valuable support and insights.

3.5 Research Time Frame

Selecting an appropriate time frame is a crucial step in the planning process of a research study. The two choices commonly used are longitudinal and cross-sectional time frames. A longitudinal time frame involves the study of a specific subject over a certain period (Aithal, 2022). Due to the limited time and the nature of the study, a cross-sectional timeframe has been deemed appropriate as opposed to the longitudinal one. Cross-sectional studies are conducted at a set time and are considered less expensive and easier

to do (Wang & Cheng, 2020).

3.6 Target Population

The target population for this study comprises employees of MohSS who are directly involved in the use of NHIS, as well as external partners collaborating with MohSS. These partners, as previously mentioned, predominantly consist of donors supporting the diverse NHIS systems.

3.7 Research Sample

Sampling is the process of selecting a portion of population for a specific research purpose (Bhardwaj, 2019). Sampling is a vital step in the research process because it determines the accuracy of the study (Bhardwaj, 2019). In qualitative studies the sample sizes are typically much smaller compared to quantitative studies. The main goal of sampling in qualitative studies is to obtain sufficient participants or observations that provide enough depth to answer the research questions (Gill, 2020).

Various sampling methods and techniques can be considered including probability sampling and non-probability sampling. Probability sampling is a technique used when the probability of selecting each participant is the same whilst non-probability sampling is when selection is purely based on judgment (Sharma, 2017). This study employs a non- probability sampling method because participants were selected based on their individual experiences working with NHIS systems. Non-probability is often used in qualitative case study research (Taherdoost, 2016). The type of non-probability sampling that was applied is purposive sampling. Purposive sampling is when the case or units of study are selected based on the personal judgment of the researcher (Sharma, 2017).

The research sample included 11 employees from MohSS and partner organizations who work directly with the NHIS and their roles are summarized in table 3.1 below:

Job Title	Number of Participants
MIS Officers / Data Captures	4
Hospital Managers	1
Data Analyst / Scientist	1
Data Manager	1
NHIS Project Managers / Coordinators	2
NHIS Infrastructure Manager	1
System Analyst	1

Table 3.1: Participants

3.8 Research Instruments

The research is qualitative in nature. Qualitative research generally aims to seek deeper understanding of the values, beliefs and behaviours of a particular research context (Azungah, 2018). The research instruments used are semi-structured interviews with open-ended questions and documentation. Semi-structured interviews are the widely used methods to collect data in qualitative research studies (Bearman, 2019). The interview questions were informed by the research questions and themes identified in literature.

Interview questions presented in Appendix A were carefully tailored to each participant's specific role to mitigate the potential challenges of participants being unable to address certain questions. The interviews were conducted within a designated time frame ranging from 15 to 45 minutes. Prior to recording each section, explicit consent was sought from every interviewee. The interviews themselves were conducted through various platforms, including Zoom and Microsoft Teams, as well as through face-to-face interactions.

3.9 Ethics

The ethics process in research design is pivotal in identifying any ethical risks that may arise during data collection. Ethical consideration, in this case, followed the following steps; First, the researcher went through the process of Ethics Approval after the research design. The approval was gained from the UCT Ethics in Research Committee. Once the approval was given from UCT Ethics in Research Committee, the researcher then

proceeded to seek approval from MohSS through a formal letter to the Executive Director. After the approval was granted by MohSS to conduct the research, the same process was done for the partnering organizations. The researcher prepared a formal letter to the directors of the organization which included the approval letter from MohSS, an approval letter from the UCT Ethics in Research Committee, and a brief description of the research purpose. Once all the approvals have been granted, the researcher then obtained individually signed approvals from the research participants.

3.10 Confidentiality

All the responses were collected anonymously to protect the identity of the participants.The participants were not required to provide their full names or the organizations represented. The data collected was purely based on the EA data management with no reference to any patient information.

3.11 Project Timeline

Table 3.2 below contains a summary timeline of the project deliverables.

TASK	DUE DATE	STATUS
Research Proposal Presentation	April 2021	Done
Literature Review	June 2021	Done
Research Proposal	July 2021	Done
Research Design	October 2021	Done
Ethics Approval	March 2021	Done
Data Collection	August 2022	Done
Data Analysis	November 2022	Done
Empirical Report Preparation	December 2022	Done
Empirical Report Submission	May 2023	Done

Table 3.2: Project timeline

3.12 Data Collection

The primary source of data collection used for the study is interviews. Interviews are an important component of qualitative research (Roschelle et al., 2018). Data collection and analysis were done concurrently.

3.13 Data Analysis

The data collected was analysed using NVIVO software version 12. The method of analysis is an inductive iterative process of coding based on grounded theory methodology divided into open coding, selective coding, and axial coding (Hoffart, 2000). In qualitative research, a code is described as a word or brief phrase that symbolically represents a concise and/or suggestive attribute for a segment of language-based or visual data (Mohajan & Mohajan, 2022; Wicks, 2017).

Open coding

Open coding is the process of breaking down raw data and identifying key concepts to represent groups of data (Glaser & Strauss, 1967). Open coding is the first step that is carried out in a grounded theory analysis (Williams & Moser, 2019). During the analysis, the concepts are identified and grouped into different categories at a high level (Williams & Moser, 2019). Analysis in open coding involves comparing codes and grouping similar codes. During the open coding stage, researchers have sought to find themes in the data that related to the themes found in the initial literature review.

Axial coding

Axial coding is concerned with forming relationships between concepts and categories identified in the open coding phase (Vollstedt & Rezat, 2019). These relationships between concepts are determined by examining the data through causal conditions, consequences, strategies and intervening conditions (Vollstedt & Rezat, 2019). Causal conditions are defined as events leading to the outcome of the phenomenon (Masood et al., 2020). Intervening conditions impact the strategies while consequences represent the outcome of the action (Vollstedt & Rezat, 2019).

Selective coding

Selective coding is a third level of coding that involves the process of selecting a core category by integrating categories from open and axial coding (Mohajan & Mohajan, 2022). The final stage of coding is the use of core categories to determine a theoretical framework (Corner et al., 2019).

3.14 Data Reliability and Validity

In qualitative studies, reliability and validity show that the researchers have done what they intended to do based on the research purpose (Coleman, 2022). Validity and reliability are considered vital in justifying the quality of research (Vu, 2021).

3.14.1 Reliability

There are many definitions of reliability, however, according to Vu (2021), reliability is the level of consistency in which different observers come to the same conclusion or identify similar outcomes. A qualitative study is considered reliable when there is consistency without bias in the data collected (Gani et al., 2020). There are four strategies proposed by Lincoln & Guba (1985) as cited by Prasad & Rupandehi (2019) to ensure the reliability of qualitative research; 1) Dependability which refers to the consistency of the findings 2) Conformity means that findings are found to be neutral and formed by the respondents and not by researcher biases 3) Transferability (relates to external validity) shows that the same outcomes can be applied in other contexts 4) Credibility (relates to internal validity) refers to the confidence in the accuracy of the findings. All these strategies were considered and applied during the data collection and analysis phase.

To ensure reliability, all participants were approached individually and interviewed separately at different times. The responses collected were the individual's subjective views without outside influence. Interview questions were role-based, for instance, all MIS officers were asked the same questions ensuring that the responses are consistent. Finally, all the interview questions constructed were based on the research questions and supported by relevant findings in the literature.

3.14.2 Validity

Validity refers to a subjective view of an instrument measurement being what it was intended to be (Sileyew, 2019). It aims to indicate the correctness or credibility of the subject of study (Coleman, 2022). Although validity cannot be completely guaranteed, various tools in qualitative studies can be used in validity checking. Some of the tools include respondent validation, mechanical recording, member checking, triangulation, and neutrality (Coleman, 2022). This study adapted validation, mechanical recording, and member checking.

For respondent validation, the researcher confirmed this by doing site visits, contacting the organizations directly, and obtaining contacts of respondents directly from the organization's websites. The mechanical recording method that was applied is through audio and video recording platforms such as Zoom and Microsoft teams. The audios were then transcribed using Otter.ia to ensure that the data collected is verbatim to what was discussed during the interview process. During the data collection, the researcher ensured clarity of responses by seeking further clarification from the interviewees and paraphrasing where the responses were unclear ensuring member checking. Furthermore, the correct sample size also indicates the validity of the study. In this case, the sample size of 11 participants was considered to be relevant to the nature of the study.

CHAPTER 4: ANALYSIS AND FINDINGS

This chapter includes a discussion of the findings and is sub divided according to the following sections.

Section 4.1 Gives a brief description of the overall aim of the chapter and includes the research questions that will be covered.

Section 4.2 Provides an overview of participant profiles.

Section 4.3 Describes the process of analysis including open coding, axial coding and selective coding

Section 4.4 Discusses the findings on the Business architecture

Section 4.5 Discusses the findings on the Application architecture

Section 4.6 Discusses the findings on the Data architecture

Section 4.7 Discusses the findings on the Technology architecture

Section 4.8 Summaries the challenges of DQM into sub themes

Section 4.9 Discusses the causes of DQM challenges

Section 4.10 Provides an overview on the findings of contextual healthcare conditions that influence data quality management

Section 4.11 Discusses findings on the mitigation strategies for DQM challenges

Section 4.12 Discusses the Data Quality Assurance (DQA) theme that emerged from the data

Section 4.13 Discusses healthcare Governing standards and laws

4.1 Research Findings and Discussion

The purpose of this study is to determine the influence of the Enterprise architecture principles in managing the data quality within Namibian HIS systems. The chapter aims to address the research question and the subsequent sub-questions listed below:

RQ How do principles of Enterprise Architecture (EA) influence data quality management within Namibian HIS (NHIS)?

- What are the data quality management challenges within NHIS?
- What are the major causes of data quality management challenges within NHIS?

- What are the contextual conditions influencing data quality management within NHIS?
- How do EA principles influence data quality management?
- How can EA principles mitigate data quality management challenges in NHIS?

This chapter summarizes the research findings with the key themes highlighted to show relevance to the research questions.

4.2 Participant's Profile

The selection of participants for this study was conducted based on their extensive experience and expertise in working with diverse NHIS systems within MohSS. The sample comprised of individuals from both MohSS and private non-profit organizations, ensuring a comprehensive representation of perspectives. Among the 11 participants included in the study, it is worth noting that two participants had been employed in their current roles for less than a year. Furthermore, only four participants have over five years of experience specifically related to working with NHIS, highlighting a varying range of experience levels within the participants.

Although the number of years was not a determinant for the research participants, the researcher, however, considered the number of prior years' experience in a similar role. Therefore, based on the participant's profiles, they were all deemed to be appropriate candidates for the study.

Table 4.1 indicates the role of all the participants and the years of experience.

Interviewee	**Role**	**Experience Level**
Participant 1	Chief Systems Analyst: Health Information Systems	8 years
Participant 2	Management Information Systems Officer	7 years
Participant 3	Health Data Management Information officer	2 years
Participant 4	Chief Systems Administrator	7 years
Participant 5	NHIS and Disease Surveillanceofficer	< 1 year
Participant 6	NHIS Project Coordinator	13 years
Participant 7	NHIS Officer	3 years

Participant 8	NHIS Data Manager	10 years
Participant 9	NHIS Data Scientist	< 1 year
Participant 10	NHIS Officer	1 year and 6 months
Participant 11	NHIS System Analyst	3 years

Table 4.1: Participant Profile

4.3 The process of Analysis

The data was analysed following three steps of open coding, axial coding and selective coding in Figure 4.1.

Figure 4.1: Data Analysis Process

4.3.1 Open Coding

Table 4.2 summarizes all the categories and sub-categories that were identified in the data with associated descriptions.

The first step was to thoroughly read the responses line by line and group the related data into high level categories. Each line of response that related to a specific concept was coded into that category. For example, the categories of EA were identified as business architecture, application architecture, data architecture and technology architecture.
Below those categories of EA, the sub-categories were defined. The other core categories identified are classified as DQM challenges, DQM causes, Contextual healthcare conditions, mitigate data quality challenges, data quality assurance, governing standards, and quality healthcare outcome.

CATEGORY	DESCRIPTION
Business Architecture	Defines the overall business architecture based on current business scenarios using tools such as BPM diagramming, use case diagrams, class models (Sofyana & Putera, 2019)
Business Continuity	Refers to the organization's ability to continue with operations in the case of system disruptions (Anir et al., 2019).
Compliance with Law	The ability of the organization's information management processes to comply with set laws and policies (Haki & Legner, 2021)
Application Architecture	The application architecture provides a guideline on the way applications are developed and their overall interactions with business processes and other applications (Tao et al., 2017)
Ease-of-Use	Aims to create information systems that properly manage the business environment and that are transparent and easy to use for the end users (Marwati, 2022)
Technology Independence	Technology independence means that applications are not dependent on any underlying hardware or software (Walusimbi & Wamema, 2022).
Data Architecture	Defines the data entities used for every business activity (Pasiak & Emanuel, 2021)
Common Vocabulary and Data Definitions	Data classification is consistent, and definitions are understood by all the stakeholders (Kencana et al., 2022)
Data is Accessible	Data is available for users to carry out their daily functions (Matheus et al., 2021)
Data is an Asset	Data adds value to the organization (Kencana et al., 2022)
Data is Shared	Data is distributed accordingly to all stakeholders (Imanudin et al., 2022)
Data Security	Data must be safeguarded from unauthorized use (Kencana et al., 2022)
Data Trustee	There is a trustee accountable for each element of data (TOGAF, 2021)
Technology Architecture	Design of the organization's technology architecture necessary to support the business functions (Sidiq & Sumitra, 2019)
Interoperability	Refers to the ability of multiple information systems to work together to exchange information (ANGULA et al., 2019)
Requirements-Based Change	Changes done are only as a response to a business need (TOGAF, 2021)
Responsive Change Management	The changes are done promptly (TOGAF, 2021)
DQM Challenges	Indicates the main challenges of DQM
DQM causes	Indicates the causes of DQM challenges
Contextual Healthcare conditions	Refers to healthcare conditions that only impact the area of the study.
Mitigate Data Quality Challenges	Refers to the strategies in place to mitigate data quality challenges
Data Quality Assurance	Defined as the process of reviewing data to uncover anomalies and inconsistencies in the data (Karthikeyan & Benjamin, 2019)
Governing Standards and laws	Standards and laws that govern the use and management of data in HIS
Quality Healthcare data Outcome	The positive outcome of quality healthcare data

Table 4.2: Summary of categories and description

4.3.2 Axial Coding

The process of axial coding analysis involved a systematic comparison of categories and subcategories using matrix coding, as depicted in Figure 4.2. The matrix served as a visual representation of the relationships between different codes, with the highlighted cells indicating the specific connections and associations identified within the data. By examining these patterns, similarities within the data were identified and analysed. The darkest shades represented a strong correlation between the codes. Matrix coding in NVIVO has been used by researchers to find reoccurrences in the data that fit a certain criterion (Woods et al., 2016).

	F : Compliance with Law	H : Contextual Healthcare conditions	J : Common Vocabulary and Data Definitions	K : Data is Accessible	L : Data is an Asset	M : Data is Shared	N : Data Security	O : Data Trustee	P : Data Quality Assurance	Q : DQM causes	R : Data Quality Challenges	S : Governing Guidelines and Policies	T : Mitigate Data Quality Challenges	U : Quality healthcare Outcome	Interopera
6 : Compliance with Law	8	0	0	0	0	0	3	0	0	0	0	4	0	0	0
8 : Contextual Health care conditions	0	11	0	0	0	0	0	0	0	0	2	0	2	0	0
9 : Data Architecture	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 : Common Vocabulary and Data Definitions	0	0	8	0	0	0	1	0	0	0	0	0	0	0	0
11 : Data is Accessible	0	0	0	5	0	0	0	0	0	0	1	0	0	0	0
12 : Data is an Asset	0	0	0	0	18	1	0	0	0	0	0	0	0	6	0
13 : Data is Shared	0	0	0	0	1	12	0	0	0	0	0	0	1	0	0
14 : Data Security	3	0	1	0	0	0	17	0	0	0	0	2	0	0	0
15 : Data Trustee	0	0	0	0	0	0	0	27	1	0	0	0	0	0	0
16 : Data Quality Assurance	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0
17 : DQM causes	0	0	0	0	0	0	0	0	0	12	4	0	0	0	1
18 : Data Quality Challenges	0	2	0	1	0	0	0	0	0	4	51	3	1	0	4
19 : Governing Guidelines and Policies	4	0	0	0	0	0	2	0	0	0	3	17	1	0	0
20 : Mitigate Data Quality Challenges	0	2	0	0	0	1	0	0	0	0	1	1	18	0	0
21 : Quality healthcare Outcome	0	0	0	0	6	0	0	0	2	0	0	0	0	7	0
7: Technology Independence	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
23 : Interoperability	0	0	0	0	0	0	0	0	0	1	4	0	0	0	12

Figure 4.2: Matrix Coding

Figure 4.3 represents a high-level view of the way in which all the categories and sub categories are interrelated in the data. The figure represents the correlation of EA principles to data quality management. It also highlights the impact of data quality challenges on data quality management and EA principles.

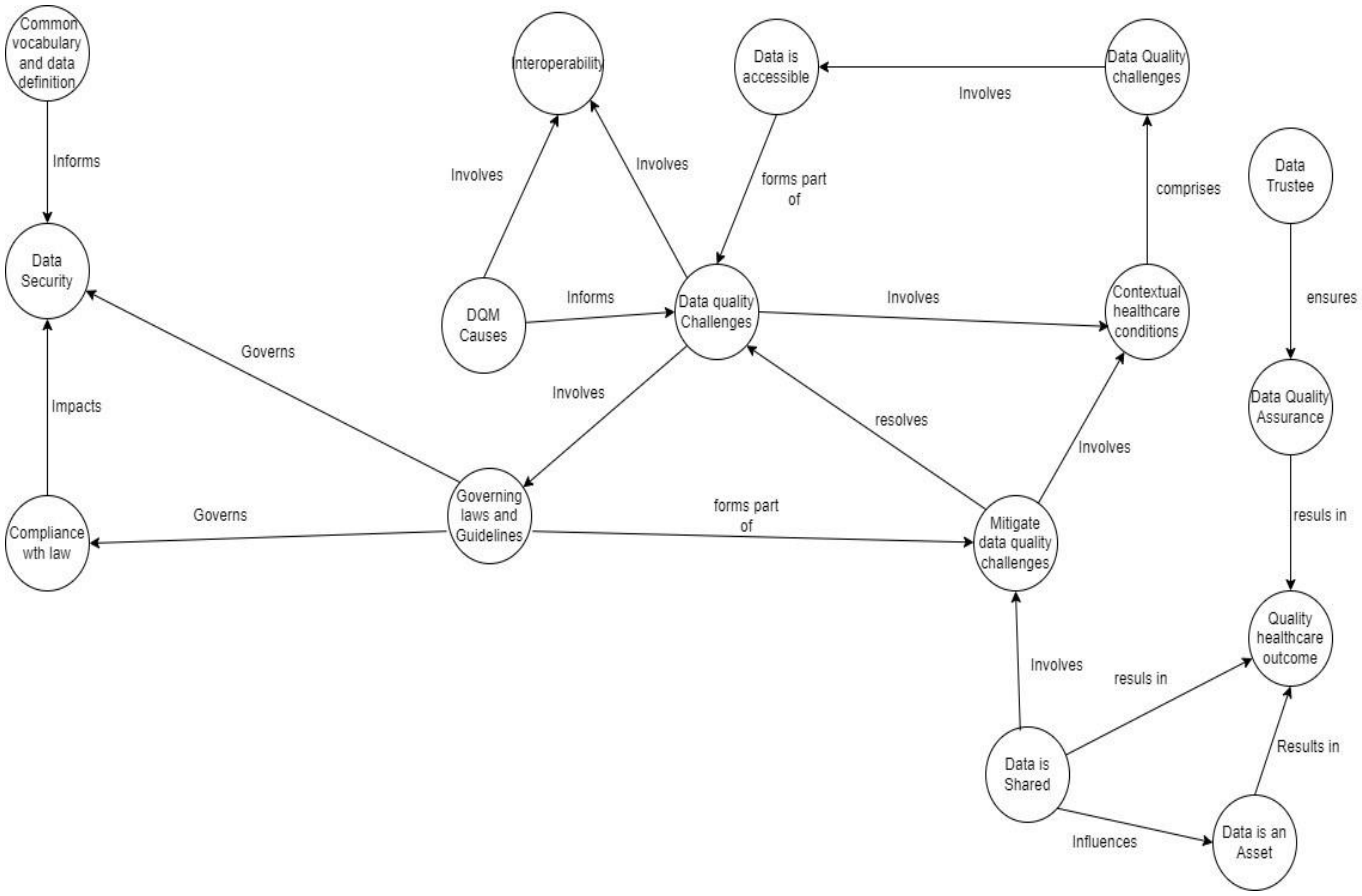

Figure 4.3: Axial relationship diagram

4.3.3 Selective Coding

Selective coding refers to the method of combining categories to form a theory (Williams & Moser, 2019). Table 4.3 summarizes the coding structure for the open codes, axial codes and selective codes following similar structure by Senyo et al., (2022) as cited byGioia et al., (2013).

Open Codes	Axial Coding	Selective Coding
Business Architecture	Business Architecture	Enterprise Architecture
Business Continuity		
Compliance with Law		
Application Architecture	Application Architecture	
Ease-of-Use		
Technology Independence		
Data Architecture	Data Architecture	
Common Vocabulary and Data Definitions		
Data is Accessible		
Data is an Asset		
Data is Shared		
Data Security		
Data Trustee		
Technology Architecture	Technology Architecture	
Interoperability		
Requirements-Based Change		
Responsive Change Management		
DQM Challenges	Data Quality conditions	Data Quality Management
DQM causes		
Mitigate Data Quality Challenges		
Data Quality Assurance	Data quality Assurance	
Contextual Healthcare conditions	Contextual Healthcare conditions	Contextual Healthcare conditions
Quality healthcare outcome	Quality healthcare outcome	Quality healthcare outcome

Table 4.3: GTM Coding structure

4.4 Business Architecture

Outlines the overall business architecture of the organization and include principles of business continuity and compliance with law. It is a vital part of the overall architecture ensuring that the organization meets business objectives.

4.4.1 Business Continuity

The business continuity theme encompasses the organization's resilience in the face of system interruptions, which are due to unplanned and sometimes unforeseen events that disrupt business operations. In the context of the Ministry of Health and Social Services (MohSS), the main DHIS2 application is hosted across two sites. In the event of a failure or disruption at the primary site, a failover is initiated to transfer the DHIS2 application's operation to the secondary site. This failover process ensures the continuity of system functionality and minimizes the impact of system interruptions on business operations.

> *"The ministry itself doesn't have a disaster recovery site but what we do with our systems hosted with the Office of the Prime Minister in cases of shutdowns at the office of the Prime Minister, it redirects to our servers here in the ministry, but that's just a temporary setup. We are working towards implementing a disaster recovery setup for the ministry"* [Participant 1].

> *"System downtime which basically caused by the data server. And the other problem that we have is we don't have proper network because most of the time, we use the Wi Fi connection and it can be off some time which delay our work"* [Participant 1].

4.4.2 Compliance with Law

Information management processes should comply with laws, policies and regulations as it pertains to the collection, synthesis, and analysis of data. The absence of these laws and policies however, causes challenges for the internal MohSS information management processes. Participant 6 highlighted that in situations where there is a lack in health laws

and policies, MohSS formulates supplementary internal guidelines to address the existing gaps.

> *"They are no set laws so we have to implement processes and procedures to cover and make sure that our information management processes do not infringe on patients, or people's rights effectively* [Participant 6].

Participants additionally confirm that the compliance policies currently in place primarily rely on pledges made by healthcare professionals.

> *"When it comes to confidentiality, for example, then it's more based on the oath that they take as health practitioners"* [Participant 1].

The absence of specific governing laws and policies regarding data privacy and security affects operational efficiency in the ministry.

> *"And what slows us down is we don't have laws, specifically for data privacy and security. So what that means is that you constantly have to redevelop specific data sharing agreements, policies and specific SOPs to make sure that we handle the information that we collect or that we work with in in a responsible way* [Participant 1]*."*

4.5 Application Architecture

The application architecture is defined under the information systems architecture within TOGAF ADM model. It covers the organization's application landscape and includes principles such as technology independence. Application architecture plays a pivotal role in guiding the design, development, and management of the organization's applications, ensuring alignment with strategic objectives and promoting effective use oftechnology resources.

4.5.1 Technology Independence

The main DHIS2 is an open-source system and hosted within an open-source environment. DHIS2 exhibits platform independence, as it is developed using Java and can be executed on any platform with Java Runtime Environment support. Embracing technology

independence as a core principle of The Open Group Architecture Framework(TOGAF) stems from the rationale of achieving cost-effective and timely software development, upgrading, and migration. Platform-independent applications facilitate seamless integration with other software systems, including legacy applications, thereby enhancing interoperability and overall system functionality.

> *"DHIS2 is open-source software. All supporting tools that are used are open-source. We use ubuntu for server administration and PostgreSQL for database administration. It is coded in Java programming.* [Participant 1].

4.6 Data Architecture

Data architecture forms part of the Information systems architecture in the TOGAF ADM. A well-defined and responsive data architecture meets data quality standards of accessibility, accuracy, timeliness, usefulness established by WHO for health information systems. The architecture includes principles such as Common vocabulary and data definition, data accessibility, data is shared, data security, data is an asset and data trustee.

4.6.1 Common Vocabulary and Data Definitions

According to several respondents, there is a consensus that common vocabulary and data definitions are widely used and understood within the ministry.

> *"The way we collect our data is program specific. Now the programs have their terms and vocabulary that they use per program or service that they deliver in the health facilities. You will find that there are common terms that are utilized that are understood within the ministry those are guided by each program's guidelines."* [Participant 1].

> *"I'm now talking about metadata vocabulary. Okay, let me talk about field names first. Field names have weird acronyms. if you look at the data, you won't be able to understand and see if this one is an HIV result, because it is not indicated as HIV. There is a use of acronyms to protect the patient just in case these data comes into the wrong hands"* [Participant 9].

The presentation and interpretation of data becomes easier when the language is understood.

> *"Yes, more for casual use. Everyone understands what it means. Simplifies things during data presentation. Everyone understands Indicator definitions. There is also a data dictionary where the indicator is explained"* [Participant 8]

4.6.2 Data is Accessible

In the current structure of the MohSS, data accessibility is regulated and limited to authorized parties. Accessibility levels are divided into the district, regional and national levels. Within each level, access to data is restricted to the respective authorized stakeholders in accordance with their designated level of access.

> *"HIS can be accessed at all levels. But at the district level, we have HIS officers that use the system for data entry as well as data analysis. So upon receipt of the data collection tools from the facilities, they then use DHIS2, to capture the data at the district level."* [Participant 1]

> *The access of regional HIS officer is information at their level, the district level, and the health center and clinic level."* [Participant 2]

Participant 2 expressed that all other access requirements from outside the ministry goes through appropriate approval channels.

> *"If somebody from outside the ministry wants information, you have to go through Ministry of Health head office, because they are the ones to authorize you to access our information."* [Participant 2]

4.6.3 Data is an Asset

Table 4.4 summarizes the responses for the data is an asset principle. The sub themes that emerged from the principle are planning and budgeting, data sharing, timely decision

making, managing disease outbreaks, monitoring and evaluations.

Data Use Characteristics	
Theme	**Sample of response**
Planning and Budgeting	*"The ministry uses it more for budgeting purposes, planning purposes, planning in terms of a campaign that needs to be held for example, then they use that data to forecast where to put most of the resources"* [Participant 1] *" for planning and deploying resources accordingly"* [Participant 5]
Data Access	*"Data sharing, when you have to attend workshops or meetings that require data for the country or for the ministry, we then also access that and use that for different functionalities or purposes."* [Participant 1]
Timely decision making	*"The positive outcome of data quality management is that all the decisions are always made on time if you make sure that your data is correctly entered"* [Participant 10]
Managing Disease outbreaks	*"Ministry of Health uses data to monitor disease trends in cases of outbreaks to devise appropriate interventions"* [Participant 10] *"Give a projection in terms of incidence rates of certain diseases"* [Participant 11]
Monitoring and Evaluation	*"The ministry also uses these HIS data for programme evaluation"* [Participant 5]

Table 4.4: Data Use Characteristics

4.6.4 Data is Shared

The data sharing principle coincides with the data accessibility principle. According to TOGAF, data sharing is concerned with the user's access to timely data to perform their task (TOGAF, 2021). The underlying rationale of this principle is to centralize data storage within a unified platform, typically a data warehouse.

> *"Each project is unique, so if you look at one project it could be dealing only with HIV and HIV prevalence, but the second project would then be on malaria. Each of these projects builds sort of their data system, because there is no commonality between the projects."* [Participant 9]

"Actually, the data warehouse is not there, but there are plans to do so. I think there's a project which is already underway." [Participant 11]

4.6.5 Data Security

MohSS has implemented a range of security measures aimed at safeguarding the system against potential security breaches. A noteworthy measure, as highlighted by participant 1, involves the enforcement of contractual agreements with all contractors. These contracts require strict adherence to the data use policies that have been outlined, thereby ensuring the protection and proper handling of sensitive data.

> *"When it comes to implementing systems, in most cases, we use external stakeholders, donors, consultants, and so forth. Before the implementation, they sign contracts that ensure that they do not utilize any of the information that they have access to during their period of contract for personnel benefits or business benefits"* [Participant 1]

MoHSS has other measures in place such as upgrading security infrastructure, IT security awareness, SSL and VPN, active directory, user roles and profiles summarized in table 4.5.

Security Measure	Sample of Response
Security infrastructure	*"The ministry upgraded the security infrastructure, meaning we put in a firewall, making sure that intrusion protection system, intrusion detection, intrusion prevention system is in place, whereby we monitor the incoming and outgoing traffic within and outside the ministry. We have a firewall antivirus, whereby we'll make sure that every machine is protected. Most security breaches normally come from within the network.* [Participant 4]
User roles and Profiles	*"In terms of the HIS data server itself, it has got security features in it. You need to be authenticated for you to be able to access the system. And there are user roles and profiles"* [Participant 4]
IT Security Awareness	*The ministry puts emphases on security awareness, sometimes we send out communication, talk to the users, educate users on security issues that we can face within the Ministry."* [Participant 4]
SSL and VPN	*"We normally use SSL and virtual private network communication for us to make sure that we are securely accessing the system"* [Participant 4]
Active Directory	*"Our Active Directory does the job whereby we know which users accessing what. So you need to have that authorization to access the network or the system"* [Participant 4]

Table 4.5: Data Security

4.6.6 Data Trustee

Based on the overall feedback from the participants, the findings show that there is no role assigned in MohSS to ensure data quality. The responsibility for data quality assurance is instead distributed across various levels of data management. Nonetheless, one participant mentioned that the MohSS is currently engaged in the incorporation of draft guidelines that have distinct roles, including data collector, data owner, and data controller, which are regarded as the custodians of data. This initiative signifies a step toward establishing clear roles and responsibilities to uphold data quality standards within the MohSS.

"At the district level, we have HIS offices, but our HIS officers are nurses. Regional level, we also have HMIS officers, they've managed the districts within their region. And in that case, all aspects of data quality, they're responsible for it

for their region. At national level in HIS, regardless of your role, you are also responsible for data quality management" [Participant 1]

"The data controller which is the government needs to make sure that the policies and procedures are in place and are being followed. The data owner has the responsibility of making sure it gets implemented. They have to notify the controller if there are any breaches and so forth. The data collector also has a responsibility in ensuring that good quality data is being collected." [Participant 6]

4.7 Technology Architecture

Technology architecture is necessary to support the business operations of organizations. The principles included in the technology architecture are Responsive Change Management, Requirements-based changes and Interoperability.

4.7.1 Responsive Change Management

The findings indicated that response to change management is often slow, due to the lack of effective communication and coordination between frontline healthcare workers and IT change management.

"Sometimes they would just implement the change, they would put people on a new regimen or new treatment, and forget to tell the IT people that listen, this is a new change." [Participant 6]

4.7.2 Requirements-Based changes

Based on the feedback from the participants, it is apparent that changes within NHIS are primarily driven from a patient-centered approach, with the overarching goal of improving patient care. In addition, the integration of emerging technologies and the adherence to global standards also foster transformative changes within the system.

"You can customize the system according to your business processes. And in terms of technology or IT, as we grow with technology, some things change." [Participant 1]

"So obviously when a treatment regimen comes out, that directly changes people's outcomes, the quality of care, then that will be a key driver of change. So for health, it will be patient care. If it leads to improved patient care, better patient outcomes, it is must be the key driver" [Participant 6]

4.7.3 Interoperability

Participant 11 expressed grievances regarding the integration challenges faced by MohSS. These observations shed light on the significant issue of limited interoperability within the NHIS landscape.

"Lack of interoperability because our system in the health is also not linked" [Participant 7]

"Alright, to be honestly speaking, it's so sad because TB and HIV, these programmes some how they will always borrow a certain component from one another. Because you may find a baby that have got HIV or that has TB. There is supposed to be link among each programme but the integration is really poor" [Participant 11]

4.8 DQM Challenges

Table 4.6 presents a concise overview of the challenges pertaining to Data Quality Management (DQM) that emerged from the interviews. The primary theme identified within the collected data revolves around the timeliness of data reporting. Participants voiced concerns regarding the impact of delayed data reporting on data quality.
Analysis of the responses revealed several factors contributing to this issue includes high workload, system downtime, and human resource-related issues. Moreover, other recurrent themes include the incompleteness of data, data inaccuracy resulting from human errors or

training deficiencies, and duplicate data due to absence of unique identifiers. Finally, among the prominent themes discussed by multiple participants, the lack of standards and laws emerged as a significant concern.

Theme	Sample of response
Timeliness	*"We have issues with the timeliness of data"* [Participant 1]
Completeness	*"completeness of data in terms of submission"* [Participant 1]
Outliers	*"When you look at the trend of the performance of the data over time, you'll find that there are certain times when you have lower variables and sometimes higher variables"* [Participant 1]
Poor infrastructures	*"System downtime which is caused by the overworked data server" We don't have a proper network because most of the time, we use the Wi-Fi connection and it can be off sometimes"* [Participant 10]
Understaffed	*"The challenges in regard to data quality in the hospital is a shortage of staff, that only one person overloaded by a lot of work"* [Participant 2]
Guidelines and Policies	*"We don't have a proper guideline that you can say look for HIS in Namibia or for the hospital we have this policy or guideline that we can follow to maintain or to make sure that our data is well managed"* [Participant 2]
Inaccurate reporting	*"Inaccurate reporting or inaccurate data*" [Participant 4]
Design of the data collection tools	*"having too many open-ended questions"* [Participant 6]
Training	*"I think lack of training, very often you have people using health information systems, but they have not had training, there is no up-to-date user manuals available"* [Participant 6]
Paper-based data collection	*"Namibian context, we have very much a paper-based data collection model that we are following still."* [Participant 6]
Interoperability	*"lack of interoperability, because our systems are not linked. Every project might be using different systems and lack of interoperability might lead to that"* [Participant 7]
Lack of standards	*"Definitely the number one is the lack of standards, there is no standard for data collection for patient demographics"* [Participant 6]
Duplicate data	*"Need a unique identifier that links the patient to all the points of care. Currently, when you go to a different location they give you a different ID which leads to Duplication"* [Participant 8]
Data Anomalies	*"Anomalies in the data caused by undefined business rules"* [Participant 8]
Lack of data dictionaries	*"The challenge is also a lack of data dictionaries"* [Participant 8]
Silo systems	*"Challenges that we have been experiencing with projects is that there are different projects. And each of these projects has their own standalone system for capturing data"* [Participant 9]

Table 4.6: DQM challenges

4.9 Causes of DQM challenges

The findings of the study reveal similarities between the challenges expressed by the participants and the underlying causes. Some of the sub themes found in the causes of DQM challenges include siloed systems, untrained staff, network challenges, IT resource constraints and human errors.

4.9.1 Siloed systems

According to responses, the presence of siloed systems contributes to the lack of interoperability within the NHIS. This is often due to the diverse nature of projects, which are often funded by different donors with their own distinct objectives and priorities.

> *"It's different every project might be using different systems"*
> [Participant 7]

> *"I think that could be the cause of each of these projects, building sort of their own data system, and having their own data and because there is no commonality between the projects"* [Participant 9]

4.9.2 Untrained staff

Participant 6 expressed that the lack of training leads to inaccurate data entry.

> *"Then also, I think lack of training, very often you have people using health information systems, but they have not had training, there is no up to date user manuals available"* [Participant 6]

4.9.3 Network challenges

Insufficient network connectivity, particularly in remote regions, emerged as a significant contributing factor to the challenges encountered in data quality. Participant 10 confirmed this observation, highlighting the limited Wi-Fi connection in those areas.

"We don't have a proper network because most of the time, we use the Wi-Fi connection and it can be off sometimes" [Participant 10]

4.9.4 IT resource constraints

The findings of the study indicate that the main DHIS2 system is currently experiencing resource constraints, leading to performance limitations such as slow responsiveness. These constraints stem from the resource-intensive nature of the data being captured and processed within the system.

"What is happening now currently is that the server itself now is under pressure. And then resource intensive, especially the data that has been captured, be it COVID related data that has been captured" [Participant 4]

4.9.5 Unique identifiers

Both participant 11 and participant 8 agreed that the issue of duplicate data arises from the absence of unique identifiers within the system. The participant 8 provided examples where patients receiving treatment at different locations are assigned unique identities due to the absence of data integration within the ministry. Consequently, each patient ends up with multiple profiles based on their location or type of treatment received.

"Duplicate data, which is mainly caused by the lack of unique identifier, which is doesn't exist within the Ministry" [Participant 11]

"The lack of unique identifiers for example patient moves from point A to point B point of care. Then B to C. As a data person, you need to tell the story. Treatment of point A to Point B and medication etc. If patient is missing on the different points of care this leads to data inaccuracy" [Participant 8]

4.9.6 Bureaucracy

Participant 8 has identified a significant factor contributing to the challenges associated

with data quality, namely, the bureaucratic nature of approval processes involved in data sharing. This bureaucratic framework leads to a prolonged process of change management.

> *"Bottlenecks in data. Approvals levels. Requesting data. Getting data out. Ministry may take a while for certain changes to happen"* [Participant 8]

4.10 Contextual Health care conditions

The contextual healthcare themes that have emerged include remotely located health centres, patient care over data collection, paper-based data collection and donor influence.

4.10.1 Remotely located Health centres

Namibia has more clinics than any other health facilities as evidenced in Figure 2.3 on page 18. Majority of these clinics are situated in geographically remote regions with limited access to reliable internet connectivity. Furthermore, the research findings confirm that health centers located in remote areas are often understaffed, thereby influencing the accuracy of the collected data.

> *"One of our biggest challenges in Namibia is that the first point of care or point of entry into the health system is typically at a clinic. And some clinics are very far and very remote, they can also be very understaffed, so you literally might just have one nurse there, and one administrative person."* [Participant 6].

4.10.2 Patient care priority over data collection

The prioritization of patient care over data collection represents an additional factor influencing data management, as emphasized by participant 6. This prevailing theme bears implications for the accuracy of collected data, due to the use of paper-based processes for data collection in most clinics. As a result, healthcare professionals responsible for patient care overlook the efficient collection of data in attending to patients' needs.

"So in terms of the context, for a person that presents at that clinic, it might be if the person is very sick, the nurse has to spend all of her time to just tend to that person and she might not have time to correctly collect the data and patient demographic information. She might not have time to do a proper data collection to get the history of the patient. She will come and complete paperwork at the end of the day, which then means she has to rely on her own memory." [Participant 6]

4.10.3 Paper-based data collection

The use of paper-based tools for data entry results in data collection officers exclusively entering aggregated data into the system, thereby influencing the interpretation of the data.

"*there's a lot of paper-based entry of data. These paper records then get collected at the end of every week by the data collection officers, and these offices then capture only aggregated data. So they combine, tally the data then enter into the system to say that we've received, say, 20 women between the ages of 15 to 20 years, so you won't exactly know how many 15 year olds, how many 16 year olds"* [Participant 9].

4.10.4 Donor influence

Donors play a pivotal role in bolstering the healthcare system. Nonetheless, the prevailing situation within the NHIS is characterized by diverse donor organizations funding distinct projects. For instance, donors may finance specific initiatives like combating malaria, thereby developing an isolated system for its implementation without adequately considering the potential ramifications on existing processes and integration with existing systems.

"*Donors influence how data management processes should run because they fund the project which does not always align with internal processes."* [Participant 8]

4.11 Mitigate Data Quality Challenges

The participants noted different mitigation strategies for data quality challenges. The sub themes identified as such include a technical work group, design of proper guidelines, data quality assessments, digitization and infrastructure upgrades.

4.11.1 Technical Working Group

The findings uncover the establishment of a technical work group functioning as a committee responsible for addressing interoperability matters within the MohSS. According to the input received from participant 1, the work group is presently in its preliminary stages and has not been fully implemented.

> *"We are aware that we have an issue with integration in the ministry so we came up with a technical working group that was initially meant to control or manage any system that comes within the ministry."*
> [Participant 1]

4.11.2 Guidelines

Apart from the technical work group, the ministry has guidelines that inform stakeholders developing NHIS systems to adhere to the integration guidelines.

> *"We also have a guideline, we inform stakeholders that if a system is to be developed within the Ministry, it needs to talk to DHIS2, and it needs to be integrated into DHIS2."* [Participant 1]

4.11.3 Data Quality assessment

The data undergoes a series of data quality assessment stages, commencing at the district level, where NHIS officers examine the data for attributes such as completeness, timeliness,and accuracy. Subsequently, the data proceeds to the regional and national levels, where further data quality assessments are conducted. These assessments take place at both the national and

regional levels, ensuring a comprehensive evaluation of the data quality.

> *"Provide monthly feedback at the national level, we assess the timeliness, completeness, and so forth of the data every month"* [Participant 1]

> *"Data is actually being verified at about three or four different levels. Each facility validates their data at the facility level, and also at a district level. This is also done at the regional level, because they do host what we call a regional review, where districts within a region comes together and validate their data.*
> *And then after it has been verified in the region, it's then sent to the national level for further validation"* [Participant 11]

4.11.4 Digitization

The ministry is currently in the process of digitizing the manual data collection tools at the facility level.

> *"The issue is more because data is still manual from the facility level. So we are in the process of digitalizing. We want to digitalize data entry at the facility level"* [Participant 1]

4.11.5 Infrastructure upgrades

The ministry is actively exploring the possibility of upgrading the hardware of the main DHIS2 host server as a potential solution to address the resource constraints it currently faces.

"So what we are currently busy with is sourcing another entirely new server with more memory and processor power, so that we do not havethese constraints." [Participant 4]

4.12 Data Quality Assurance (DQA)

Data quality assurance emerged as a prominent theme in the collected data, indicating its significance within the context of the MohSS. Multiple participants confirmed the existence of data quality assurance (DQA) processes implemented to ensure accurate and validated data.

> *"Data has to go through six steps of data quality assurance, whereby we check the accuracy, precision, completeness, relevance, validity, and then the ability to be understood."* [Participant 3]

DQA theme was covered by over 80% of the overall responses as indicated in Figure 4.4 and therefore identified as an emerging theme.

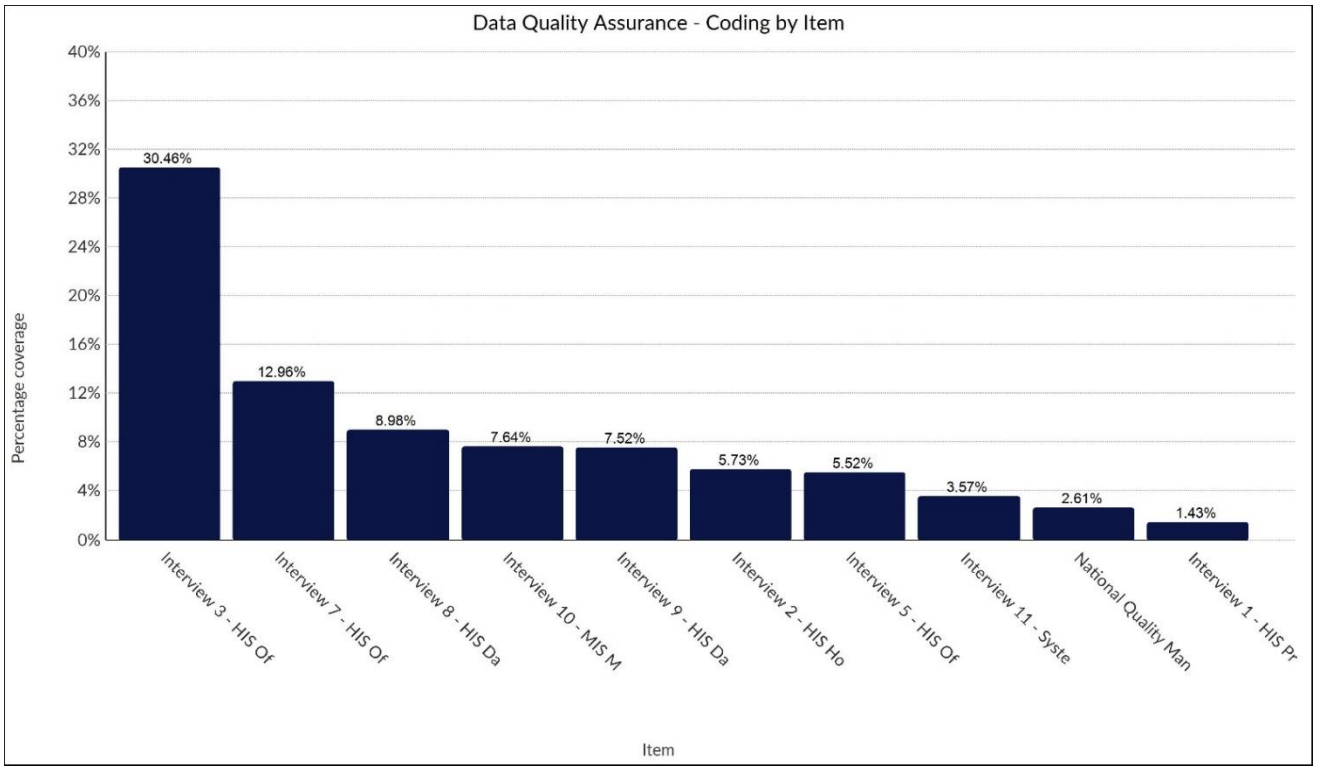

Figure 4.4: Data Quality Assurance coverage

4.12.1 Data Verification

Based on the responses provided by the participants, MohSS has established processes for data verification. Data verification procedure occurs during the data collection stage,

wherein healthcare workers validate the collected data before entering it into the system.

> *"We check also for completeness, before we enter into the DHIS2 system, you have to check for incompleteness. And you make sure that all forms that you are receiving are signed to indicate that they were checked by a supervisor and everything is in line."* [Participant 2]

> *"Data monitoring where we get people from the region, they come and confirm our data that is on paper and the one that we have in the system corresponds."* [Participant 10]

4.12.2 Data Cleaning

Once the data is entered into the system, the health workers do regular data cleaning excises to ensure that the data entered into the system corresponds with the data that is onthe paper records.

> *"We do data cleaning every end of the month we harmonize especially mortality data whereby the wards come with their daily census and we'll compare what is in their registers with what is in the system."* [Participant 2]

4.12.3 Data Review

The ministry has regular data review workshops to validate the data collected over a certain period.

> *"We conduct regular data review meetings to review all the data that is captured in the system for a particular period in the clinic and validate against certain variables, do some analysis as well going back to the to the paper tools that are utilized to collect the data and correcting where necessary,"* [Participant 1]*"Data is managed by doing data quality assessment during data review meetings, verification before entering the data on the system and also data auditing which may also include validity checks by the system."* [Participant 5]

4.12.4 Final data cleaning on ETL

Data on the system goes through a data cleaning procedure whereby any junk data that is flagged by the system is removed from the database.

> *"Yes, we have a data cleaning process on our ETL. Our team sets up automated business rules that censor records that need to be corrected on data correction sheets. Once these records are reviewed and flagged for deletion; the data manager then deletes the junk data from the system."* [Participant 8]

4.13 Data governing standards and laws

Another theme that has emerged from the data is the governing laws and standards for health information management. Several participants expressed their concerns regarding the absence of established standards and laws governing the collection, assessment, and dissemination of data. According to one participant, the lack of these standards has a profound impact on data quality within the healthcare system.

> *"Definitely, the number one is the lack of standards, there is no standard for data collection. No set standard in how Date of Birth would be collected across multiple systems for example"* [Participant 6]

> *"But in terms of standard, even though there is some standard, they are not really well implemented"* [Participant 11]

Responses show that this theme was covered by 4 out of 11 participants. Overall coverage of participant 6 is over 12% while the other participants briefly mentioned this theme on a coverage of less than 2%.

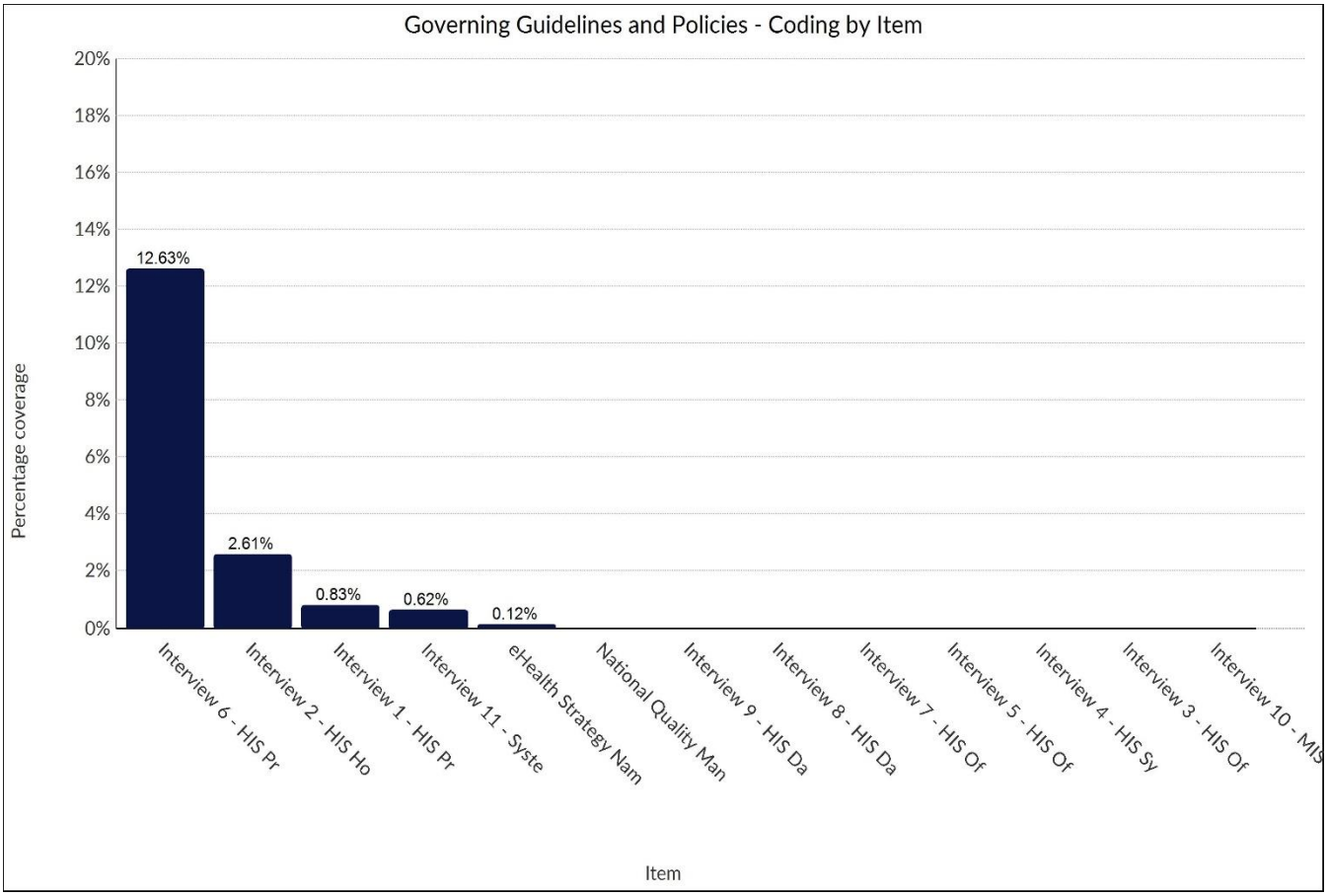

Figure 4.5: Data governance standards and laws

4.14 Quality Healthcare Outcome

Based on the findings, a significant number of respondents emphasized the role of quality data in facilitating informed decision-making by key stakeholders within the Namibian health system. Participants highlighted that accurate and reliable data will enable decision makers to make well-informed choices that positively impact various aspects of the health system. Furthermore, it was noted that data-driven decision making, facilitated by data quality, is essential for enhancing health service delivery and overall healthcare outcomes in Namibia.

> *"Improved healthcare service delivery"* [Participant 1]

> *"So it really helps in terms of making decisions as to even when the Ministry has to buy medications, obviously, they have to make use of those data."* [Participant 11]

"Minister of Health use data to monitor disease trends in cases of outbreaks in devise appropriate interventions" [Participant 5]

CHAPTER 5: DISCUSSION

This chapter will discuss the research findings from chapter 4 as it relates to the research questions and the conceptual model.

The following sections will cover the research questions structured below:

Section 5.1 Enterprise Architecture addresses the following research questions:
RQ How do principles of Enterprise Architecture (EA) influence data quality management within Namibian HIS (NHIS)?

- How do EA principles influence data quality management?
- How can EA principles mitigate data quality management challenges NHIS?

Section 5.2
Data Quality Management addresses the following research questions:

- What are the data quality management challenges within NHIS?
- What are the major causes of data quality management challenges within NHIS?

Section 5.3

- What are the contextual conditions influencing data quality management within NHIS?

Section 5.4 Discusses the Emerged theme of Data quality assurance
Section 5.5 Discusses findings on Governing Laws and Standards as a key factor in NHIS data management
Section 5.7 Looks at the Revised Conceptual model that has been reworked according to the themes gathered from data collected.

5.1 Enterprise Architecture

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5.1.1 Business Architecture

The principles discussed under the business architecture theme include business continuity and compliance with law.

Business continuity refers to the ability of organization to manage system downtimes without impacting business operations. Downtimes can be as a result of software or hardware failures, system maintenance, power failures, network failures and many other causes (Roush et al., 2021). Reliability is key in Health Information Systems (HIS) as it serves as the foundation for making informed decisions related to healthcare. The findings of this study underscore the significant impact of inadequate business continuity planning. Although the main DHIS system currently has standby instance in place, the ministry has not made provisions for a dedicated disaster recovery site. The absence of a disaster recovery plan poses challenges to ensuring consistent and uninterrupted access to reliable data. Disaster recovery assures the recovery of critical systems to ensure normal business operations (Mendonja et al., 2019). Furthermore, according to Biru et al., (2022), HIS systems can be advanced with business continuity capability.

MohSS has however initiated plans to establish a disaster recovery site as an integral component of its business continuity management plan. This strategic undertaking reflects the ministry's approach towards ensuring uninterrupted operations and safeguarding critical health data in the event of unforeseen disruptions.

Compliance with law theme is concerned with the organization’s compliance with set laws, regulations, and policies (Haki & Legner, 2021). This study revealed a notable gap in laws and standards governing the management of HIS data in Namibia. Consequently, the enforcement of policies related to data security and data sharing has encountered challenges due to the absence of a legal framework at the national level. In the absence of specific legislation, the current approach involves the development of

guidelines aimed at managing data quality. These guidelines serve as a substitute for formal regulations and provide a basis for ensuring adherence to established standards and best practices in data management within the healthcare sector. Participants expressed concern in the processes of redeveloping data sharing agreements and Standard Operating Procedures (SOPs), emphasizing that such activities slow down the internal information management processes. The need for renegotiation and revision of data sharing agreements and SOPs not only imposes administrative burdens but also hampers the efficiency and timeliness of information exchange among stakeholders.

5.1.2 Information Systems Architecture

i) Data Architecture

The data architecture principles that were presented include Data is an Asset, Data is Shared, Data is Accessible, Data Trustee, Common Vocabulary and Data Definitions and Data Security.

Data is an Asset principle focuses on data being a value generating asset for the organization (Camatti et al., 2020). The study confirmed that data is an asset for NHIS and used for various functions including planning and budgeting, data sharing with decision makers, timely decision making, managing disease outbreaks as well as monitoring and evaluation purposes. This result is backed by several authors who have stated that appropriate data use provides better health quality care (Askar et al., 2017; Malakoane et al., 2020; Platt & Kardia, 2015; Reynolds et al., 2022; Wong et al., 2019).

Data is Shared Data is shared focuses on the mechanism that enable readily accessible data such a data warehouse implementation. Based on the findings, it is evident that the majority of NHIS systems operate as standalone entities, lacking automated data sharing capabilities. This situation is in contrast to the principle of data sharing, as highlighted by Ajer et al. (2019), who argue that the sensitive nature of healthcare data contained in HIS systems may present challenges for data sharing. Nonetheless, it is important to recognize that the establishment laws and standards regulating data sharing and usage in Namibia can serve as essential guidelines for ensuring appropriate and secure data sharing procedures.

Data is Accessible principle findings show that the ministry has processes in place for data accessibility. These findings align with those in Kapepo & Yashik (2018),that highlight the data accessibility structure in MohSS. The structure has three layers of access from the district level, regional and national level. At each level, only authorized personnel have access to the data. All the access requirements from outside MohSS requires signed approval from the Executive Directors office. This indicates that data in NHIS is readily available for the users to perform their functions at each level of access.

Data Trustee The study confirms that there is no single person assigned for the management of data quality. The ownership of this responsibility lays in the different phases of data handling starting from data collection, data entry to data processing. Thus, data trustee principle does not apply to the NHIS environment.

Common Vocabulary and Data Definitions The common vocabulary and data definitions principle serves different purposes and is understood by all the relevant stakeholders in MohSS. This principle facilitates data sharing by establishing a shared understanding of the language. Evidence from the study suggests a strong link between common vocabulary and data security theme. This connection gives rise to the causal condition that can be summarized as follows: common vocabulary and data definitions protects patient privacy.

Data Security principle outlines the practises in place to safe guide information management processes (Palupi & Surosa, 2018). Security breaches in HIS can put the patient's privacy and wellbeing at risk (Al-Marsy et al., 2021). MohSS has put measures in place to protect the main DHIS system against security threats. These measures include upgrade of IT security infrastructures, SSL and VPN implementation, user roles and profiles, IT security awareness and active directory.

i) Applications Architecture

Technology independence shows that main DHIS2 system does not relay on any underlying hardware and software. DHIS2 is an open-source application that is developed in Java language. This observation aligns with a comparable study conducted by Gebreslassie et al., (2020). According TOGAF (2021), technology or platform-independent applications offers enhanced interoperability with existing legacy applications. This advantage holds significant implications for data management within the NHIS, particularly in addressing the challenges associated with data integration that have been previously discussed.

5.1.3 Technology Architecture

Responsive change management The findings of the study reveal that NHIS processes are not responsive to change management. For instance, when a new treatment is introduced, the current practice entails doctors manually documenting the treatment on the patient's profile without communicating this update to the NHIS data collectors. As a result, these changes are only noticed and implemented when the data collectors specifically request the IT department to make the necessary adjustments in the system. This approach directly affects the quality of data as it leads to a slowdown in data processing and compromises timeliness.

Interoperability, according to the feedback, it is evident that there is a lack of interoperability among the various NHIS systems. In developing countries such as Namibia, the underutilization of HIS is common due to fragmented information creation and storage (V. Garises & J. Quenum, 2018).

This can be attributed to the fact that many of these systems are donated by international organizations and are developed as standalone solutions. The absence of interoperability or integration among these systems

has significant implications for data quality, primarily due to the occurrence of duplicate records. For instance, a patient who receives treatment at one healthcare facility (Location A) may subsequently receive a different treatment at another facility, yet the records are not synchronized. This discrepancy directly impacts the quality of care provided to the patient. Nonetheless, several frameworks exist that deal with interoperability in healthcare such as Health Level 7 (HL7) (Cardoso et al., 2018).

5.2 Data Quality Management

5.2.1 DQM challenges and causes

DQM challenges and causes has been combined under one theme due to the overlapping similarities in the responses. The challenges identified in the study have been corroborated by the existing literature, as outlined in Table 5.1.

Themes	**Literature reference**
Timeliness	(Njuguna et al., 2020)
Incompleteness	(Begum et al., 2020)
Outliers	(Kagoya et al., 2020; Maïga et al., 2019b)
Poor infrastructures	(Taye, 2021)
Understaffed	(Moukénet et al., 2021a; Roomaney et al., 2017)
Lack Guidelines and Policies	(D'Costa & Sinha, 2018)
Inaccurate reporting	(Maïga et al., 2019b)
Design of the data collection tools	(Moukénet et al., 2021a; Moukénet et al., 2021b; Tilahun et al., 2022) (Njuguna et al., 2020)
Lack of Training	(Nengomasha et al., 2018)
Paper-based data collection	(Moukénet et al., 2021a)
Lack Interoperability	(Kaplan, 2020)
Lack of standards	(O'Hagan et al., 2017)
Duplicate data	(Cresswell et al., 2017)
Data Anomalies	(OLANIYAN & OWOSENI, 2022)
Lack of data dictionaries	(Kirkendall et al., 2019)
Silo systems	(Higman et al., 2018; Meke I Kapepo & Singh Yashik, 2018)

Table 5.1: DQM challenges

5.2.2 Mitigation strategies for DQ challenges

The participants in the study have offered several mitigation strategies in response to the challenges encountered in Data Quality (DQ) management which include:

- Technical work groups or communities (for NHIS advisory and solutions)
- Development of proper guidelines and enforcing adherence to the guidelines
- Data Quality Assessments
- Digitization
- IT infrastructure upgrades

5.3 Contextual healthcare conditions

Several contextual healthcare conditions were identified within NHIS. Firstly, the presence of remotely located health centers that often suffer from staffing shortages and inadequate internet connectivity. The scarcity of healthcare facilities and staff has an impact on the economic growth of developing nations like Namibia (Iyamu, 2021). Insufficient or non-existent internet connection renders the system offline, thereby preventing data capturers from effectively collecting data. Consequently, this situation gives rise to challenges in timely data reporting, ultimatelycompromising the quality and timeliness of the data.

Secondly, the findings highlight that healthcare workers primarily prioritize patient care, which often results in the neglect of data collection responsibilities. This tendency to prioritize patient care over data collection contributes to data inaccuracies and inconsistencies.

Lastly, a significant contextual challenge identified is the influence of donors on data management processes. Donors play a pivotal role in the implementation NHIS and their funding support for various projects may introduce initiatives that conflict with other donors or the existing business processes of MohSS. Furthermore, the absence of standardized guidelines results in donors implementing projects without adhering to established procedures.

5.4 Data Quality Assurance

Data Quality (DQ) assurance is a fundamental part of data quality management. The Namibian Health census considers quality assurance as an important component in healthcare provision because it ensures quality of care by identifying potential issues in data management and determines mechanisms to address them (Nengomasha et al., 2018c).

HIS data quality is assessed on validity, timeliness, completeness, and accuracy (Kagoya et al., 2020). DQ assurance involves the process of validating data to find anomalies and cleaning the data (Boadu et al., 2021). Several sub-themes pertaining to Data Quality (DQ) assurance have been identified, namely data verification, data cleaning, data review,and final data cleaning ETL (Extract, Transform, Load). It is important to note that these steps are not standardized and may vary depending on the specific program. Each program has its distinct processes and approaches for managing data quality. Participants from MohSS confirmed that quality assurance activities occur at various stages throughout the data life cycle. Moreover, implementing data quality assurance measures at each level, starting from data collection, holds the potential to enhance the overall quality of data and minimize inconsistencies (Kagoya et al., 2020c).

5.5 Governing Laws and Standardization

The outcome of the findings as it pertains to laws and standards is that there is a lack of standardization in the data collection, storage, compilation, synthesis, and analysis of data. The findings of this study are consistent with previous research conducted by O'Hagan et al., (2017), which involved a review of 23 countries using the PRISM framework. The review revealed that a lack of standards and data management procedures resulted in low data quality across the assessed countries.

Moreover, the theme of Governing laws and standardization was found to be associated with EA principles such as Compliance with Law and Data Security, as depicted in Figure 4.2 pg 37 of the matrix coding. These results collectively indicate that the governing laws and standardization theme significantly influence the aforementioned EA principles.

5.6 Revised conceptual model developed

The revised conceptual model incorporates three domains of Enterprise Architecture (EA) ADM that significantly impact data quality management. These domains consist of the principles of technology architecture, principles of information systems architecture, and principles of business architecture. As illustrated, the principles of technology architecture and data architecture play a vital role in addressing data quality challenges and underlying causes.

The challenges and causes related to data quality include various contextual conditions, giving rise to the theme of governing laws and standards. Governing laws and standards oversee both the principles of data architecture and principles of business architecture. Additionally, the model emphasizes a key domain centered on the principles of data architecture, which directly impacts the processes of data quality assurance and ultimately contributes to the attainment of high-quality healthcare outcomes. The diagram further illustrates the link between effective data quality assurance processes and improved healthcare
outcomes.

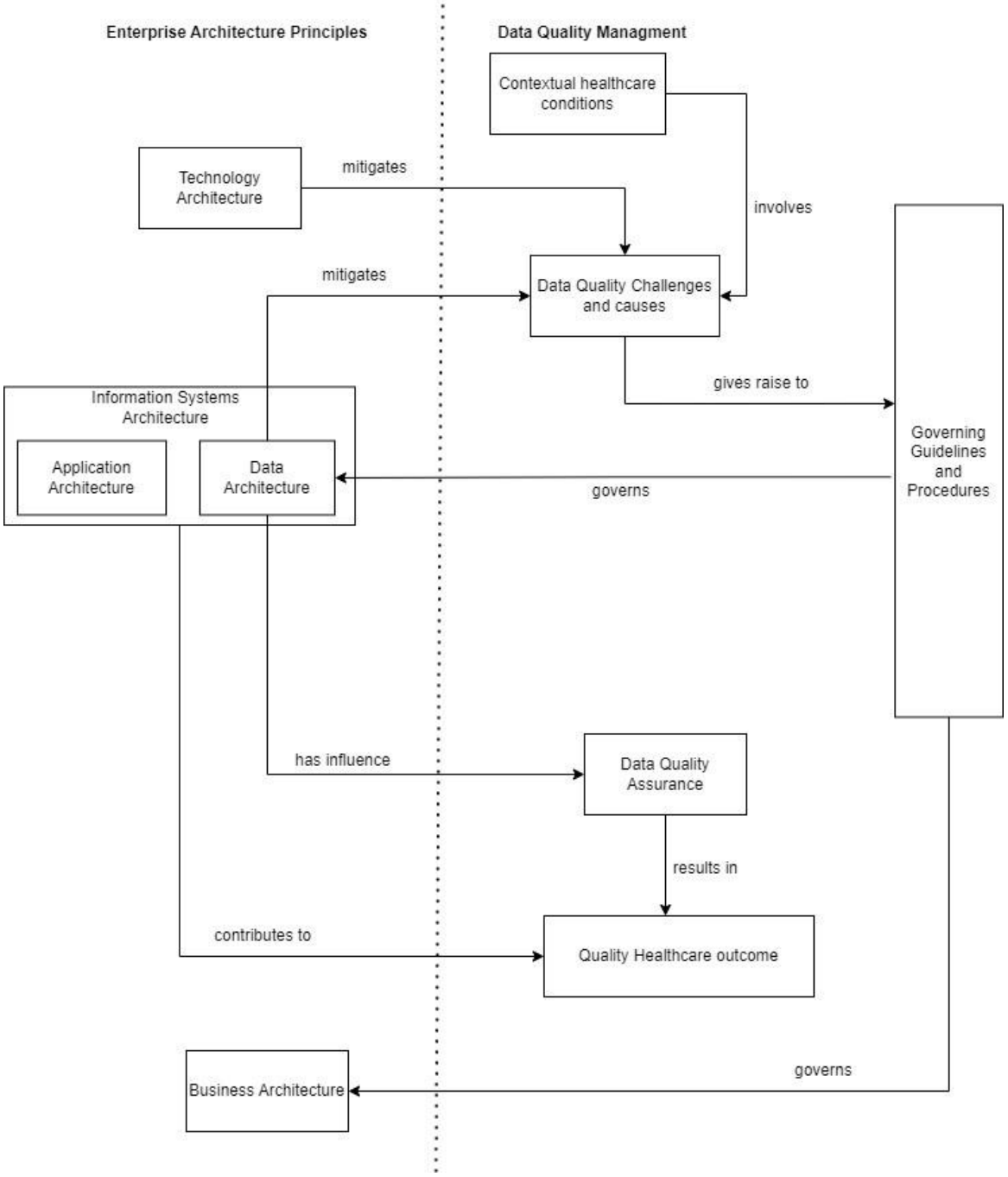

Figure 5.1: Revised conceptual model

CHAPTER 6: CONCLUSIONS

This chapter highlights the overall research findings and draws conclusions from the findings.

Section 6.1 Gives a brief summary of the research findings

Section 6.2 Highlights the theoretical contributions

Section 6.3 Discusses the practical implications of the study

Section 6.4 Highlights the limitations of this study

Section 6.5 Recommends grounds for future studies based on the findings of this study

6.1 Revisiting research questions

The following research questions and sub questions have been covered in chapter 5 and a brief summary of these questions is covered in this section.

RQ How do principles of Enterprise Architecture (EA) influence data quality management within Namibian HIS (NHIS)?

The findings in this research reveal that the main EA principles that influence data quality management include principles of information system architecture, principles of technology architecture and principles of business architecture as covered in chapter 5.

Sub Question 1

- **What are the data quality management challenges within NHIS?**

  The challenges identified in this study are supported by the existing literature. Among these challenges, the issue of timeliness of data emerges as a recurring theme throughout the data analysis. Furthermore, incomplete data poses a significant challenge, which can be attributed to factors such as limited human resources. Additionally, challenges related to data outliers, inadequate infrastructure, absence of guidelines and policies, lack of interoperability, and duplicate data resulting from interoperability issues were also observed.

Sub Question 2

- **What are the major causes of data quality management challenges within NHIS?**

  The findings of the study indicate that the primary causes of challenges in data quality management include a range of factors, such as inadequate infrastructure, insufficient training, absence of comprehensive guidelines and policies, limited interoperability, absence of standardized practices, and the lack of well-defined data dictionaries, among other contributing factors.

Sub Question 3

- **What are the contextual conditions influencing data quality management within NHIS?**

  From the research findings it was observed that there are three main contextual conditions that impact the quality of data management in NHIS. These conditions are:

  1) The remotely located health centres that are usually understaffed and have poor internet connectivity.
  2) Neglect of proper data collection by healthcare workers due to the healthcare worker's primary responsibility of patient care.
  3) Donor influence on the data management processes.

Sub Question 4

- **How do EA principles influence data quality management?**

  Based on the findings, EA principles that impact data quality management are principles of technology architecture and principles of data architecture. The technology architecture principles mitigate data quality management challenges through proper interoperable systems and change management procedures.

  Evidence from the study show that the NHIS systems are not interoperable and there are no proper change management procedures in place which negatively impact the quality of data. Furthermore, principles of data architecture mitigate

data quality management challenges through various ways including the data sharing, data security procedures and adherence, data use, and data definitions. Data architecture principles influences data assurance processes and is submerged within data quality management.

Sub Question 5

How can EA principles mitigate data quality management challenges in NHIS?

The mitigation strategies found in the study are summarized as:

- Technical work groups or communities (for NHIS advisory and solutions)
- Development of proper guidelines and enforcing adherence to the guidelines
- Data Quality Assessments
- Digitization
- IT infrastructure upgrades

6.2 Theoretical Contributions

The theoretical contribution of this study is grounded in both the empirical research outcomes and the extensive literature review. The study makes several noteworthy contributions. Firstly, it presents a comprehensive conceptual model that highlights relationship between Enterprise Architecture (EA) principles and data quality management in HIS. This model serves as a valuable framework for understanding and analysing the interplay between these two domains. Secondly, the study highlights the significance of principles related to data architecture and technology architecture in effectively addressing data quality challenges within the context of NHIS. These principles serve as key pillars for mitigating issues pertaining to data quality. Lastly, the research emphasizes the critical role of guidelines and policies in governing the implementation and adherence to EA principles for establishing a robust framework for managing healthcare data of high quality. Collectively, these contributions enhance understanding of the complex dynamics underlying data quality management in NHIS and offer insights for designing effective strategies and frameworks.

6.3 Practical Implications

The practical implications for which this study can be applied are:

- EA principles fit for use should be assessed within a particular healthcare setting based on internal business processes, external influences and contextual conditions. This tailored approach ensures that the selected EA principles align with the specific requirements and characteristics of the organization, maximizing their effectiveness and relevance.
- Governing standards and policies should guide the implementation of EA principles. These guidelines and policies serve as valuable resources for ensuring consistency and coherence.
- Implementing EA principles as standalone without an understanding of the entire organizational and business landscape would not achieve the desired outcome. A holistic perspective, considering the interconnections and dependencies between different aspects of the organization, is essential for the successful integration and realization of the benefits associated with EA principles. By adhering to these practical implications, healthcare organizations can enhance their decision-making processes, optimize resource allocation, and achieve improved outcomes in line with their strategic objectives.

6.4 Limitations

The following limitations have been identified:

- Certain aspects of the EA principles may not apply for healthcare sector due to laws surrounding data sharing and data privacy
- The full scope EA has not been considered for this study
- The research sample have limited knowledge of EA frameworks
- The study has been conducted only in Namibia. The findings may not apply to other geographical regions.
- Only TOGAF framework was considered for this study.
- The principles considered serve as guidelines only and not methodologies

6.5 Future research

One of the avenues that future researchers could look into is the evaluation of data quality assurance (DQA) procedures for HIS and their effectiveness in data quality. Whilst there are current processes in place for DQA specifically in NHIS, the data quality challenges that have been identified are similar to those found in many other countries. Researchers could investigate a standardization framework for data collection, storage, synthesis and analysis considering the laws that govern the use of healthcare data contextually.

Lastly, researchers should consider the extent to which EA can be implemented in HIS considering the full scope of such an implementation. It is crucial for researchers to explore the feasibility and extent of Enterprise Architecture (EA) implementation in HIS, considering the entire scope that includes architectural vision, business architecture planning, information systems architecture, technology architecture, opportunities and solutions, migration planning, implementation governance, as well as architecture and change management. By directing research efforts toward these avenues, scholars can contribute to the advancement of knowledge in data quality management, facilitate the establishment of robust frameworks for HIS, and promote effective use of EA principles in healthcare settings.

References

Ajer, A. K. S., Hustad, E., & Vassilakopoulou, P. (2019). Enterprise Architecture in Hospitals: Resolving Incongruence Issues. *Studies in Health Technology and Informatics, 264*, 659-663. 10.3233/SHTI190305

Alipour, J., & Ahmadi, M. (2017). *Dimensions and assessment methods of data quality in health information systems Electronic Medical record adoption View project Survey and Explanation of Information Management of Computerized Nursing Information Systems View project*10.19193/0393-6384_2017_2_047

Amukugo, H. J., Shatilwe, J. T., Justus, H., & Namibia, A. (2016). *The factors affecting the implementation of succession planning in the ministry of health and social services (mohss), namibia the factors affecting the implementation of succession planning in the ministry of health and social services (mohss), namibia*

Angula, n., dlodlo, n., & mtshali, p. Q. (May 2019). (May 2019). Enabling Semantic Interoperability of Crowdsourced Disease Surveillance Data for Namibia Through a Health-Standards-Based Approach. Paper presented at the 1-9. 10.23919/ISTAFRICA.2019.8764830 https://ieeexplore.ieee.org/document/8764830

Anir, H., Fredj, M., & Kassou, M. (2019). Towards an approach for integrating business continuity management into enterprise architecture. *International Journal of Computer Science & Information Technology (IJCSIT) Vol, 11*

Armat, M. R., Assarroudi, A., Rad, M., Sharifi, H., & Heydari, A. (2018). Inductive and deductive: Ambiguous labels in qualitative content analysis. *The Qualitative Report, 23*(1), 219-221.

Alharahsheh, H. H., & Pius, A. (2020). A review of key paradigms: Positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences, 2*(3), 39-43.

Alipour, J., & Ahmadi, M. (2017). *Dimensions and assessment methods of data quality in health information systems Electronic Medical record adoption View project Survey and Explanation of Information Management of Computerized Nursing Information Systems View project*10.19193/0393-6384_2017_2_047

Al-Marsy, A., Chaudhary, P., & Rodger, J. A. (2021). A model for examining challenges and opportunities in use of cloud computing for health information systems. *Applied System Innovation, 4*(1), 15.

Amalia, E., & Supriadi, H. (2017). *Articles you may be interested in Design of information systems for population data collection based on client-server at Bagolovillage AIP Conference*

Arman, A. A., Ruhman, G., & Hurriyati, R. (2018). Design of EA Development Guideline for Small Enterprises Based on TOGAF 9.1. Paper presented at the *Information Systems Architecture and Technology: Proceedings of 38th International Conference on Information Systems Architecture and Technology – ISAT 20*, 210-219.

Askar, A., Ardakani, M., & Majdzade, R. (2017). Bridging gaps in health information systems: a case study from Somaliland, Somalia. *Eastern Mediterranean Health Journal, 23*(11), 764-773. 10.26719/2017.23.11.764

Azizi, L., & Sumitra, I. D. (2019). Designing of Enterprise Architecture for Interior Furniture Production Based on TOGAF 9.1. *IOP Conference Series. Materials Science and Engineering, 662*(4), 42026. 10.1088/1757-899X/662/4/042026

Azungah, T. (2018). *Qualitative research: deductive and inductive approaches to data analysis*. Emerald. 10.1108/qrj-d-18-00035

Bai, L., Meredith, R., & Burstein, F. (2018). A data quality framework, method and tools for managing data quality in a health care setting: an action case study. *Journal of Decision Systems, 27*, 1-11. 10.1080/12460125.2018.1460161

Bearman, M. (2019). Eliciting rich data: A practical approach to writing semi-structured interview schedules. *Focus on Health Professional Education: A Multi-Disciplinary Journal, 20*(3), 1-11.

Begum, T., Khan, S. M., Adamou, B., Ferdous, J., Parvez, M. M., Islam, M. S., Kumkum, F. A., Rahman, A., & Anwar, I. (2020). Perceptions and experiences with district health information system software to collect and utilize health data in Bangladesh: a qualitative exploratory study. *BMC Health Services Research, 20*(1), 1-13.

Ben-Assuli, O., Shabtai, I., & Leshno, M. (2015). Using electronic health record systems to optimize admission decisions: The Creatinine case study. *Health Informatics Journal, 21*(1), 73-88. 10.1177/1460458213503646

Bernardia, F. A., Alvesc, D., Crepaldia, N. Y., Bettiol, D., Yamadaa, V. C. L., & Rijoa, Rui Pedro Charters Lopes. (2022). Data Quality in health research: a systematic literature review.

Bhardwaj, P. (2019). Types of sampling in research. *Journal of the Practice of Cardiovascular Sciences, 5*(3), 157.

Biru, A., Birhan, D., Melkamu, G., Gebeyehu, A., & Omer, A. M. (2022). Pathways to improve health information systems in Ethiopia: current maturity status and implications. *Health Research Policy and Systems, 20*(1), 78.

Bischoff, S., Aier, S., & Winter, R. (2014). (2014). Use IT or lose IT? The role of pressure for use and utility of enterprise architecture artifacts. Paper presented at the*2014 IEEE 16th Conference on Business Informatics, , 2* 133-140.

Bloland, P., & Macneil, A. (2019). *Defining & assessing the quality, usability, and utilization of immunization data*. Springer Science and Business Media LLC. 10.1186/s12889-019-6709-1

Boadu, R. O., Obiri-Yeboah, J., Okyere Boadu, K. A., Kumasenu Mensah, N., & Amoh-Agyei, G. (2021). Assessment of RHIS Quality Assurance Practices in Tarkwa Submunicipal Health Directorate, Ghana. *Advances in Public Health, 2021*

Camatti, J. A., Rabelo, G. M., Borsato, M., & Pellicciari, M. (2020). Comparative study of open IoT architectures with TOGAF for industry implementation. *Procedia Manufacturing, 51*, 1132-1137.

Cardoso, L., Marins, F., Quintas, C., Portela, F., Santos, M., Abelha, A., & Machado, J. (2018). Interoperability in healthcare. *Health Care Delivery and Clinical Science: Concepts, Methodologies, Tools, and Applications* (pp. 689-714). IGI Global.

Cheti, E. O. (2019). Assessing quality of non-communicable disease data in kenya: a case study of medicines sans frontier project in kibera a research project submitted in

partial fulfillment of the requirements for the award of the degree of master of arts in monitoring and evaluation of population and development programmes

Cichy, C., & Rass, S. (2019). *An Overview of Data Quality Frameworks*. Institute of Electrical and Electronics Engineers (IEEE). 10.1109/access.2019.2899751

Coleman, P. (2022). Validity and Reliability within Qualitative Research for the Caring Sciences. *International Journal of Caring Sciences*, *14*(3), 2041-2045.

Corbell, C., Katjitae, I., Mengistu, A., Kalemeera, F., Sagwa, E., Mabirizi, D., Lates, J., Nwokike, J., Fuller, S., & Stergachis, A. (2012). Records linkage of electronic databases for the assessment of adverse effects of antiretroviral therapy in sub-Saharan Africa. *Pharmacoepidemiology and Drug Safety*, *21*(4), 407-414. 10.1002/pds.2252

Corner, E. J., Murray, E. J., & Brett, S. J. (2019). Qualitative, grounded theory exploration of patients' experience of early mobilisation, rehabilitation and recoveryafter critical illness. *BMJ Open*, *9*(2), e026348.

Cresswell, K. M., Mozaffar, H., Lee, L., Williams, R., & Sheikh, A. (2017). Safety risks associated with the lack of integration and interfacing of hospital health information technologies: a qualitative study of hospital electronic prescribing systems in England. *BMJ Quality & Safety*, *26*(7), 530-541.

Dagnew, E., Woreta, S. A., & Shiferaw, A. M. (2018). Routine health information utilization and associated factors among health care professionals working at public

health institution in North Gondar, Northwest Ethiopia. *BMC Health Services Research, 18*(1), 685. 10.1186/s12913-018-3498-7

Daneshkohan, A., Alimoradi, M., Ahmadi, M., & Alipour, J. (2022). Data quality and data use in primary health care: A case study from Iran. *Informatics in Medicine Unlocked, 28*, 100855. 10.1016/j.imu.2022.100855

Dang, D. D., & Pekkola, S. (2017). Problems of Enterprise Architecture Adoption in the Public Sector: Root Causes and Some Solutions. In L. Rusu, & G. Viscusi (Eds.), *Information Technology Governance in Public Organizations: Theory and Practice* (pp. 177-198). Springer International Publishing. 10.1007/978-3-319-58978-7_8

Darmawan, A. K., Siahaan, D. O., Susanto, T. D., Hoiriyah, Umam, B. A., & Hermanto, A. (2020). A model of smart regency framework using Meta-ethnography approach and TOGAF ADM 9.1. *Journal of Physics. Conference Series, 1569*(2), 22005. 10.1088/1742-6596/1569/2/022005

Davids, Z., & Brown, I. (2021). The collective storytelling organisational framework for social media use. *Telematics and Informatics, 62*, 101636. 10.1016/j.tele.2021.101636

D'Costa, S., & Sinha, R. K. (2018). Usability assessment of hospital information system integrated electronic medical record. *Online J Health Allied Sci, 17*(3), 5.

Dehnavieh, R., Haghdoost, A., Khosravi, A., Hoseinabadi, F., Rahimi, H., Poursheikhali, A., Khajehpour, N., Khajeh, Z., Mirshekari, N., Hasani, M., Radmerikhi, S., Haghighi, H., Mehrolhassani, M. H., Kazemi, E., & Aghamohamadi, S. (2019b). TheDistrict Health Information System (DHIS2): A literature review and meta-synthesis

of its strengths and operational challenges based on the experiences of 11 countries. *Health Information Management, 48*(2), 62-75. 10.1177/1833358318777713

Dlodlo, N., & Hamunyela, S. (2017). The Status of Integration of Health Information Systems in Namibia. *Electronic Journal of Information Systems Evaluation, 20*(2), 61-75. https://www.proquest.com/scholarly-journals/status-integration-health-information-systems/docview/1969778390/se-2?accountid=14500

de Sá Pinheiro, A., Souza Lima, S., Oliveira Naiff Ferreira, Glenda Roberta, Rodrigues Feijão, A., Rosendo da Silva, Richardson Augusto, Gir, E., Reis, R. K., Vieira Pereira, F. M., Hisako Takase Gonçalves, L., & Isse Polaro, S. H. (2022). HIV epidemic in a province of the Brazilian Amazon region: Temporal trend analysis. *Journal of Public Health Research, 11*(2), jphr. 2021.2513.

de Oliveira, K. V., Fernandes, E. C., & Borsato, M. (2021). A TOGAF-based Framework for the Development of Sustainable Product-Service Systems. *Procedia Manufacturing, 55*, 274-281. 10.1016/j.promfg.2021.10.039

D. Proença, & J. Borbinha. (2017). Enterprise Architecture: A Maturity Model Based on TOGAF ADM. Paper presented at the - *2017 IEEE 19th Conference on Business Informatics (CBI), , 01* 257-266. 10.1109/CBI.2017.38

de Oliveira, K. V., Fernandes, E. C., & Borsato, M. (2021). A TOGAF-based Framework for the Development of Sustainable Product-Service Systems. *Procedia Manufacturing, 55*, 274-281. 10.1016/j.promfg.2021.10.039

Dumitriu, D., & Popescu, M. A. (2020a). Enterprise Architecture Framework Design in IT Management. *Procedia Manufacturing, 46*, 932-940. 10.1016/j.promfg.2020.05.011

Ebneyamini, S., & Sadeghi Moghadam, M. R. (2018). Toward Developing a Framework for Conducting Case Study Research. *International Journal of Qualitative Methods, 17*(1), 160940691881795. 10.1177/1609406918817954

Endriyas, M., Alano, A., Mekonnen, E., Ayele, S., Kelaye, T., Shiferaw, M., Misganaw, T., Samuel, T., Hailemariam, T., & Hailu, S. (2019a). Understanding performance data: health management information system data accuracy in Southern Nations Nationalities and People's Region, Ethiopia. *BMC Health Services Research, 19*(1), 175. 10.1186/s12913-019-3991-7

Endriyas, M., Alano, A., Mekonnen, E., Ayele, S., Kelaye, T., Shiferaw, M., Misganaw, T., Samuel, T., Hailemariam, T., & Hailu, S. (2019b). Understanding performance data: health management information system data accuracy in Southern Nations Nationalities and People's Region, Ethiopia. *BMC Health Services Research, 19*(1), 175. 10.1186/s12913-019-3991-7

Eskaluspita, A. Y., & Sumitra, I. D. (2020). The Open Group Architecture Framework for Designing the Enterprise Architecture of ALIT. *IOP Conference Series.Materials Science and Engineering, 879*(1)http://dx.doi.org/10.1088/1757-899X/879/1/012083

Fadahunsi, K. P., O'Connor, S., Akinlua, J. T., Wark, P. A., Gallagher, J., Carroll, C., Car, J., Majeed, A., & O'Donoghue, J. (2021). Information Quality Frameworks for Digital Health Technologies: Systematic Review. *Journal of Medical Internet Research, 23*(5), e23479. 10.2196/23479

Farnham, A., Utzinger, J. ü, Kulinkina, A. V., & Winkler, M. S. (2020). Using district health information to monitor sustainable development. *Bulletin of the World Health Organization, 98*(1), 69-71. 10.2471/BLT.19.239970

Gaganpreet Sharma. (2017). *Pros and cons of different sampling techniques*

Gebayew, C., & Arman, A. A. (Jul 2019). Modify TOGAF ADM for Government Enterprise Architecture : Case Study in Ethiopia. Paper presented at the 1-6. 10.1109/ICWT47785.2019.8978260 https://ieeexplore.ieee.org/document/8978260

Gill, S. L. (2020). Qualitative sampling methods. *Journal of Human Lactation, 36*(4), 579-581.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods, 16*(1), 15-31.

Glaser, B. G., & Strauss, A. L. (2017). *Discovery of grounded theory: Strategies for qualitative research*. Routledge.

Gunawan, W., & Liejaya, B. (2020). Formulating cloud based hospital information system (HIS) with Zachman framework. *IOP Conference Series. Materials Science and Engineering, 725*(1), 12092. 10.1088/1757-899X/725/1/012092

Gani, A., Imtiaz, N., Rathakrishnan, M., & Krishnasamy, H. N. (2020). A pilot test for establishing validity and reliability of qualitative interview in the blended learning English proficiency course. *Journal of Critical Reviews, 7*(05), 140-143.

Gebayew, C., & Arman, A. A. (Jul 2019). (Jul 2019). Modify TOGAF ADM for Government Enterprise Architecture : Case Study in Ethiopia. Paper presented at the 1-6. 10.1109/ICWT47785.2019.8978260 https://ieeexplore.ieee.org/document/8978260

Gebreslassie, A. A., Below, M. T., Ashebir, M. M., Gezae, K. E., & Chekole, M. K. (2020). Enhancing health facility-based data quality and use for decision making at primary health care units to improve health service delivery of maternal newborn child and adolescent health, Tigray Ethiopia 2018. *Archives of Community Medicine and Public Health, 6*(1), 31.

Girsang, A. S., & Abimanyu, A. (2021a). Development of an Enterprise Architecture for Healthcare using TOGAF ADM. *Emerging Science Journal, 5*(3), 305-321. 10.28991/esj-2021-01278

Global Programs. (2022). *Health informatics and Technology.* http://ucglobalprograms.org/namibia/what-we-do

Grave, F., van de Wetering, R., & Kusters, R. (2021). Enterprise architecture artifacts facilitating the strategy planning process for digital transformations: a systematic literature review and multiple case study. *IADIS International Journal on Computer Science and Information Systems, 16*(1), 46-62.

Guntara, A., Saeppani, A., Fadil, I., & Supriadi, F. (Oct 23, 2020). (Oct 23, 2020). Enterprise Information System Planning Using TOGAF Architecture Development Method on XYZ College. Paper presented at the 1-6. 10.1109/CITSM50537.2020.9268798 https://ieeexplore.ieee.org/document/9268798

Hadaya, P., Leshob, A., Marchildon, P., & Matyas-Balassy, I. (2020). Enterprise architecture framework evaluation criteria: A literature review and artifact development. *Service Oriented Computing and Applications, 14*, 203-222.

Haki, K., & Legner, C. (2021a). The mechanics of enterprise architecture principles. *Journal of the Association for Information Systems, 22*(5), 1334-1375.

Hall, G. C., Sauer, B., Bourke, A., Brown, J. S., Reynolds, M. W., & LoCasale, R. (2012). Guidelines for good database selection and use in pharmacoepidemiologyresearch. *Pharmacoepidemiology and Drug Safety, 21*(1), 1-10. 10.1002/pds.2229

Hamunyela, M., & Nekongo-Nielsen, H. (2015). Namibia. *International Perspectives on Older Adult Education* (pp. 273-283). Springer International Publishing. 10.1007/978-3-319-24939-1_24

Handayani, P. W., Pinem, A. A., Munajat, Q., Azzahro, F., Hidayanto, A. N., Ayuningtyas, D., & Sartono, A. (2019). Health Referral Enterprise Architecture Design in Indonesia. *Healthc Inform Res, 25*(1), 3-11. 10.4258/hir.2019.25.1.3

Hazel, E., Wilson, E., Anifalaje, A., Sawadogo-Lewis, T., & Heidkamp, R. (2018). Building integrated data systems for health and nutrition program evaluations: lessons learned from a multi-country implementation of a DHIS 2-based system. *Journal of Global Health, 8*(2), 020307. 10.7189/jogh.08.020307

Higman, S., Dwivedi, V., Nsaghurwe, A., Busiga, M., Sotter Rulagirwa, H., Smith, D., Wright, C., Nyinondi, S., & Nyella, E. E. (2018). *Designing interoperable health information systems using Enterprise Architecture approach in resource-limited countries: A literature review*. Wiley. 10.1002/hpm.2634

Hosseini Teshnizi, S., Hayavi Haghighi, M. H., & Alipour, J. (2021). Evaluation of health information systems with ISO 9241-10 standard: A systematic review and meta-analysis. *Informatics in Medicine Unlocked, 25*, 100639. 10.1016/j.imu.2021.100639

Hoffart, N. (2000, Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory.*27*, 248. https://link-gale-com.ezproxy.uct.ac.za/apps/doc/A66924450/AONE?u=unict&sid=bookmark-AONE&xid=d7ca8244

HR, G., & Aithal, P. S. (2022). When to Collect Data? Choosing an Appropriate Time Frame for Data Collection During Ph. D. Program in India? *International Journal of Applied Engineering and Management Letters (IJAEML), 6*(2), 271-287.

Hoxha, K., Hung, Y. W., Irwin, B. R., & Grépin, K. A. (2020). Understanding the challenges associated with the use of data from routine health information systems in low- and middle-income countries: A systematic review. *Health Information Management, ,* 183335832092872-1833358320928729. 10.1177/1833358320928729

Imanudin, D. R. M., Izzati, B. M., & Dewi, F. (2022). Design of enterprise architecture for smartvillage in sumur bandung sub-district (case study: governance dimension). *JIPI (Jurnal Ilmiah Penelitian Dan Pembelajaran Informatika), 7*(3), 869-879.

Intrahealth. (2022). *ePMS Quantum Health Information Systems.* https://www.intrahealthnamibia.org/quantum

Iwelunmor, J., Blackstone, S., Veira, D., Nwaozuru, U., Airhihenbuwa, C., Munodawafa, D., Kalipeni, E., Jutal, A., Shelley, D., & Ogedegbe, G. (2015). *Toward the sustainability of health interventions implemented in sub-Saharan Africa: a*

systematic review and conceptual framework. Springer Science and Business Media LLC. 10.1186/s13012-016-0392-8

Job Shipululo Amupanda. (2019). From outrage to action: Namibian Civil Society and the Struggle Against Corruption.

Kagoya, H. R., Kibuule, D., Rennie, T. W., Wuletaw, C., & Mitonga, K. H. (2020). Optimizing data quality of pharmaceutical information systems in public health care in resource limited settings. *Research in Social and Administrative Pharmacy, 16*(6), 828-835. 10.1016/j.sapharm.2019.09.057

Kahn, M. G., Callahan, T. J., Barnard, J., Bauck, A. E., Brown, J., Davidson, B. N., Estiri, H., Goerg, C., Holve, E., Johnson, S. G., Liaw, S., Hamilton-Lopez, M., Meeker, D., Ong, T. C., Ryan, P., Shang, N., Weiskopf, N. G., Weng, C., Zozus, M. N., & Schilling, L. (2016). A Harmonized Data Quality Assessment Terminology and Framework for the Secondary Use of Electronic Health Record Data. *EGEMS (Washington, DC), 4*(1), 1244-9214.1244. eCollection 2016. 1244

Kaloyanova, K., Naydenova, I., & Kovacheva, Z. (2021). Addressing Data Quality in Healthcare. *Information Systems and Grid Technologies, ISGT,* , 155-164.

Kapepo, M., & Yashik, S. (2018). A process analysis of the Namibian Health System: An exploratory case study. *The Ethiopian Journal of Health Development, 32*(4), 200. https://search.proquest.com/docview/2229890153

Kaplan, B. (2020). Revisiting health information technology ethical, legal, and social issues and evaluation: telehealth/telemedicine and COVID-19. *International Journal of Medical Informatics, 143*, 104239.

Karthikeyan, C., & Benjamin, A. (2019). A Bibliographical Study on Importance of Data Profiling and Data Mining for Effective Business Transactions; a Techno-Business Leadership Perspective. *International Journal of Research in Social Sciences, 9*(4), 27-70.

Kearny, C., Gerber, A., & van der Merwe, A. (Oct 2016). (Oct 2016). Data-driven enterprise architecture and the TOGAF ADM phases. Paper presented at the 004603-004608. 10.1109/SMC.2016.7844957 https://ieeexplore.ieee.org/document/7844957

Kebede, M., Adeba, E., & Chego, M. (2020). Evaluation of quality and use of health management information system in primary health care units of east Wollega zone, Oromia regional state, Ethiopia. *BMC Medical Informatics and Decision Making, 20*(1), 107-4. 10.1186/s12911-020-01148-4

Kempegowda, S. M., & Chaczko, Z. (Dec 2018). (Dec 2018). The optimum number of Principles ideal for Enterprise Architecture practice. Paper presented at the 1-4. 10.1109/ICSENG.2018.8638237 https://ieeexplore.ieee.org/document/8638237

Kencana, A. S., Fajrillah, A. A. N., & Hanafi, R. (2022a). Design of enterprise architecture in e-government development using togaf adm 9.2 framework in electricity sector of department energy and mineral resource of west java province. *Jipi (Jurnal Ilmiah Penelitian Dan Pembelajaran Informatika), 7*(4), 1068-1079.

Keutel, M., Michalik, B., & Richter, J. (2014). Towards mindful case study research in IS: a critical analysis of the past ten years. *European Journal of Information Systems, 23*(3), 256-272.

Kirkendall, E. S., Ni, Y., Lingren, T., Leonard, M., Hall, E. S., & Melton, K. (2019). Data challenges with real-time safety event detection and clinical decision support. *Journal of Medical Internet Research, 21*(5), e13047.

Koa, Y., Weinbach, J. r., Posada-de-la-Paz, M., Coi, A., Lemonnier, S. L., van Enckevort, D., Roos, M., Jacobsen, A., Cornet, R., Ahmed, S. F., Bros-Facer, V., Popa, V., van Meel, M., Renault, D., von Gizycki, R., Santoro, M., Landais, P., Torreri, P., Carta, C., . . . Taruscio, D. (2018). Recommendations for improving the quality of rare disease registries. *International Journal of Environmental Research and Public Health, 15*(8), 1644. 10.3390/ijerph15081644

Kotusev, S. (2018). TOGAF-based Enterprise Architecture Practice: An Exploratory Case Study. *Communications of the Association for Information Systems, 43*, 321-359. 10.17705/1CAIS.04320

Kotusev, S. (2019). Enterprise architecture and enterprise architecture artifacts: Questioning the old concept in light of new findings. *Journal of Information Technology, 34*(2), 102-128. 10.1177/0268396218816273

Kotusev, S. (2019). Fake and real tools for enterprise architecture: the Zachman framework and business capability model. *Enterprise Architecture Professional Journal (EAPJ), URL: Https://Eapj.Org/Fake-and-Real-Tools-for-Enterprise-Architecture,*

Kotusev, S., Kurnia, S., & Dilnutt, R. (2022). *The Practical Roles of Enterprise Architecture Artifacts: A Classification and Relationship*. Elsevier BV. 10.1016/j.infsof.2022.106897

Laranjeiro, N., Soydemir, S. N., & Bernardino, J. (Nov 2015). (Nov 2015). A Survey on Data Quality: Classifying Poor Data. Paper presented at the 179-188. 10.1109/PRDC.2015.41 https://ieeexplore.ieee.org/document/7371861

Larno, S., Seppänen, V., & Nurmi, J. (2019). Method Framework for Developing Enterprise Architecture Security Principles. *Complex Systems Informatics and Modeling Quarterly*, (20), 57-71. 10.7250/csimq.2019-20.03

Lemma, S., Janson, A., Persson, L., Wickremasinghe, D., & Källestål, C. (2020). Improving quality and use of routine health information system data in low- and middle-income countries: A scoping review. *Plos One*, *15*(10), e0239683. https://doi.org/10.1371/journal.pone.0239683

Liu, Q., Liu, Z., Wang, Y., Zhong, R., & Zhang, Y. (2021). How Does The Open Group Architecture Framework (TOGAF®) Realise Queensland's Digital Health Transformation?

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. sage.

Locke, E. A. (2007). The Case for Inductive Theory Building. *Journal of Management*, *33*(6), 867-890. 10.1177/0149206307307636

Mabirizi, D., Phulu, B., Churfo, W., Mwinga, S., Mazibuko, G., Sagwa, E., Indongo, L., & Hafner, T. (2018a). Implementing an Integrated Pharmaceutical Management Information System for Antiretrovirals and Other Medicines: Lessons From Namibia. *Global Health: Science and Practice*, *6*(4), 723-735. 10.9745/GHSP-D-18-00157

Mabirizi, D., Phulu, B., Churfo, W., Mwinga, S., Mazibuko, G., Sagwa, E., Indongo, L., & Hafner, T. (2018b). Implementing an Integrated Pharmaceutical Management Information System for Antiretrovirals and Other Medicines: Lessons From Namibia. *Global Health, Science and Practice, 6*(4), 723-735. 10.9745/GHSP-D-18-00157

Mahalie, R., Angula, P., Mitonga, K. H., & Oladimeji, O. (2022). *Predictors of cardiovascular diseases among people living with HIV initiated on antiretroviral therapy in Khomas region, Namibia: A cross-sectional study*. PAGEPress Publications. 10.4081/jphia.2022.1561

Maïga, A., Jiwani, S. S., Mutua, M. K., Porth, T. A., Taylor, C. M., Asiki, G., Melesse, D. Y., Day, C., Strong, K. L., Faye, C. M., Viswanathan, K., O'Neill, K. P., Amouzou, A., Pond, B. S., & Boerma, T. (2019b). Generating statistics from health facility data: the state of routine health information systems in Eastern and Southern Africa.*BMJ Global Health, 4*(5), e001849. 10.1136/bmjgh-2019-001849

Majeed, I. (2019). Understanding positivism in social research: A research paradigm of inductive logic of inquiry. *International Journal of Research in Social Sciences, 9*(11), 118-125.

Malakoane, B., Heunis, J. C., Chikobvu, P., Kigozi, N. G., & Kruger, W. H. (2020). *Public health system challenges in the Free State, South Africa: a situation appraisal to inform health system strengthening*. Springer Science and Business Media LLC. 10.1186/s12913-019-4862-y

Malyzhenkov, P., & Ivanova, M. (2017). (2017). An Enterprise Architecture-Based Approach to the IT-Business Alignment: An Integration of SAM and TOGAF

Framework. Paper presented at the *Enterprise and Organizational Modeling And*, 159-173.

Marwati, A. (2022). Designing Information Technology Architecture Based on TOGAF Methodology At Padang Karunia Group. *Jurnal Tata Kelola Dan Kerangka Kerja Teknologi Informasi*, *8*(1), 1-9.

Masood, Z., Hoda, R., & Blincoe, K. (2020). How agile teams make self-assignment work: a grounded theory study. *Empirical Software Engineering : An International Journal*, *25*(6), 4962-5005. 10.1007/s10664-020-09876-x

Matheus, R., Janssen, M., & Janowski, T. (2021). Design principles for creating digital transparency in government. *Government Information Quarterly*, *38*(1), 101550.

Mayakul, T., Sa-Nga-Ngam, P., Srisawat, W., & Kiattisin, S. (Dec 2019). A Comparison of National Enterprise Architecture and e-Government Perspectives. Paper presented at the 1-6. 10.1109/TIMES-iCON47539.2019.9024591 https://ieeexplore.ieee.org/document/9024591

Mbeya Munkhondya, T. E., Smyth, R. M., & Lavender, T. (2021). *Facilitators and barriers to retention in care under universal antiretroviral therapy (Option B+) for the Prevention of Mother to Child Transmission of HIV (PMTCT): A narrative review*. Elsevier BV. 10.1016/j.ijans.2021.100372

Meke I Kapepo, & Singh Yashik. (2018). A process analysis of the Namibian Health System: An exploratory case study. *The Ethiopian Journal of Health Development*, *32*(4), 200. https://search.proquest.com/docview/2229890153

Mendonja, J., Andrade, E., Endo, P. T., & Lima, R. (2019). Disaster recovery solutions for IT systems: A Systematic mapping study. *Journal of Systems and Software, 149*, 511-530.

mhss. (2023). *Dashboard - Namibia Master Health Facility List.* https://mfl.mhss.gov.na/

Mjelva, M. K. (2017). *Benefits and Challenges of Integrating Fragmented Health Information Systems - A Case Study of the Vaccine Supply Chain in Tanzania* http://hdl.handle.net/10852/56892

Mohajan, D., & Mohajan, H. (2022). Exploration of Coding in Qualitative Data Analysis: Grounded Theory Perspective.

Moukénet, A., de Cola, M. A., Ward, C., Beakgoubé, H., Baker, K., Donovan, L., Laoukolé, J., & Richardson, S. (2021a). Health management information system (HMIS) data quality and associated factors in Massaguet district, Chad. *BMC Medical Informatics and Decision Making*, *21*(1), 326. 10.1186/s12911-021-01684-7

Moyo, C. M. (2017). *Transformational Feedback: Breaking the vicious cycle of information use in Health Information Systems-A case from Malawi* http://hdl.handle.net/10852/86811

Muñoz-Moreno, M. F., Ryan, P., Alvaro-Meca, A., Valencia, J., Tamayo, E., & Resino, S. (2019). National temporal trend analysis of infective endocarditis among patients infected with HIV in Spain (1997–2014): a retrospective study. *Journal of Clinical Medicine, 8*(8), 1167.

Mukhles M. Al-Ababneh. (2020). Linking Ontology, Epistemology And Research Methodology. *Science & Philosophy, 8*(1), 75-91. 10.23756/sp.v8i1.500

Mutasa, A. (2017). E-health and E-governance integration framework for the Namibian government. *Mental Health Practice, 21*(3), 27-34. 10.7748/mhp.2017.e1219

Mutasa, L. S., & Iyamu, T. (2022). Application of activity theory to examine the implementation of e-health in Namibia. *International Journal of Healthcare Management, ahead-of-print*(ahead-of-print), 1-10. 10.1080/20479700.2022.2083046

Myers, M. D., & Klein, H. K. (2011). A set of principles for conducting critical research in information systems. *MIS Quarterly*, , 17-36.

Nama, G. F., Tristiyanto, & Kurniawan, D. (Nov 2017). An enterprise architecture planning for higher education using the open group architecture framework (togaf): Case study University of Lampung. Paper presented at the 1-6. 10.1109/IAC.2017.8280610 https://ieeexplore.ieee.org/document/8280610

Nawaz, R., Khan, S. A., Khattak, T., Nasir, F., & Abbas, K. (2020). Interventional Study for Improving Health Information System in Khyber Pakhtunkhwa, Pakistan. *Cureus, 12*(11), e11785. 10.7759/cureus.11785

Negara, J. G. P., & Emanuel, A. W. R. (2020). (2020). Enterprise Architecture Design Strategies for UGK Using TOGAF ADM. Paper presented at the *1st Borobudur International Symposium on Humanities, Economics and Social Sciences (BIS-HESS 2019)*, 491-495.

Nengomasha, C. T., Abankwah, R., Uutoni, W., & Pazvakawambwa, L. (2018). *Health information systems in Namibia*. Emerald. 10.1108/ils-03-2018-0015

Niemi, E., & Pekkola, S. (2020). The benefits of enterprise architecture in organizational transformation. *Business & Information Systems Engineering, 62*, 585-597.

Nikodemus Angula, & Nomusa Dlodlo. (2018). Towards a Framework to Enable Semantic Interoperability of Data in Heterogeneous Health Information Systems in Namibian Public hospitals. https://d1wqtxts1xzle7.cloudfront.net/60552546/SPRINGERLIBRO_pag._1094_Ecuador_Miguel_Orosa-comprimido20190910-50947-3np0nk-with-cover-page-v2.pdf?Expires=1670173130&Signature=E3rU5882xuvMdIGtkL0W93DZCeeu9C2IisC~ozU0myAa3mSnor8-X1a-1geX3DBe65BAUdVmk2QAXyoiwIj0I2qNqRfL6XDOLM58eKIiBP7ZjSPAaQLwYkx8G0y8ZfOrdzlyhrT7NwS-Lk~AZeR3UW6OljXJ~R9FR10p3VGqTj7b-T2IB6qGTEVFNuiAnUOBsOXWpdDs4Rs~mImkeXnGTL2g3PCgV5shWb95T7J~O6MfCmPWKWPJbIA7z6XBRK16HaLYqn6Dqy0n9SlLWJAPIBq9Yg3UsscuHEjFE6XDgh2DBbJOaE93JJhTfX-zM0nzncwan1HyZkJcnlKNUmeRlQ__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA#page=845

Njuguna, C., Vandi, M., Mugagga, M., Kanu, J., Liyosi, E., Chimbaru, A., Gachari, W., Caulker, V., Sesay, S., Githuku, J., Yoti, Z., Yahaya, A. A., Talisuna, A., & Fall, I. S. (2020). Institutionalized data quality assessments: a critical pathway to improving the accuracy of integrated disease surveillance data in Sierra Leone. *BMC Health Services Research, 20*(1), 724-x. 10.1186/s12913-020-05591-x

Noranita, B., Nugraheni, D. M. K., Fitriyani, M. I., & Nurhayati, Y. (2021). Business architecture and information system architecture design in savings and payment unit Koperasi Pegawai Republik Indonesia (KPRI) Diponegoro University using TOGAF

9 framework. *Journal of Physics: Conference Series, 1943*(1)http://dx.doi.org/10.1088/1742-6596/1943/1/012105

Nsaghurwe, A., Dwivedi, V., Ndesanjo, W., Bamsi, H., Busiga, M., Nyella, E., Massawe, J. V., Smith, D., Onyejekwe, K., Metzger, J., & Taylor, P. (2021). *One country's journey to interoperability: Tanzania's experience developing and implementing a national health information exchange*. Springer Science and Business Media LLC. 10.1186/s12911-021-01499-6

Nuuyoma, V., & Ashipala, D. O. (2020). Healthcare System in Namibia: An Overview. *Biopsychosocial Perspectives and Practices for Addressing Communicable and Non-Communicable Diseases, ,* 1-17.

O'Connor, A., Carpenter, B., & Coughlan, B. (2018). An Exploration of Key Issues in the Debate Between Classic and Constructivist Grounded Theory. *Grounded Theory Review, 17*(1)

O'Hagan, R., Marx, M. A., Finnegan, K. E., Naphini, P., Ng'ambi, K., Laija, K., Wilson, E., Park, L., Wachepa, S., & Smith, J. (2017). National assessment of data quality and associated systems-level factors in Malawi. *Global Health: Science and Practice, 5*(3), 367-381.

OLANIYAN, F. M. A., & OWOSENI, A. (2022). Toward Improved Data Quality in Public Health: Analysis of Anomaly Detection Tools applied to HIV/AIDS Data in Africa.

Olavsrud, T. (2020). What is data architecture? A framework for managing data. *Cio*, , n/a. https://www.proquest.com/trade-journals/what-is-data-architecture-framework-managing/docview/2457432409/se-2?accountid=14500

Palupi, A. D., & Surosa, R. M. (2018). (2018). Enterprise Architecture Design for Construction Services Using The Open Group Architecture Framework (TOGAF): Case Study Ministry of Public Works and Housing, Indonesia. Paper presented at the *2018 International Conference on Information Technology Systems and Innovation (ICITSI)*, 66-71.

Pasiak, M. L., & Emanuel, A. W. R. (2021). (2021). Enterprise Architecture Planning (EAP) Using TOGAF-ADM at Fuel Supplier. Paper presented at the *2021 13th International Conference on Information & Communication Technology and System (ICTS)*, 73-77.

Pearse, N. (2019). An illustration of a deductive pattern matching procedure in qualitative leadership research. *Electronic Journal of Business Research Methods, 17*(3), pp143-154.

Peer, E., Rothschild, D., Gordon, A., Evernden, Z., & Damer, E. (2022). Data quality of platforms and panels for online behavioral research. *Behavior Research Methods, 54*(4), 1643-1662. 10.3758/s13428-021-01694-3

Pham, L. (2018). *A Review of key paradigms: positivism, interpretivism and critical inquiry*. Unpublished. 10.13140/rg.2.2.13995.54569

Platt, J., & Kardia, S. (2015). *Public Trust in Health Information Sharing: Implications for Biobanking and Electronic Health Record Systems*. MDPI AG. 10.3390/jpm5010003

Prasad, K. D., & Rupandehi, N. (2019). Restating Validity and Reliability in Qualitative Studies.

Proenca, D., & Borbinha, J. (Jul 2017). (Jul 2017). Enterprise Architecture: A Maturity Model Based on TOGAF ADM. Paper presented at the , *1* 257-266. 10.1109/CBI.2017.38 https://ieeexplore.ieee.org/document/8010729

Putra, Y. P., & Hadiana, A. (2020). Designing Enterprise Architecture for Public Health Center Based on TOGAF Architecture Development Method. *IOP Conference Series. Materials Science and Engineering, 879*(1), 12163. 10.1088/1757-899X/879/1/012163

Qurratuaini, H. (2018b). Designing enterprise architecture based on TOGAF 9.1 framework. *IOP Conference Series. Materials Science and Engineering, 403*(1), 12065. 10.1088/1757-899X/403/1/012065

Ragab, M. A., & Arisha, A. (2017). Research Methodology in Business: A Starter's Guide. *Management and Organizational Studies, 5*(1), 1. 10.5430/mos.v5n1p1

Rashid, Y., Rashid, A., Warraich, M. A., Sabir, S. S., & Waseem, A. (2019). Case study method: A step-by-step guide for business researchers. *International Journal of Qualitative Methods, 18*, 1609406919862424.

Reynolds, H. W., Salentine, S., Silvestre, E., Millar, E., Strahley, A., Cannon, A. C., & Bobrow, E. A. (2022). A learning agenda to build the evidence base for

strengthening global health information systems. *Health Information Management, 51*(2), 79-88. 10.1177/1833358320936801

Ribeiro, C. M., de Carvalho, Jonas Lotufo Brant, de Santis Bastos, Paula Andrea, Mendes, R. G., Katagiri, S., & da Costa, V. M. (2020). Spatial and temporal trend analysis of bovine brucellosis in Brazil, 2014 to 2018. *Semina: Ciências Agrárias, 41*(4), 1279-1290.

Rocco, T. S., & Plakhotnik, M. S. (2009). Literature reviews, conceptual frameworks, and theoretical frameworks: Terms, functions, and distinctions. *Human Resource Development Review, 8*(1), 120-130.

Roomaney, R. A., Pillay-van Wyk, V., Awotiwon, O. F., Nicol, E., Joubert, J. D., Bradshaw, D., & Hanmer, L. A. (2017). Availability and quality of routine morbidity data: review of studies in South Africa. *Journal of the American Medical Informatics Association : JAMIA, 24*(e1), e194-e206. 10.1093/jamia/ocw075

Roush, K., Opsahl, A., Parker, K., & Davis, J. (2021). Business Continuity Planning. *Nurse Leader, 19*(5), 525-531. 10.1016/j.mnl.2021.01.003

Ryan, G. (2018). Introduction to positivism, interpretivism and critical theory. *Nurse Researcher, 25*(4), 14-20. 10.7748/nr.2018.e1466

Ryder, M., Jacob, E., & Hendricks, J. J. (2019). *An inductive qualitative approach to explore Nurse Practitioners views on leadership and research: An international perspective*. Wiley. 10.1111/jocn.14853

Saigí-Rubió, F., Pereyra-Rodríguez, J. J., Torrent-Sellens, J., Eguia, H., Azzopardi-Muscat, N., & Novillo-Ortiz, D. (2021). Routine Health Information Systems in the

European Context: A Systematic Review of Systematic Reviews. *International Journal of Environmental Research and Public Health, 18*(9), 4622. doi: 10.3390/ijerph18094622. 10.3390/ijerph18094622

Salman, T., Zolanvari, M., Erbad, A., Jain, R., & Samaka, M. (2019). Security Services Using Blockchains: A State of the Art Survey. *IEEE Communications Surveys and Tutorials, 21*(1), 858-880. 10.1109/COMST.2018.2863956

Sanchez, J. I., Bonache, J., Paz-Aparicio, C., & Oberty, C. Z. (2022). Combining interpretivism and positivism in international business research: The example of the expatriate role. *Journal of World Business : JWB, *, 101419. 10.1016/j.jwb.2022.101419

Sari, T. R., Rahmawati, E., & Harafani, H. (2019). TOGAF ADM to Improve The Promotion of Farm Edu-Tourism in Pondok Rangon Area. *SinkrOn, 3*(2), 280-287. 10.33395/sinkron.v3i2.10108

Schoch, K. (2020). Case study research. *Research Design and Methods: An Applied Guide for the Scholar-Practitioner, *, 245-258.

Scotland, J. (2012). Exploring the philosophical underpinnings of research: Relating ontology and epistemology to the methodology and methods of the scientific, interpretive, and critical research paradigms. *English Language Teaching, 5*(9), 9-16.

Seidel, S., & Watson, R. T. (2020). Integrating Explanatory/Predictive and Prescriptive Science in Information Systems Research. *Communications of the Association for Information Systems, 47*(1), 284-314. 10.17705/1CAIS.04714

Senyo, P. K., Karanasios, S., Gozman, D., & Baba, M. (2022). FinTech ecosystem practices shaping financial inclusion: The case of mobile money in Ghana. *European Journal of Information Systems*, *31*(1), 112-127.

Setiawan, A., & Yulianto, E. (2018). E-Government Interoperability and Integration Architecture Modeling Using TOGAF Framework Based On Service Oriented Architecture. *The Asian Journal of Technology Management*, *11*(1), 26-45. http://dx.doi.org/10.12695/ajtm.2018.11.1.3

Sidiq, M., & Sumitra, I. D. (2019). (2019). Strategic Information Systems Planning Using The Togaf Architecture Development Method. Paper presented at the *IOP Conference Series: Materials Science and Engineering*, , *662*(2) 022057.

Sileyew, K. J. (2019). *Research design and methodology*. IntechOpen Rijeka.

Shama, A. T., Roba, H. S., Abaerei, A. A., Gebremeskel, T. G., & Baraki, N. (2021). Assessment of quality of routine health information system data and associated factors among departments in public health facilities of Harari region, Ethiopia. *BMCMedical Informatics and Decision Making*, *21*(1), 287-2. 10.1186/s12911-021- 01651-2

Shilamba, M., Osakwe, J., Iyawa, G., & Ujakpa, M. (May 16, 2022). (May 16, 2022). The Use of Electronic Notification Systems (e-Notification system) for Registering Births and Deaths: Findings from a Developing Country. Paper presented at the 1-8. 10.23919/IST-Africa56635.2022.9845592 https://ieeexplore.ieee.org/document/9845592

Sofyana, L., & Putera, A. R. (2019a). Business architecture planning with TOGAF framework. *Journal of Physics. Conference Series, 1375*(1), 12056. 10.1088/1742-6596/1375/1/012056

Susan Higman, Vikas Dwivedi1, Alpha Nsaghurwe1, Moses Busiga, Hermes Sotter Rulagirwa, Dasha Smith, Chris Wright, Ssanyu Nyinondi, Edwin Nyella. (2017). Designing interoperable health information systems using Enterprise Architecture approach in resource-limited countries: A literature review. https://pdf.usaid.gov/pdf_docs/PA00TM1R.pdf

Swedberg, R. (2020). *Exploratory Research*. Cambridge University Press. 10.1017/9781108762519.002

Ta, C. N., & Weng, C. (2019). Detecting Systemic Data Quality Issues in Electronic Health Records. *Studies in Health Technology and Informatics, 264*, 383-387. 10.3233/SHTI190248

Taherdoost, H. (2016). *Sampling Methods in Research Methodology; How to Choose a Sampling Tech-nique for Research*

Tamara Hafner. (2017). *The Use of Pharmaceutical Information for Decision Making in Namibia's National ART Program: Assessment Report*

Tamminen, K. A., & Poucher, Z. A. (2020). Research philosophies. *The Routledge international encyclopedia of sport and exercise psychology* (pp. 535-549). Routledge.

Tao, Z., Luo, Y., Chen, C., Wang, M., & Ni, F. (2017). Enterprise application architecture development based on DoDAF and TOGAF. *Enterprise Information Systems, 11*(5), 627-651.

Taye, G. (2021). *Improving health care services through enhanced Health Information System: Human capacity development Model*

Thornberg, R., & Dunne, C. (2019). Literature review in grounded theory. *The Sage Handbook of Current Developments in Grounded Theory, ,* 206-221.

Thulare, T., Herselman, M., & Botha, A. (Aug 2020). (Aug 2020). A scoping review on identifying aspects of data integrity in health information systems for South Africa. Paper presented at the 1-8. 10.1109/icABCD49160.2020.9183870 https://ieeexplore.ieee.org/document/9183870

Tilahun, H., Abate, B., Belay, H., Gebeyehu, A., Ahmed, M., Simanesew, A., Ayele, W., Mohammedsanni, A., Knittel, B., & Wondarad, Y. (2022). Drivers and Barriers to Improved Data Quality and Data-Use Practices: An Interpretative Qualitative Study in Addis Ababa, Ethiopia. *Global Health, Science and Practice, 10*(Suppl 1), e2100689. doi: 10.9745/GHSP. 10.9745/GHSP-D-21-00689

TOGAF. (2021). TOGAF 9.2. https://pubs.opengroup.org/architecture/togaf92-doc/arch/chap20.html#tag_20_06_02

TOGAF Open Group. (2022). *TOGAF Open Group.* https://pubs.opengroup.org/architecture/togaf9-doc/arch/chap03.html

TOGAF. (2021). TOGAF 9.2. https://pubs.opengroup.org/architecture/togaf92-doc/arch/chap20.html#tag_20_06_02

van de Wetering, R., Kurnia, S., & Kotusev, S. (2021). *The Role of Enterprise Architecture for Digital Transformations*10.3390/su13042237

Vollstedt, M., & Rezat, S. (2019a). An introduction to grounded theory with a special focus on axial coding and the coding paradigm. *Compendium for Early Career Researchers in Mathematics Education, 13*(1), 81-100.

Vu, T. T. N. (2021). Understanding validity and reliability from qualitative and quantitative research traditions. *VNU Journal of Foreign Studies, 37*(3)

Wagenaar, B. H., Hirschhorn, L. R., Henley, C., Gremu, A., Sindano, N., & Chilengi, R. (2017). *Data-driven quality improvement in low-and middle-income country health systems: lessons from seven years of implementation experience across Mozambique, Rwanda, and Zambia*. Springer Science and Business Media LLC. 10.1186/s12913-017-2661-x

Walusimbi, S., & Wamema, J. (2022). Improving Collaboration Among Healthcare providers in Resource Constrained Healthcare Facilities: An Enterprise Architecture Approach. *Journal of Health Informatics in Africa, 9*(1), 14-30.

Wang, X., & Cheng, Z. (2020). Cross-sectional studies: strengths, weaknesses, and recommendations. *Chest, 158*(1), S65-S71.

Wanjiku Ndegwa. (2015). *Dimensions and assessment methods of data quality in health information systems*10.19193/0393-6384_2017_2_047

Williams, M., & Moser, T. (2019). The art of coding and thematic exploration in qualitative research. *International Management Review*, *15*(1), 45-55.

Willig, C. (2019). Ontological and epistemological reflexivity: A core skill for therapists. *Counselling and Psychotherapy Research*, *19*(3), 186-194. 10.1002/capr.12204

Woiceshyn, J., & Daellenbach, U. (2018). Evaluating inductive vs deductive research in management studies. *Qualitative Research in Organizations and Management*, *13*(2), 183-195. 10.1108/QROM-06-2017-1538

Wong, Z. S. Y., Zhou, J., & Zhang, Q. (2019). Artificial Intelligence for infectious disease Big Data Analytics. *Infection, Disease & Health*, *24*(1), 44-48. 10.1016/j.idh.2018.10.002

Woods, M., Paulus, T., Atkins, D. P., & Macklin, R. (2016). Advancing Qualitative Research Using Qualitative Data Analysis Software (QDAS)? Reviewing Potential Versus Practice in Published Studies using ATLAS.ti and NVivo, 1994–2013. *Social Science Computer Review*, *34*(5), 597-617. 10.1177/0894439315596311

World Health Organization, (2015). . OECD Publishing. 10.1787/9789264243590-en

Wuetherick, B. (2010). Basics of qualitative research: Techniques and procedures for developing grounded theory. *Canadian Journal of University Continuing Education*, *36*(2)

Xia, Y., Zhou, Y., Liu, X., Zhao, N., & Xiao, S. (2021). How the integration of emergency medical services with Health Information Systems enhances quality of service. *Accessed January*, *5*

Yourkavitch, J., Prosnitz, D., & Herrera, S. (2019). Data quality assessments stimulate improvements to health management information systems: evidence from five African countries. *Journal of Global Health, 9*(1), 010806. 10.7189/jogh.09.010806

Appendix A – Interview Questions

Topic: An Enterprise Architecture approach for Data Quality management within Namibian Health Information Systems

General Questions

Participant Profile		Rationale
Q1	What is your role at the Ministry/Organization?	**Aim**: Background of the role of the users that use the HIS system.
Q2	How many years of experience do you have working with HIS?	**Aim**: Determine the level of experience that users have working with HIS system

Role based Questions

MIS Officers / Data Capturers		Rationale
Q1	What are some of challenges experienced with data entry process?	Contextual data challenges
Q2	What are the ways in which common language is used during data entry process?	Data definitions and common vocabulary
Q3	What are some of the process/processes in place to ensure data quality?	Data is an Asset
Q4	Explain your experience in using the system to record or enter the data?	Ease of use

Namibian HIS Project Managers / IT Directors		Rationale
Business Architecture Principles		
Q1	How is information managed across the ministry? Is it managed from a centralized point? How is decision making done?	Information Management is Everyone's Business
Q2	In what ways does the ministry maintain HIS operation during system disruptions?	Business Continuity
Q3	How does the ministry account for HIS Disaster recovery? Any periodic reviews, vulnerability checks?	Business Continuity
Q4	How does regulatory and government compliance influence information management processes?	Compliance with Law

Q5	How does the ministry account for protection of intellectual property?	Protection of Intellectual Property
Data Architecture Principles		
Q6	What are the main data quality challenges from a management perspective?	Data Quality challenges
Q7	In What ways does the ministry/organization benefit from common data vocabulary and definitions?	Data definitions and common vocabulary
Q8	How does the ministry use HIS data for decision making?	Data is an Asset
Q9	What are the processes/policies in place to ensure the management of quality data?	Data is an Asset
Q10	How is data shared across districts?	Data is Shared
Q11	How does the ministry address challenge of data integration if any?	Data is Shared
Q12	What is the level of Business and IT Alignment as it pertains to data management?	Data is Shared
Q13	Which roles are assigned to ensure data quality and what are their responsibilities?	Data Trustee
Q14	What are the policies in place to safeguard HIS data?	Data Security
Q15	How is HIS data accessed across districts?	Data is Accessible
Application Architecture Principles		
Q16	How is HIS application maintained in terms of technology? Does it rely on underlying technology or can it be run independently? What is best practise and why?	Technology Independence
Technology Architecture		
Q18	Are changes to technology or application only in response to business or IT or both? Why and why not the other?	Requirements Based changes
Q19	How does the ministry ensure compliance to software and hardware standards as it pertains to HIS?	Interoperability

Business Stakeholders - Hospital Managers / Hospital Directors		Rationale
Q1	What are the main data quality challenges from a management perspective?	Data Quality Challenges
Q2	How does MoHSS use HIS data for decision making?	Data is an Asset
Q3	How is data quality managed?	Data is an Asset
Q4	What is the perceived outcome of quality health care data?	Perceived Outcome
Application Architecture Principles		
Q5	How do you find the usability of the HIS system?	Ease of use

HIS System Analyst		Rationale
Data Architecture Principles		
Q1	What are the main data quality challenges within HIS?	Data Quality challenges
Q2	What are the causes of the data quality challenges?	Data Quality causes
Q3	How is data quality managed?	Data Quality Management
Q4	How does HIS data aid in decision making?	Data is an Asset
Q5	What is the perceived outcome of quality health care data?	Perceived Outcome
Q6	Which roles are assigned to ensure data quality and what are their responsibilities?	Data Trustee
Q7	What are the processes/policies in place to ensure the management of data quality?	Data is an Asset
Q8	How does the ministry address challenge of data integration if any?	Data is Shared
Q9	What are the policies in place to safeguard HIS data?	Data Security
Q10	What are the processes or strategies in place to mitigate data quality challenges?	Data is an Asset
Technology Architecture		
Q12	Are changes to technology or application only in response to business or IT or both? Why and why not the other?	Requirements based changes

Q11	How does the MoHSS/organization ensure compliance to software and hardware standards as it pertains to HIS?	Interoperability

	Data Manager/Data Engineer	Rationale
Q1	What are the main data challenges from your perspective?	Contextual data challenges
Q2	What are the causes of the data challenges?	Contextual data challenges
Q3	What in your opinion are the possible solutions to the challenges experienced?	Contextual data challenges
Q4	How do you deal with junk data if any? Are there processes in place?	Data is an Asset
Q5	What are the contextual health care conditions that may influence data management?	Contextual data challenges
Q6	How does HIS data aid in decision making?	Data is an Asset
Q7	Which roles are assigned to ensure data quality and what are their responsibilities?	Data Trustee
Q8	In What ways does the ministry/organization benefit from common data vocabulary and definitions?	Data definitions and common vocabulary

Appendix B - NVIVO Codes

Name	Files	References	Created on	Created by	Modified on	Modified by
2. Develop a framework for measurement hat will help organize	1	1	20/04/2023	VK	20/04/2023	VK
Application Architecture	0	0	13/09/2022	VK	13/09/2022	VK
Ease-of-Use	1	1	19/09/2022	VK	06/01/2023	VK
Technology Independence	2	8	19/09/2022	VK	25/10/2022	VK
Business Architecture	0	0	13/09/2022	VK	13/09/2022	VK
Business Continuity	3	4	19/09/2022	VK	07/05/2023	VK
Compliance with Law	2	8	19/09/2022	VK	27/11/2022	VK
Information Management is Everybody's Business	1	2	19/09/2022	VK	06/01/2023	VK
Contextual Health care conditions	5	11	13/09/2022	VK	10/04/2023	VK
Data Architecture	0	0	13/09/2022	VK	13/09/2022	VK
Data Quality Assurance	10	25	25/10/2022	VK	10/04/2023	VK
DQM causes	6	12	13/09/2022	VK	24/01/2023	VK
DQM Challenges	2	3	13/09/2022	VK	27/11/2022	VK
Governing Guidelines and Policies	5	17	06/01/2023	VK	10/04/2023	VK
Mitigate Data Quality Challenges	6	18	13/09/2022	VK	10/04/2023	VK
Participant Profile	1	2	02/10/2022	VK	27/11/2022	VK
Quality healthcare Outcome	7	10	02/02/2023	VK	22/05/2023	VK
Technology Architecture	0	0	13/09/2022	VK	13/09/2022	VK

Codes — Search Project

Name	Files	References
Technology Independence	2	8
Technology Architecture	0	0
Responsive Change Management	1	6
Requirements-Based Change	3	9
Interoperability	5	9
Participant Profile	1	2
DQM Challenges	2	3
Data Quality Challenges	11	49
Quality Health care data Outcome	4	6
Contextual Health care conditions	4	9
Governing Guidelines and Policies	4	12
Mitigate Data Quality Challenges	5	12
DQM causes	6	12

Quality Health care data Outcome	4	6
Contextual Health care conditions	4	9
Governing Guidelines and Policies	4	12
Mitigate Data Quality Challenges	5	12
DQM causes	6	12
Data Quality Assurance	9	24

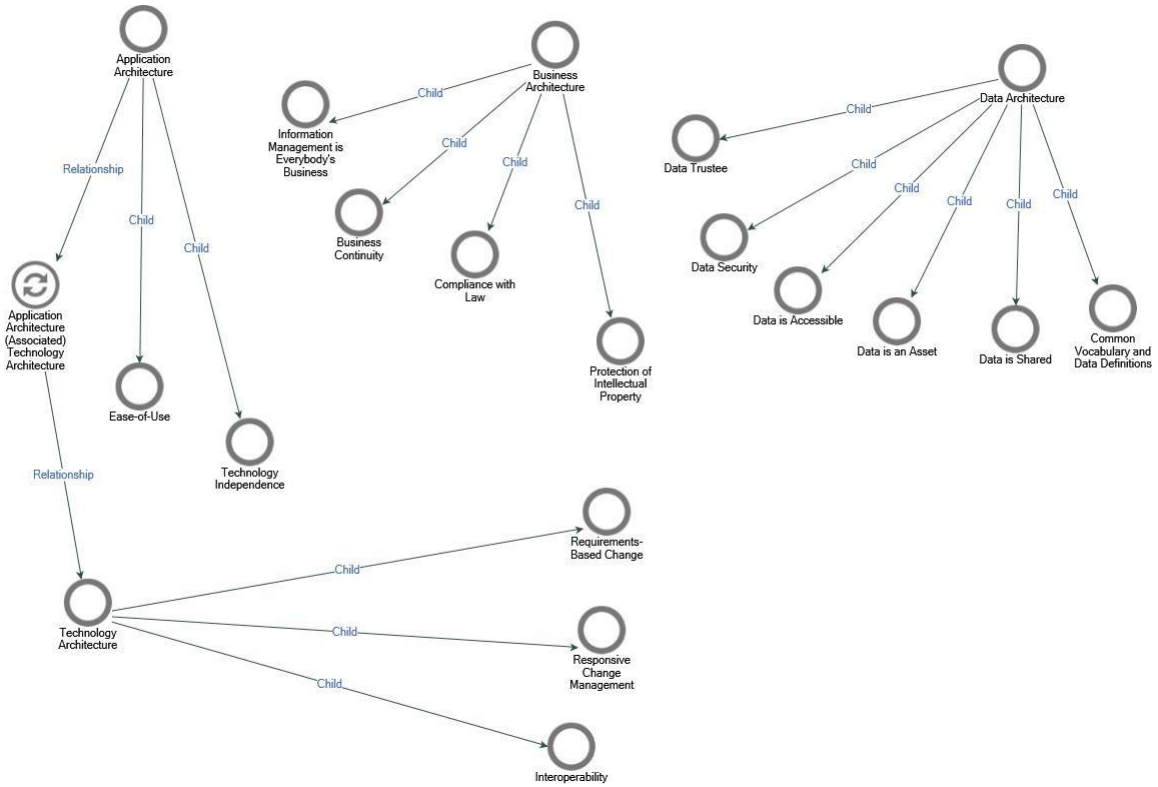

Figure 0.1: TOGAF Data Principles Map

Appendix C – Consent Letters and forms

Management Consent

I,_____, give the researcher of this study consent to conduct their study in the following organization:

_____

I am aware that participation is voluntary and that respondents may choose to withdraw from this study at any time, should they choose to do so.

_____ _____

Signature Date

09 December 2021

Request to conduct research and interview participation consent form

Dear Sir/Madam,

In terms of the requirements for completing a Masters Degree in Information Systems at the University of Cape Town a research study is required.

The researcher, in this case Vitjitua Katjimune, has chosen to conduct a case study entitled "*An Enterprise Architecture approach for Data Quality management within Namibian Health Information Systems*". The researcher would like to request permission to conduct this case study at your organization. The objective of the research is to look at the usefulness of Enterprise Architecture in managing data quality within Namibian Health information system by identifying EA principles/characteristics that influence data management as well as the underlying data management challenges.

We would like to inform you that the ethical aspect of the research ensures the preservation of the identity of the participants, the data collected will be used purely for academic purposes. All personal details will be treated with the highest form of confidentiality. Please note that participation in this research is voluntary and participants can opt out of the study at any time.

The data collection method will be one-on-one interviews with a small group of the staff who manage Health Information System. The interviews will be conducted online via zoom or on your organization's premise and will last for 30 to 45 minutes. If you authorise this study to be undertaken at your organization, please kindly sign the attached form and return to me at your earliest convenience.

Should you have any questions regarding this research, please feel free to contact me on +264 81 2818929 or email me on dkatjimune@gmail.com

Your organization's participation in this study would be greatly appreciated.

Sincerely,

Vitjitua Katjimune [signature]

Researcher \ M.Com Student, (UCT)

Department of Information Systems

University of Cape Town

Email: dkatjimune@gmail.com

Prof. Irwin Brown [signature]

Research Supervisor

Department of Information Systems

University of Cape Town

Email: irwin.brown@uct.ac.za

Research Participant Consent Form

I,_____, consent to participate in the research on *"An Enterprise Architecture approach for Data Quality management within Namibian Health Information Systems".*

I am aware that participation is voluntary and that I may choose to withdraw from this study at any time, should I choose to do so.

_____ _____

Signature Date

UNIVERSITY OF CAPE TOWN
FACULTY OF COMMERCE
Igniting Knowledge and Opportunity

Commerce Faculty Ethics in Research Application Form

Any person planning to undertake research in the Faculty of Commerce at the University of Cape Town is required to obtain ethical clearance. This form is intended for undergraduate students, honours students, PD Dip students and Masters students whose research component is less than 90 credits.

Once this form is completed it should be sent via email to your departmental ethics representative. Your supervisor will be able to provide you with the contact details.

It is assumed that the researcher has read the UCT Code for Research involving Human Subjects (Available at http://web.uct.ac.za/depts/educate/download/uctcodeforresearchinvolvinghuman subjects.pdf) in order to be able to answer the questions in this form. Students must include a copy of the completed form with the dissertation/thesis when it is submitted for examination.

1. PROJECT DETAILS		
Project title:		
Principal Researcher/s:	**Email address(es):**	ktjvit001@myuct.ac.za
Research Supervisor:	**Email address(es):**	irwin.brown@uct.ac.za
Co-researcher(s):	**Email address(es):**	

Department: Information Systems

Brief description of the project:

The research aims to look at the usefulness of Enterprise Architecture in managing data quality within Namibian Health information system by identifying the EA principles/characteristics that influence data management as well as the underlying data management challenges.

Data collection: (please select)

☒Interviews ☐Questionnaire ☐Experiment ☒Secondary data ☐Observation

☐ Other (please specify): _____

Have you attached a research proposal OR a literature review with research methodology? (please select) ☒Yes ☐No

2. PARTICIPANTS

2.1 Does the research discriminate against participation by individuals, or differentiate between participants, on the grounds of gender, race or ethnic group, age range, religion, income, handicap, illness or any similar classification?	YES	NO
2.2 Does the research require the participation of socially or physically vulnerable people (children, aged, disabled, etc.) or legally restricted groups?	YES	NO
2.3 Will you be able to secure the informed consent of all participants in the research? (In the case of children, will you be able to obtain the consent of their guardians or parents?)	YES	NO
2.4 Will any confidential data be collected or will identifiable records of individuals be kept?	YES	NO
2.5 In reporting on this research is there any possibility that you will not be able to keep the identities of the individuals involved anonymous?	YES	NO
2.6 Are there any foreseeable risks of physical, psychological or social harm to participants that might occur in the course of the research?	YES	NO

2.7 Does the research include making payments or giving gifts to any participants?	YES	NO

If you have answered **YES to any of these questions**, please describe how you plan to address these issues (appendto form):

Affiliations of participants: (please select)

☒Company employees ☒Hospital employees ☐General public ☐Military staff ☐Farm workers ☐Students

☐ Other (please specify): _____

Race / Ethnicity:

Are you asking a question about race/ethnicity in your questionnaire?

☐ Yes ☒No

Which race categories have been used?

Have you included the option: "Prefer not to answer" as part of your race/ethnicity question?

3. Provision of Services

Does your research involve the participation of or provision of services to communities?

If your answer is YES, please complete below:

3.1 Is the community expected to make decisions for, during or based on the research?	YES	NO
3.2 At the end of the research will any economic or social process be terminated or left unsupported, or equipment or facilities used in the research be recovered from the participants or community?	YES	NO
3.3 Will any service be provided at a level below the generally accepted standards?	YES	NO

If you answered YES to any of these questions, please describe below how you plan to address these issues.

3. ORGANISATIONAL PERMISSION

If your research is being conducted within a specific organisation, please state how organisational permission has been/will beobtained:

The participants are required to sign a consent form to partake in the research.

Have you attached the letter from the organisation granting permission? (please select)

☐ Yes ☒ No, but this **will be** obtained before commencing the research ☐ Not applicable

Are you making use of **UCT students** as respondents for your research? (please select) ☐ Yes ☒ No

If yes, have you contacted Executive Director: Student Affairs for permission? (please select) ☐ Yes ☐ No

Was approval granted? (please select) ☐ Yes ☐ No ☐ Awaiting a response

Are you making use of **UCT staff** as respondents for your research? (please select) ☐ Yes ☒ No

If yes, have you contacted Executive Director: Human Resources for permission? (please select) ☐ Yes ☐ No

Was approval granted? (please select) ☐ Yes ☐ No ☐ Awaiting a response

Contact Emails: Executive Director: Human Resources (**Miriam.Hoosain@uct.ac.za)**
Executive Director: Student Affairs (**Moonira.Khan@uct.ac.za)**

4. INFORMED CONSENT

What type of consent will be obtained from study participants?

How and where will consent/permission be recorded?

The concept form will be attached on the ethical requirements.

Have you attached an informed consent form to your application? ☒ Yes ☐ No

5. Sponsorship of Research

If your research is sponsored, is there any potential for conflicts of interest? No

If your answer is YES, please complete below

4.1 Is there any existing or potential conflict of interest between a research sponsor, academic supervisor, other researchers or participants?	YES	NO
4.2 Will information that reveals the identity of participants be supplied to a research sponsor, other than with the permission of the individuals?	YES	NO
4.3 Does the proposed research potentially conflict with the research of any other individual or group within the University?	YES	NO

If you have answered **YES** to any of these questions, please describe how you plan to address these issues (append to form)

6. RISK TO PARTICIPANTS

Does the proposed research pose any physical, psychological, social, legal, economic, or other risks to study participants you can foresee, both immediate and long range? **(please select)**

☐ Yes ☒No

If yes, answer the following questions:

Describe in detail the nature and extent of the risk and provide the rationale for the necessity of such risks

Outline any alternative approaches that were or will be considered and why alternatives may not be feasible inthe study

Outline whether and why you feel that the value of information to be gained outweighs the risks

2.
3.

I certify that I have read the Commerce Faculty Ethics in Research policy ☐
(http://www.commerce.uct.ac.za/Pages/ComFac-Downloads**)**

I hereby undertake to carry out my research in such a way that

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

Signed by:

	Full name and signature	Date
Principal Researcher/Student:	Vitjitua Katjimune	09 December 2021

This application is approved by:

Supervisor		7th Apr 2022
Departmental Ethics Rep		

Questionnaire checklist on next page

CHECKLIST	SELECT
A full copy of a research proposal or a literature review with methodology is attached in a separate file	☒
Interview schedules / cover letters / questionnaires / forms and other materials used in the study are attached in separate files	☒
Organisational consent letter / UCT student or staff approval letter	☐
On your cover letter to your questionnaire have you included the following?	☒
The following UCT Logo 	☒
A sentence explaining the aim of the research	☒
Sentences of a similar nature to below must be included in the coverletter or consent form:	☐
This research has been approved by the Commerce Faculty Ethics in ResearchCommittee.	☒
Your participation in this research is voluntary. You can choose towithdraw from the research at any time.	☒
The questionnaire will take approximately X minutes to completeYou will not be requested to supply any identifiable information, ensuring anonymity of your responses.	☒ OR
Due to the nature of the study you will need to provide the researchers with some form of identifiable information however, all responses will be confidential and used for the purposes of this research only.	☐
	☒
	☒
Should you have any questions regarding the research please feel freeto contact the researcher (insert contact details).	
Have you scanned in your signature for the last section of the form?	