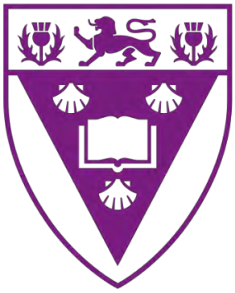


RHODES UNIVERSITY

Where leaders learn

A Conceptual IT Governance Framework to Guide the Development of Interoperable Health Information Systems

By

Lebogang Matshaba

Orcid: https://orcid.org/0000-0002-7611-7681

A Conceptual IT Governance Framework to Guide the Development of Interoperable Health Information Systems

Thesis submitted in fulfilment of the requirements for the degree of

MASTER OF COMMERCE

in

INFORMATION SYSTEMS

in the

FACULTY OF COMMERCE

of

RHODES UNIVERSITY

Supervisor

MONELO NXOZI

Co-supervisor

PROFESSOR MARLIEN HERSELMAN

December 2021

Abstract

In light of changing health needs, health information systems are presented with a plethora of challenges. For instance, the rise of COVID-19 in the past year has led to the discourse on the strength of current health systems to support health needs and the readiness for the National Health Insurance in South Africa. In addition to operating in resource-constrained environments, the lack of synchrony between health information systems across health facilities led to the fragmentation of health information and diminished access to quality healthcare. This research, following the Design Science Research Methodology (DSRM) process, developed an IT governance conceptual framework (HISIG-CF), to inform the interoperability of health information systems. The HISIG-CF is developed from literature and qualitative data collected using an expert reviews method from practitioners in the healthcare sector who evaluated the constructs of the HISIG-CF. Thematic analysis and hermeneutics were used to analyse and interpret the data. The results revealed a need for more guidance to inform interoperability interventions and strengthen current health information systems. The contribution of this study is the HISIG-CF which is deemed relevant and potentially fit-for-purpose to improve health information systems interoperability within the healthcare sector in South Africa.

Keywords: IT Governance, Health Information Systems, Interoperability, Design Science Research, National Health Insurance, Electronic Health Records

Declaration

I, **Lebogang Matshaba**, hereby declare that:

The work contained in this thesis titled, *A conceptual IT Governance framework to guide the development of interoperable health information systems*, submitted in fulfilment of the degree of Master of Commerce in Information Systems at Rhodes University, is my work and no prior submissions have been made. All sources consulted or cited have been documented and acknowledged. The researcher is fully aware of Rhodes University's policy on plagiarism and has undertaken all necessary efforts to adhere to the established regulations.

_____

Lebogang Matshaba

Acknowledgements

I would like to express my heartfelt gratitude to the following individuals and organisations, without whom, this research would not have been possible:

My supervisors Monelo Nxozi and Prof. Marlien Herselman for all the valuable feedback and guidance at every stage of this research.

The North West Provincial Department of Health for providing access to experts who contributed greatly to this research.

My family, friends and boyfriend for their ongoing support and constantly cheering me on. I appreciate you all so much.

I also wish to extend my gratitude to Allan Gray and the NRF for providing the financial assistance to complete my research.

Through this research, God has demonstrated His unending grace and favour upon my life. I do not take lightly the opportunity to have been able to complete this research. I will forever be grateful for such a fulfilling journey and hope to take the lesson learnt into the next phase of my life.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

Abbreviation	Description
CAQDAS	Computer-Assisted Qualitative Data Analysis Software
CSIR	Council for Scientific and Industrial Research
DSR	Design Science Research
DSRM	Design Science Research Methodology
EHR	Electronic Health Records
eHealth	Electronic Health
EMR	Electronic Medical Records
FEDS	Framework for Evaluation in Design Science Research
FHIR	Fast Healthcare Interoperability Resources
HIMSS	Healthcare Information and Management Systems Society
HIS	Health Information System
HISIG-CF	Health Information Systems Interoperability Governance Conceptual Framework
HIX	Health Information Exchange
HL7	Health Level Seven
HNSF	Health Normative Standards Framework
IHE	Integrating the Healthcare Enterprise
IT	Information Technology
ITG	IT Governance
NDoH	National Department of Health
NHI	National Health Insurance
PHR	Personal Health Records
PMI	Patient Master Index
RIM	Reference Information Model
SDO	Standards Development Organisation
UHC	Universal Health Coverage
USSD	Unstructured Supplementary Service Data
WHO	World Health Organisation

Chapter 1 : Introduction

1.1 Research Background

The rise of digitisation for the delivery of services is challenging traditional forms of service delivery, and the health sector is no exception. In the South African context, progress has been made towards defining the strategic context within which digital health initiatives should be developed, which has been evident following the development of a National Digital Health Strategy (initially introduced as the eHealth Strategy). The strategy seeks to guide the governance and coordination of digital health efforts (South African National Department of Health, 2019). However, implementing the first (eHealth) strategy provided evidence of inefficiencies across current health information systems (HISs). These have mainly been attributed to HISs that operate in silos across different levels of government (viz. local, provincial, and national) (Brauns, 2016). In addition to being "driven by donor-funded vertical programmes" that often operate as pilot projects that are not in alignment with the overall national health strategies set (Herselman and Botha, 2016, p.75).

Central to digital health services delivery is the need for interoperability across HISs. Interoperability relates to how systems (or components) communicate to achieve mutual goals by exchanging and sharing information (Wimmer, Boneva and Di Giacomo, 2018). Through interoperability, healthcare providers can form knowledge-sharing networks that reduce health information duplication across different HISs (Desai, 2015). For example, this can be accessible across Electronic Health Records (EHR), which provide the history of a patient's health records in a digital format, allowing real-time access as required. Additionally, the value of interoperable health systems allows key decision-making stakeholders to gain access to information needed to strengthen the provision of quality healthcare services (Desai, 2015).

As part of the digital health ecosystem, interoperability performs a significant role in sharing key health information needed to provide health services. However, although considerable progress has been made in defining interoperability constructs and their implementation in South Africa, interoperability is not yet at the stage of being fully enactable (Desai, 2015; Katuu, 2016; Clarke *et al.*, 2018). This further impedes South Africa's progress towards attaining Universal Health Coverage (UHC) through the National Health Insurance (NHI) programme.

The NHI envisions an ideal state of health provision to redress the health sector's historical and current challenges. As stated in the NHI white paper, one of the NHI's primary objectives is to reform healthcare delivery (South African National Department of Health, 2015). Through this, the NHI aims to ensure that all South Africans have access to affordable, high-quality healthcare services, regardless of their economic status (South African National Department of Health, 2015). However, if the focus is not on providing quality healthcare by strengthening local systems, UHC will produce unrealistic outcomes through the NHI program (Fusheini and Eyles, 2016).

The National Department of Health (NDoH) identified leadership, governance, and multi-sector engagement as critical enablers of a progressive health environment. Furthermore, a priority in implementing the eHealth strategy is the "use of mechanisms, expertise, coordination, and partnerships to implement the eHealth strategy and develop or adopt eHealth components (e.g. standards)" (NDoH and CSIR, 2014, p.1). The health ministry's emphasis on governance necessitates increased governance efforts to provide quality healthcare.

Although governance has been acknowledged to be of great significance, its value within the health environment is yet to be realised (Benedict and Schlieter, 2015). IT governance (ITG) continues to lag in making provisions for interoperability. This research aims to contribute to the management of health systems by defining ITG mechanisms that can inform the development of interoperable HISs. The ITG mechanisms considered will focus on using structures, processes, and relational mechanisms as key functions to define the implementation of ITG (Van Grembergen, Haes and Guldentops, 2004).

1.2 Problem Statement

The NDoH has noted the provision of healthcare services through interoperable systems as one of the key strategic interventions requiring attention towards creating efficient health systems. This promises to ensure that healthcare providers access necessary health information to provide efficient health services and improve decision-making. However, current health systems function in silos, with health information distributed across multiple health care facilities.

In the South African context, there is a need to address the issue of fragmented HISs. In order to do so, ITG mechanisms defining the structures, processes, and relational mechanisms that can be used are crucial. Accordingly, adopting an ITG lens to improve HISs interoperability interventions aims to ensure guidelines are in place to direct future developments.

1.3 Research Question

Informed by the research background and problem statement, the main research question of the study is outlined below:

What should constitute the components of a conceptual framework that outlines IT governance mechanisms to support the development of an interoperable health information system?

The research question is further divided into the following three sub-research questions (SRQ):

SRQ1: What IT governance mechanisms can be used to support interoperable health systems?

This question aims to define the implementation of ITG in aiding the progress towards creating interoperable HISs. Implementation is defined based on different structures, processes and relational mechanisms.

SRQ2: How should health information systems align with interoperability practices?

The purpose of this question is to investigate the context of the various HISs in operation across South Africa to demonstrate the value that can be added through interoperability alignment.

SRQ3: What is the role of interoperability standards on health systems?

The purpose of this question is to examine the impact of standards when defining HIS interoperability.

1.4 Research Purpose and Objectives

Considering the research problem, the purpose of this research is to strengthen the implementation of ITG in HISs across South Africa. This will be achieved by developing a conceptual framework that will enable management in the healthcare environment to make more informed decisions towards integrating interoperability across various health system.

The conceptual framework for this research will be referred to as the Health Information Systems Interoperability Governance Conceptual Framework (HISIG-CF), which will be developed using the following research objectives:

- Study and explore literature related to *IT governance, Health Information Systems* and *Interoperability*.
- Develop an initial conceptual framework informed by literature.

- Demonstrate the initial conceptual framework informed by the results and findings obtained from literature.
- Identify and define experts who will review and evaluate the initial conceptual framework within the context of the healthcare environment.
- Reflect on the insights obtained from expert reviewers to improve the initial conceptual framework.
- Communicate the results obtained towards developing the final conceptual framework.
- Develop the final conceptual framework to conclude the research.

1.5 Research Design and Methodology

The purpose of this research is to develop an artefact, in the form of a conceptual framework as such, the Design Science Research (DSR) approach is employed. DSR supports problem-solving through creating socio-technical artefacts in a given context (Adebesin and Kotzé, 2017). Rooted in the philosophy of pragmatism, this research follows the guidance provided by the Design Science Research Methodology (DSRM) defined by Peffers *et al.* (2007), which is conducted using a two-phased approach, described as:

- **Phase 1:** Defines the theoretical foundation of the conceptual framework by studying literature related to IT governance, Health Information Systems, and Interoperability. Through the Scoping Reviews process, the results are analysed to develop and demonstrate the initial conceptual framework. The output of this phase is presented as the design of the initial conceptual framework.
- **Phase 2:** Reviews and evaluates the constructs and design of the initial conceptual framework using expert reviews. The outcome of this phase is presented in the form of the final HISIG-CF, which serves as the contribution of this research.

The application of the DSRM process, which guides the development of this research (discussed in more detail in chapter 2), is applied as depicted in Figure 1-1 below.

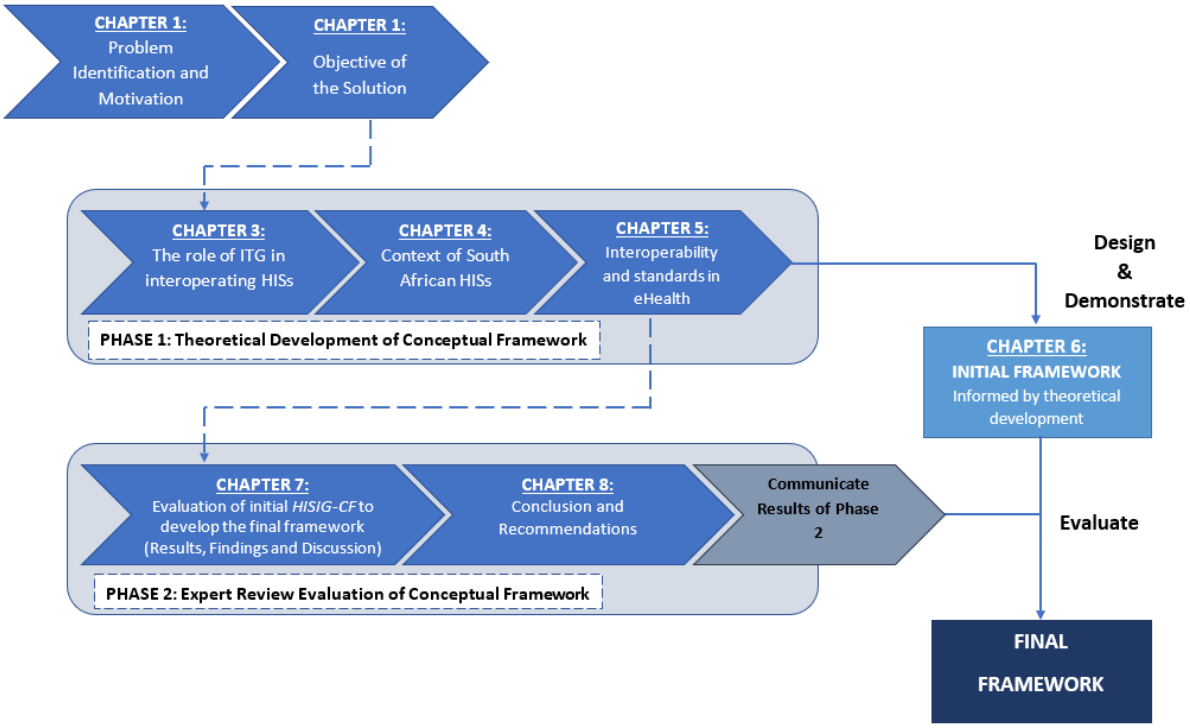


Figure 1-1: DSRM application

1.6 Ethical Considerations

The Rhodes University Human Ethics Committee (RU-HEC) and the North-West Provincial Department of Health reviewed and approved this research (see clearance letters in Appendix A). Permission to conduct this research was obtained from the CEO offices of the hospitals selected to participate in this research. Participation in this research was voluntary, and all the participants were requested to sign an informed consent form prior to partaking in the study.

1.7 Research Significance

The HISIG-CF will makes the following contributions in the South African (and developing countries alike) healthcare environment as follows:

The research will provide a synthesised conceptual framework that draws from various literature to produce the final solution at a **theoretical** level. This will be done primarily to address knowledge gaps in the literature concerning HIS interoperability. Furthermore, this activity will focus on using ITG to facilitate HIS interoperability. The foundation of the conceptual framework will be developed in alignment with Institutional Theory.

The complexities faced by the healthcare environment in South Africa require a thorough study to understand how interventions can be integrated. As such, at a **methodological** level, this

research will be developed in iterations and phases following the DSRM process to enable constant improvement (Peffers *et al.*, 2007).

The **practical** contribution will result in the final output in the form of a conceptual framework (HISIG-CF). The output will be best suited for the health environment (health systems) in the South African context. The foundation of the conceptual framework is informed by relevant literature in IT governance, Health Information Systems and Interoperability. Additionally, experts in healthcare and academia will evaluate the conceptual frameworks utility, quality, efficacy, and efficiency to ensure that it has been rigorously designed.

1.8 Delimitation of the Research

This research focuses primarily on interoperability in context to HISs and does not discuss other aspects beyond this scope. Furthermore, this research considers IT governance/ specifically in the private and public health sectors in South Africa.

1.9 Research Outline

This research is conducted across the following chapters, each addressing a specific area of the study and subsequently summarised in Figure 1-2 below:

- **Chapter 1:** Lays the foundation for this thesis by introducing the background of the research**.**
- **Chapter 2:** The focus of this chapter is to outline the methodology used to develop this research and discusses how the DSRM process was applied.
- **Chapter 3:** Guided by SRQ 1, the focus of this chapter is to critically explore the literature on the role of ITG mechanisms in health systems. The intention of this is to gain an understanding of the different ITG mechanisms that would contribute to aiding HISs interoperability. This chapter contributes to the ITG theme of the theoretical foundation.
- **Chapter 4:** The role of IT governance cannot be considered without a clear understanding of the context in which it is studied. This chapter aims to understand the current view on health systems in South Africa. Furthermore, chapter 4 is conducted to address aspects of SRQ 2. This chapter addresses the HIS theme, and the constructs relevant to the theoretical framework are defined.
- **Chapter 5:** Informed by SRQ 3, this chapter studies literature that focuses on the value and impact of standards regarding interoperability. This chapter addresses concepts

related to interoperability and defines the constructs considered valuable for the theoretical foundation of the initial HISISG-CF.

- **Chapter 6:** Guided by the various themes addressed in chapters 3 to 5, the constructs and initial design of the HISIG-CF are introduced. Scoping reviews are further conducted to evaluate the constructs of the HISIG-CF further. Chapter 6 concludes the design on the initial HISIC-CF.
- **Chapter 7:** Focuses on evaluating the initial HISIG-CF in preparation for the final design. This is done by presenting and interpreting the results from the questionnaire administered to the various experts using the FEDS to define the evaluation strategy and analysed using hermeneutics. The chapter concludes with the presentation of the final HISIG-CF, which is the contribution of this research.
- **Chapter 8:** Reflects on the research process undertaken, provides a personal reflection on the researcher's key learning areas and includes recommendations for future studies to conclude the investigation.

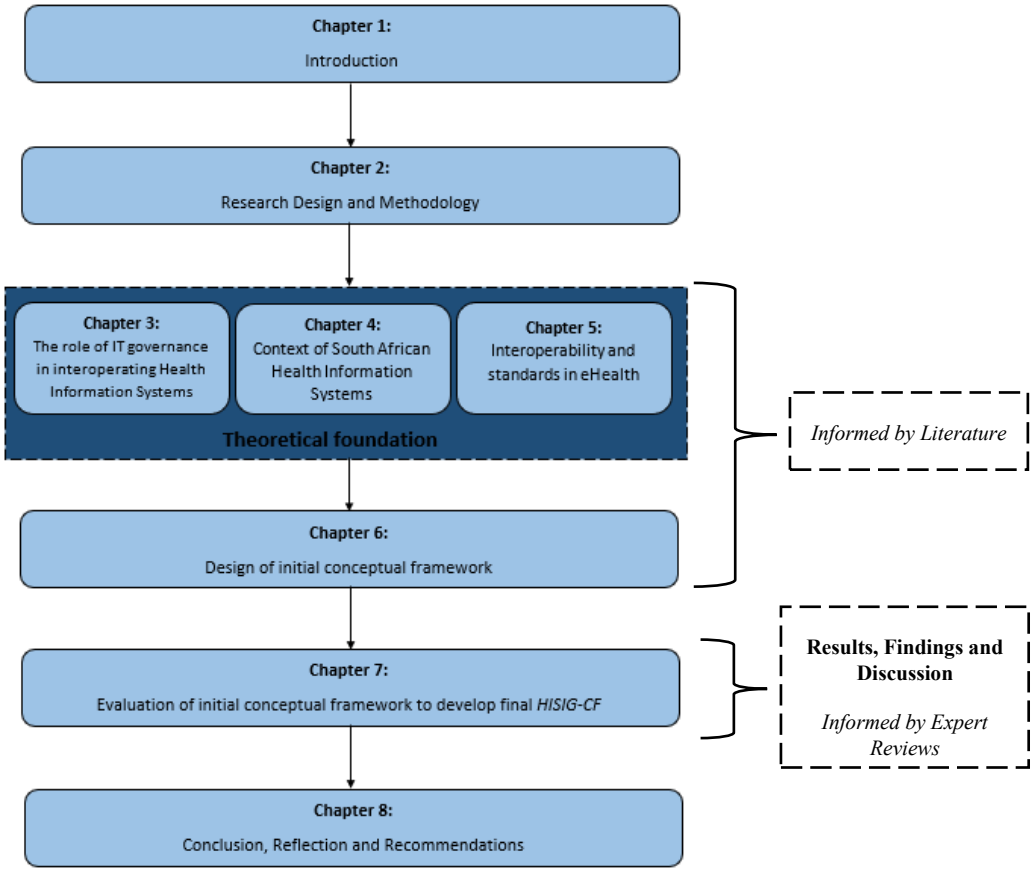


Figure 1-2: Research structure

Chapter 2 : Research Methodology

2.1. Introduction

A research methodology intends to describe the design and procedure used to develop a study (Bell, Bryman and Harley, 2018). This contributes to situating one's study within a specific methodological tradition to support and rationalise the research processes employed. Therefore, this chapter discusses the DSRM process and how it was used to develop the HISIG-CF. Additionally, the theoretical lens through which this study is developed is provided in addition to the data collection and analysis techniques. It was imperative to establish the philosophical positioning that grounds this research to commence this chapter. This enabled the researcher to relate the worldview perception on the nature of knowledge to this research.

2.2. Research Philosophy

Irrespective of the research area studied, every research rests upon a philosophical grounding. Saunders, Lewis and Thornhill (2016) define a research philosophy as the development and nature of knowledge. Further, a research philosophy can also be defined as a belief directing how a phenomenon is explored regarding data collection, analysis (Graue, 2015). The core philosophies on which Information Systems (IS) research largely stems from include: Positivism, Interpretivism and Critical Research (Saunders, Lewis and Thornhill, 2016).

Positivism	Concentrates on scientific empiricist research methods to produce outputs that are primarily factual in nature to present unbiased results.
Interpretivism	Rooted in the belief that humans and innate structures are distinct. The emphasis is on developing an in-depth understanding of the social world in order to create and appreciate its associated meaning.
Critical Realism	Considers associated underlying factors to gain insight into the influences that drive one's experiences. Critical realists are motivated primarily by their perception of reality, which inspires their actions.

Although these philosophies have long been the foundations of IS research, there has been a rising need for "more open and nuanced ways" (Goldkuhl, 2012, p.1) to investigate the

dynamic nature of the IS field. In addition, due to the transdisciplinary nature of IS, there has been an increasing need to not solely base IS research on traditional philosophies (Goldkuhl, 2012; van Zyl, 2015). For this reason, pragmatism as a research paradigm has been at the forefront of one of the emerging philosophies, gaining more acceptance and increasing use (Goldkuhl, 2012).

2.2.1 Pragmatism as a Research Philosophy

Pragmatism can be defined as a philosophy on which success is measured by producing practical solutions to problems (Saunders, Lewis and Thornhill, 2016). The paradigm focuses on knowledge produced is believed to be effective only if it is functional.

When a researcher cannot follow a positivism or interpretivism approach, pragmatism is often regarded as the best choice (Saunders, Lewis and Thornhill, 2016). However, pragmatism is not a last resort strategy. On the contrary, it is equally essential that researchers further their knowledge of the paradigm by familiarising themselves with the nature of knowledge and reality defined by pragmatism (van Zyl, 2015).

To begin, the researcher considered the epistemological and ontological perceptions or assumptions made in prior similar studies to contextualise the current research (van Zyl, 2015). Knowledge of the related philosophical beliefs serves as a crucial enabler for gaining foundational insights on the approach. For instance, the choice in one's philosophical stance may be influenced by the following set of assumptions (Saunders, Lewis and Thornhill, 2016):

Epistemological	Based on the assumptions related to the plausibility of human understanding and its potential to guide meaningful engagements.
Ontological	It is concerned with assumptions about the nature of reality and how it influences how the world is perceived.
Axiological	Takes into account the importance and impact of values in research.

In essence, researchers' perceptions of the nature of reality (ontology) influence their epistemological views and knowledge generated (Vaishnavi and Kuechler, 2013; Saunders, Lewis and Thornhill, 2016). While the axiological assumptions regarding the value accorded serve to guide the boundaries of a selected methodology.

Pragmatism focuses on practical solutions and knowledge creation in a given context and time frame (Shusterman, 2016). The relevance of pragmatism in this research is evident in its foundations and underlying assumptions that support Design Science Research (DSR) (Shusterman, 2016). As with pragmatism, DSR outputs contribute through practical and visible outcomes that may be presented as artefacts (Goldkuhl, 2012; Adebesin and Kotzé, 2017). DSR is congruent with the purpose of this research of designing a conceptual ITG framework that will guide the development of interoperability amongst HISs. As previously indicated (section 2.2), it is crucial to consider the philosophical basis on which research is conducted. Table 2-1 below summarises the assumptions of pragmatism and their relevance to this research as defined by Vaishnavi and Kuechler, 2013; Saunders, Lewis and Thornhill, (2016).

Table 2-1: Pragmatic philosophical assumptions in alignment with DSR

Basic Belief	Research Perspective	
	Pragmatism	**Design Science Research (for this research)**
Epistemology *The nature of knowledge*	Meaning and knowledge are produced in specific contexts. Research considers a research problem being a vital driving force of developing practical solutions.	The knowledge creation process is context-driven and accomplished through the development of the research artefact.
Ontology *The nature of reality*	Reality is complex, diverse, and external. The practical outcome of results defines ideas and solutions developed.	Considers a multidimensional perspective while defining the research setting and the process through which the research artefact is developed.
Axiology *Defines what is considered valuable*	Research deems values as being a crucial factor in influencing the direction of a study. Values perceived by a researcher impacts research.	Research is influenced by the need to provide beneficial and applicable solutions in a particular setting.
Methodology *Defines the process taken towards research development*	Consider multiple methods and enables a pluralistic approach to research. Focuses on producing practical solutions.	A progressive approach to developing the artefact for this research (as guided by the DSRM process). The outcome is presented in the form of a conceptual framework

Knowledge and action-oriented outputs are essential directing characteristics that contribute to pragmatism's structure (Vaishnavi and Kuechler, 2013). A prominent advantage of pragmatism is that it caters to complex and varying contexts, widening the scope of research with meaningful insights. Furthermore, pragmatism considers the values individuals ascribe and how they ultimately influence the decision-making process and the extent of their influence.

2.3. Design Science Research (DSR)

The development of this research is done in alignment with the DSR. Design Science is a research approach that aims to create knowledge using artefacts as the output (Vaishnavi and Kuechler, 2013; Adebesin and Kotzé, 2017). The strength of this methodology lies in its focus on solving problems through socio-technical artefacts, allowing one to gain knowledge about a problem and to create a solution given the context (Adebesin and Kotzé, 2017).

The use of Design Science in research has not been without its challenges. This has led to discourse about its origins, whether the approach is suitable for research and if design indeed does form part of research (Vaishnavi and Kuechler, 2013; Drechsler and Hevner, 2016). However, Design Science has proven to have utility in that new knowledge can be generated following processes to guide its use.

2.3.1 Four-Cycle View of DSR

The foundation of DSR has been demonstrated through a widely recognised three-cycle model. Drawing from the IS research framework, the model considers three critical focus areas when undertaking DSR, including the relevance cycle, rigour cycle, and the design cycle (Hevner, 2007). However, due to varying environments' dynamic nature and complexities, the three-cycle model has been extended to include and adapt to likely changes through the change and impact cycle, as illustrated in Figure 2-1 below (Hevner, 2007; Drechsler and Hevner, 2016). Through this extension, DSR integrates change as part of an artefact's design to improve its rigour to consider the broader environment in which an artefact is developed.

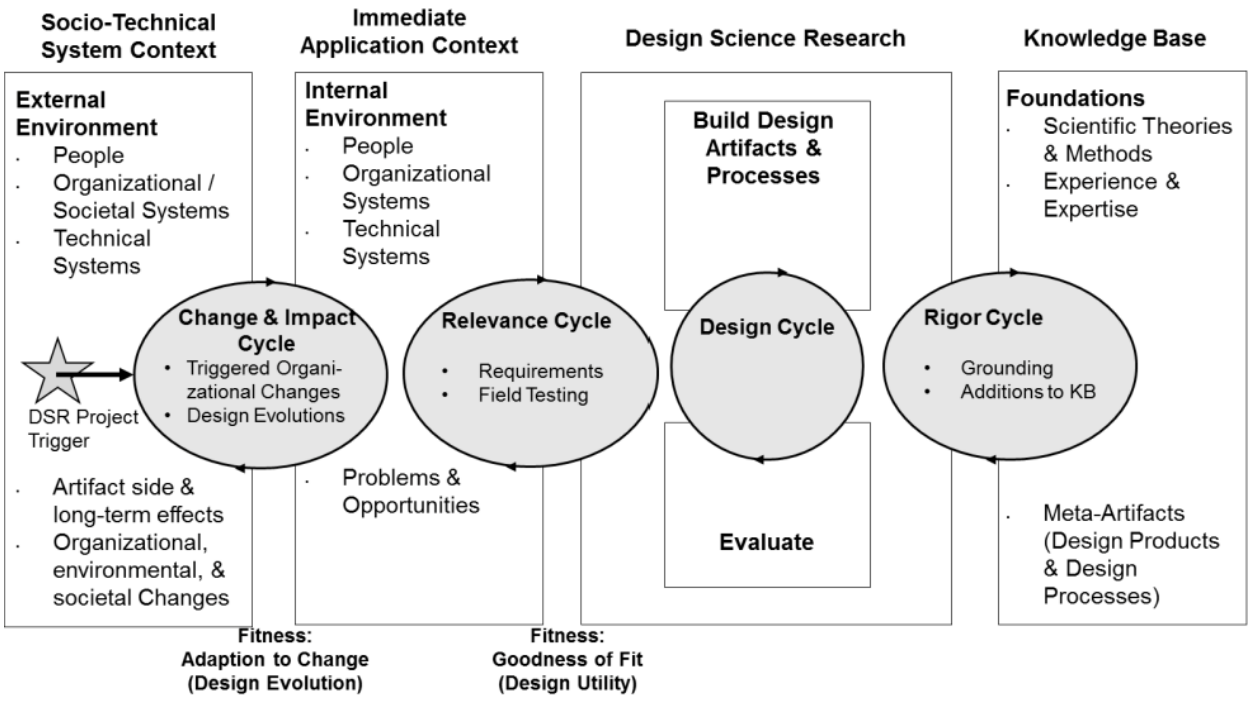


Figure 2-1: DSR four-cycle view (Drechsler and Hevner, 2016)

The following sections describe each of the cycsles and their relevance for the development of the initial HISIG-CF (Drechsler and Hevner, 2016)*:*

a) Relevance Cycle

In DSR, the Relevance Cycle starts with an application context. The problem that research intends to address functions as inputs and the criteria to evaluate the research results. Moreover, the artefact designed should further be demonstrated in the appropriate environment to determine applicability in a given domain.

The development of the HISIG-CF as an output for this research can be used to guide the use of ITG towards HIS interoperability in developing countries that share similar traits, such as South Africa. The conceptual framework would guide efforts as informed by the relevant literature. Furthermore, the constructs and identified requirements of the HISIG-CF were evaluated by experts from academia and the healthcare environment to strengthen its foundation.

b) Rigour Cycle

The Rigour Cycle draws from existing knowledge to ensure that the application of the designed artefact draws from known processes. In this research, literature related to IT governance, Health Information Systems and Interoperability was used to inform the development of the HISIG-CF.

c) Design Cycle

The Design Cycle focuses on developing design alternatives and further evaluates these to ensure that the initial requirements are integrated and well considered. For this research, the Design cycle was achieved through the demonstration and evaluation of the HISIG-CF using expert reviews.

d) Change & Impact Cycle

Considering the pervasive and dynamic nature of IS research, the design process considers probable advancements through the Change and Impact Cycle. Through this cycle, the need to create adaptable artefacts is evaluated to ensure that the relevance of the designed output remains intact. In developing the HISIG-CF, the researcher acknowledges that the success of implementation relies on the people involved with the processes in use. As such, the process mechanism of ITG in the final artefact considered change management as part of the design and requirements of the conceptual framework (further details are provided in Table 3-3, Chapter 3).

2.3.2 DSR Artefacts

The value and contribution of DSR can been seen in its ability to create aretfacts as resercah outputs. Van der Merwe, Gerber and Smuts (2020) define artefacts as objected created to resolve real life problems. In DSR, artefacts can comprise of any of the following aspects:

Table 2-2: Design Science Artefacts (Hevner and Chatterjee, 2010; Vaishnavi and Kuechler, 2013)

Examples of Artefacts in DSR	Description
Constructs	Relates to the knowledge shared in a given discipline developed through an understanding of the problem or solution defined.
Models	Describes the relationships established across constructs and represents a defined problem or solution.
Methods	Defines a set of activities that can be used to achieve an intended goal.
Instantiations	Focus on the attainment and effective use of constructs, models and methods. The HISIG-CF is an example of this type of artefact.
Better theories	Through DSR, new or existing theories can be developed to better understand how the concepts addressed relate.

Following the descriptions of the various artefacts in Table 2-2 above, the HISIG-CF developed in this research can be seen as an instantiation. The conceptual framework's focus mainly informs this on designing and demonstrating the practicality of the constructs in the healthcare context (Vaishnavi and Kuechler, 2015). Expert reviewers further evaluated the HISIG-CF's utility, quality, efficacy and effectiveness to determine if the conceptual framework would be of value toward developing interoperable HISs.

2.4. Design Science Research Methodology (DSRM) Process

The development of the HISIG-CF, which could potentially guide the ITG of interoperability in South African health systems, is done following the guidance of the DSRM process defined by Peffers *et al.* (2007). The DSRM process in this research underwent the following activities: problem identification and motivation, the definition of objectives, design and development, demonstration, evaluation, and communication, presented in Figure 2-2 below and subsequently defined (Peffers *et al.*, 2007).

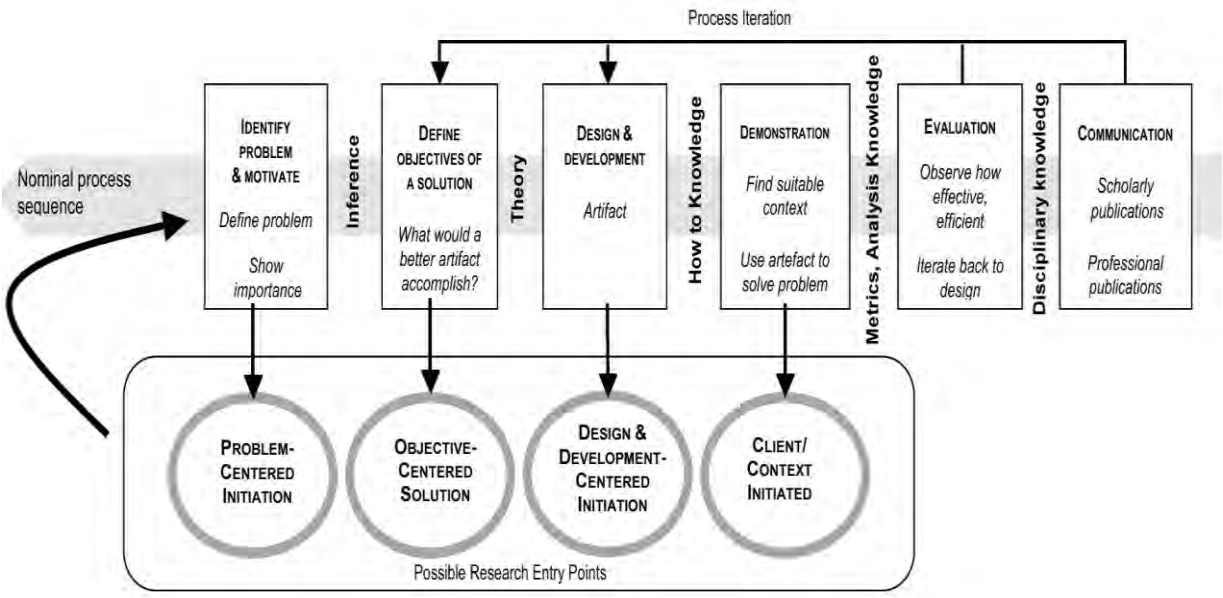


Figure 2-2: DSRM process model, adapted from Peffers et al. (2007)

2.4.1 Problem Identification and Motivation

This activity focuses on defining the problem to be solved which infoms the solution designed. The research problem stated in section 1.2 serves as the motivation for creating the HISIG-CF. The research problem was additionally translated into the main RQ and SRQ to focus this research (See section 1.3).

2.4.2 Define the Objective of the Solution

In light of the research's motivation, as stated in the research statement, the primary objective of this study was outlined in Section 1.4 as being motivated by the need to provide a solution through an IT governance conceptual framework that would enhance knowledge of HIS interoperability. Conceptual frameworks are critical components of research because they enable researchers to examine subjects using abstractions (Bharti, Agrawal and Sharma, 2015). Additionally, conceptual frameworks have traditionally functioned as a guide for comprehending specific areas of investigation (Bharti, Agrawal and Sharma, 2015). As a result, this research was conducted to develop a solution suited to the healthcare environment.

2.4.3 Design and Development

This activity aims to create the actual solution or conceptual framework, as motivated in the research problem and overall objective. The process of creation includes knowledge drawn from theory to aid the constructs of the solution. For this reason, the design of the initial

conceptual framework was informed by literature and theory. These served as reinforcement for the solution and were imperative in positioning the research in the greater research field of IT governance in the health environment.

2.4.4 Demonstration

The purpose of this activity was to demonstrate the use of the designed solution (artefact). The intent was motivated by establishing the feasibility implementation (Vaishnavi and Kuechler, 2013). Furthermore, the demonstration activity was driven by a qualitative approach to generate a comprehensive understanding of ITG to guide further investigation into the development of interoperable HISs.

This was done by conducting a thorough literature review, whereby the outcome was used to define the constructs of the initial HISIG-CF design. Once the literature review was complete, the result was further analysed using Thematic Analysis to search for patterns across the data sets (Bell, Bryman and Harley, 2018). To draw themes from the literature that would produce meaningful insights, Computer-Assisted Qualitative Data Analysis Software (CAQDAS), namely NVIVO, was used (Saunders, Lewis and Thornhill, 2016). In using NVIVO, it was vital to define an appropriate strategy to ensure that the tasks align to determine the constructs contributing to developing the initial conceptual framework. As such, this research follows the data analysis process defined by Creswell and Poth (2016) which includes: organising data; exploring data; describing and classifying data; visualising and interpretation; reporting on data (discussed and applied in more detail in chapter 6).

Guided by the SRQs, the themes of this research were defined as *IT governance, Health Information Systems,* and *Interoperability* addressed across chapters 3 to 5. The themes were used to guide the theoretical foundation of the initial HISIG-CF (presented in chapter 6) and the associated constructs. After completing the literature review, the results were analysed using thematic analysis to inform phase 2 of the DSRM process. Conducting thematic analysis was essential in understanding the literature studied to determine the themes conveyed to address the objectives of this research (Bell, Bryman and Harley, 2018).

2.4.5 Evaluation

The evaluation activity is crucial to the process of DSR with the intent of producing an artefact. According to Saunders, Lewis and Thornhill (2016), evaluations enable a researcher to judge the methods used based on accuracy and consistency. Importantly, it is also a valuable measure

of determining the comprehensiveness of a solution designed. To subscribe to the nature of a DSR approach, evaluation occurred iteratively across the research during Phase 2. This was done by formulating an evaluation strategy using the Framework for Evaluation in Design Science (FEDS) to guide the evaluation of the initial conceptual framework in preparation for the final HISIG-CF (Venable, Pries-Heje and Baskerville, 2016).

Through evaluations, the researcher was able to determine the extent to which the HISIG-CF reaches its intended outcome in producing a novel solution to the management of healthcare information (Venable, Pries-Heje and Baskerville, 2016). The outcome contributed to the choice to either iterate back to the design activity or proceed to the next final stage (communication). Evaluating the rigour of the HISIG-CF is a process that cannot be done by the researcher alone. For this reason, assessing the adequacy and comprehensiveness of the conceptual framework required the contribution of expert reviewers, further discussed in section 2.5.2.

As part of the evaluation of the HISIG-CF in Phase 2, qualitative data collection and analysis techniques were employed. This was done in the form of an expert review questionnaire and further analysed using hermeneutics. Employing a qualitative technique to evaluate enabled the researcher to understand the phenomenon in more depth and appreciate the meaning the participants ascribe (Bradshaw, Atkinson and Doody, 2017). On the other hand, through employing hermeneutics, the researcher was able to understand the relationships between social actors, organisations, and technology and their impact on the design of the conceptual framework (Kroeze and Van Zyl, 2015). Additionally, to ensure further rigour in analysis, hermeneutics' constant iteration and reflection enabled the researcher to make sense of the insights obtained from the expert reviews (Myers, 2016). The value in using hermeneutics is that it aligns with the interpretive nature of this research (Kroeze and Van Zyl, 2015). As such, the principles for conducting evaluation were considered as presented in Table 2-3 below (and are applied in Chapter 7 during evaluation).

Table 2-3: Principles considered for evaluation (Klein and Myers, 1999)

Principles	Description
The fundamental principle of the hermeneutic cycle	Suggests that human understanding can be advanced by drawing meaning from parts to understand how these contribute to the bigger picture. This principle lays the foundation for all the other principles.
Principle of contextualization	Concerned with understanding the background in which a study is conducted. This principle is used to inform further investigation.
Principle of interaction between researchers and subjects	Focuses on how the research data is constructed based on the researcher's interactions with participants.
Principle of abstraction and generalization	Concerned with relating the insights revealed from interpretation with the first and second principle.
Principles of dialogical reasoning	Focuses on the differences that may occur based on what theory defines and what is found after collecting data.
Principle of multiple interactions	Relates to the differences that occur when interacting with multiple participants and ensuring that these are considered.
Principle of suspicion	This principles is focused on ensuring that interpretation considers possible biases from the insights or narrattives communicated by participants.

Owing to the complexities of HISs interoperability (Clark, 2019), the expert reviews were valuable in obtaining an interpretive view that assisted in the following ways:

- Understanding the context of health systems and interoperability in South Africa.
- Contributing to addressing the research objectives.
- Validating and evaluating the initial HISIG-CF to consider the identified experts' input.

2.4.6 Communication

The last stage of the DSRM process involved communicating the results obtained from the evaluation phase. To effectively complete this activity, discussions of the results gathered from the data collected were conducted. Additionally, this led to the presentation of the final HISIG-CF, forming part of the recommendations provided. In summary, as informed by disciplinary knowledge, the underlying assumptions associated with IS research development, and the different phases of the DSRM process, the culmination of the knowledge gathered in this research contributes to the knowledge of HIS interoperability and its development using ITG.

2.5. Application of DSRM Process

The iterative nature of the DSRM process makes it relevant for the application of this research. As the research similarly follows an incremental approach to development. It further provides an opportunity for the researcher to consider different contexts and use a range of sources (through literature reviews and case studies) to promote collaboration in designing a relevant solution (Peffers *et al.*, 2007). The concept of this process emphasises a constant refinement of an artefact designed, from its initial conceptual stage to a final design output informed by multiple contributions. The DSRM process was applied in this research using a phased approach, presented in Figure 2-3 below.

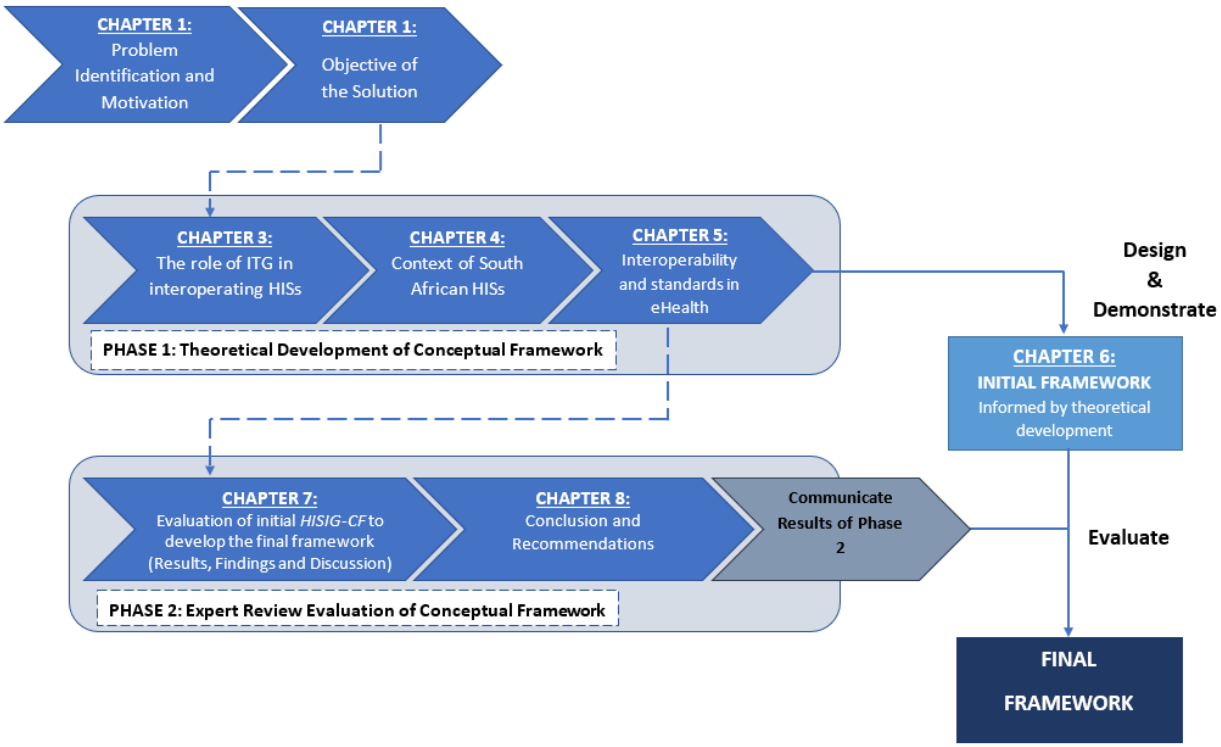


***Figure 2-3: Application of DSRM process* (Peffers et al., 2007; Herselman et al., 2016)**

2.5.1 Phase 1: Theoretical Development of Conceptual Framework

The purpose of this phase of the research was to gain insights into prior research that has contributed to ITG in the healthcare environment and how it can aid the interoperability of HISs. According to Nakano and Muniz (2018, p.1), the value of meaningful research is a "collective and cumulative endeavour" in which the contribution made by a researcher rests on prior knowledge that has been developed. This alludes to research being a community of scholars with the intention of making valuable contributions.

The protocol used in this research was developed using the scoping reviews approach. A scoping review of prior literature in ITG, HISs and Interoperability in the health sector was conducted. The method guides the synthesis of knowledge through the systematic mapping of literature (Levac, Colquhoun and O'Brien, 2010). It provides an overview of the literature in a discipline and creates an opportunity for studying a broader range of conceptual themes (Booth, Sutton and Papaioannou, 2016). As a result, the literature and theoretical background used for the initial conceptual framework design was done across chapters three (3) to five (5), each consecutively addressing the themes: ITG, HIS, and Interoperability. The scoping review approach was further discussed in detail in Chapter 6, which subsequently resulted in the design of the constructs of the initial HISIG-CF.

According to Saunders, Lewis and Thornhill (2016), a combination of both secondary and primary data has the potential to offer invaluable insights that can assist in addressing the research questions of a study. For this reason, secondary data results (analysis) defined following the scoping review process (conducted in Phase 1), as well as insights obtained from expert reviewers (primary data) were used to assess the constructs of the initial design. The results obtained from both sources subsequently informed the refinement and a discussion on the HISIG-CF.

2.5.2 Phase 2: Expert Review Evaluation

The second phase of the process was mainly focused on evaluation. In this phase, the results from the expert review (questionnaire) are presented. This is followed by an analysis and further interpretation. This phase concludes by using the insights gathered to refine and design the final HISIG-CF which serves as the contribution made by this research.

In summary, the foundational aspects of this research (i.e., the research problem, questions, and the motivation for conducting the research), form the basis on which the HISIG-CF was designed. Each phase of the design process underwent the design, demonstration, and evaluation, and the outcomes were presented as:

- **Phase 1 Outcome: Design and demonstration of the initial framework**
  The value of *design* in this research is relevant to contribute to the overall objective of the research – developing a conceptual framework as a research output. To practically consider the relevance of the conceptual framework, it will be *demonstrated* and

assessed using a literature review. The purpose was to position and contextualise the abstract idea of the research in alignment with the relevant theory.

- **Phase 2 Outcome: Evaluation of the initial framework to develop the final framework**

  Through evaluation, the intention was to observe the efficiency of the conceptual framework design within the healthcare environment. Additionally, evaluations were essential in ensuring that the conceptual framework was rigorously developed to determine whether it aligned with the healthcare knowledge base. The insights obtained from relevant expert reviewers played a valuable role in improving the final framework.

2.6. Theoretical Lens

In this section, the theoretical lens through which the research is conducted is discussed.

2.6.1 Institutional Theory

In studying the healthcare environment and communicating the use of ITG to guide interoperability, it was essential to understand its (healthcare) broader context and how this influences its functioning. For this reason, this research makes use of the Institutional Theory. According to Raynard, Johnson and Greenwood (2015), organisations comprise controlled activities that function within complex networks. However, the parallels between formal organisational structures and the institutionalised contexts have gained more prominence, influencing their operations. Against this backdrop, this research employs the Institutional theory in developing the conceptual framework to ensure that it aligns with the broader healthcare context.

Institutionalised norms are embedded in organisations with the intent to create industry standards that guide operations. Furthermore, the Institutional Theory has been grounded on the belief that internal and external pressures influence how organisations operate (AlKalbani et al., 2016). This alludes to the idea that organisational structures are defined to reflect significantly and subscribe to institutionalised norms while their demands are subordinate (Othman, 2016). Additionally, institutions have been influenced by a combination of coercive isomorphism, normative isomorphism and mimetic isomorphism (DiMaggio and Powell, 1983). Coercive isomorphism defines the role of regulatory bodies which seek to influence the practices of social actors through laws, regulations, sanctions and the like (DiMaggio and Powell, 1983).

On the other hand, normative isomorphism is associated with professionalism and can be demonstrated through certifications, formal training and education. Lastly, mimetic isomorphism looks at how other organisations operate in order imitate them. This assist in creating stability when faced with uncertainty in an organisation and could include following a standard manner of performing or directing activities based on industry norms. The three dimensions of pressure from an isomorphism perspective are summarised in Table 2-4 below.

Table 2-4: Influence of isomorphism on institutional dimensions (DiMaggio and Powell, 1983)

Institutional dimensions	Area of focus (examples)
Coercive isomorphism	Laws, rules, and sanctions
Mimetic isomorphism	Industry norms and shared beliefs
Normative isomorphism	Formal training, certification

Kobusinge (2020) notes that to create stability, highly institutionalised contexts drive formal structures in which organisations operate by means of policies and procedures. The health environment comprises a complex setting consisting of organisational factors, social influences, and other related institutional mechanisms. It was critical to recognise the factors that influence its operations to comprehend how these function. According to Kobusinge (2020), healthcare systems comprise different institutions that have founded their legitimacy through varying social structures. Additionally, "cultural-cognitive, normative, and regulatory elements" provide the basis of operation (Kobusinge, 2020, p.16). Through the Institutional Theory, the researcher was able to unpack the varying factors that contribute to the ecosystem of health information systems and confront the issues related to the fragmentation of HISs and how a conceptual ITG framework can be designed.

For the purposes of this study, strategic documents and policies defined by the National Department of Health (NDoH) were considered. The development of the conceptual framework proposed in this study considers the influence of the goals set out by the NDoH across the various strategic documents and the gazetted South African National Health Normative Standards Framework for Interoperability (HNSF) to define the extent of interoperability interventions. Following the guidance of the NDoH to ensure that the recommendations are contextualised in the current health setting.

2.7. Data Collection Techniques

In this research, qualitative data collection techniques were used to refine the initial HISIG-CF. Two approaches were employed: secondary data was derived from the literature review results followed by primary data obtained from the expert review questionnaires. Both methods (secondary data through the literature review and expert reviews) were used during the evaluation and communication stages of the DSRM processes (see sections 24.5 and 2.4.6) and are further expanded in this section. In collecting the data for this research, it was necessary to keep in mind the primary RQ this research intended to address, as introduced in Chapter 1 as:

"*What should constitute the components of a conceptual framework that outlines IT governance mechanisms to support the development of interoperable health information systems?"*

In considering the RQ, the remainder of this section describes how each technique was considered and the value in combing the two approaches, and how this has assisted in generating more significant insights to refine the initial HISIG-CF.

2.7.1 Secondary Data

In this research, secondary data was usedin Phase 1 of the DSRM process. This was first used to define the theoretical foundation of the conceptual framework across chapters 3 to 5, focusing on the SRQs (the research themes). The subsequent results were used to refine the constructs of the initial conceptual framework. This was achieved by transferring the core readings related to the inclusion criteria onto NVIVO to establish the research themes. Word clouds and concepts that were mostly used across the literature were used to inform further analysis and refinement.

2.7.2 Expert Review (Questionnaire)

The design of the final HISIG-CF relevant and appropriate for the healthcare context required an evaluation of its comprehensiveness in order to assess its relevance. In their study, defining the framework for evaluating DSR artefacts, Venable, Pries-Heje and Baskerville (2016) posit that evaluation is a critical activity in strengthening designed solutions. For this reason, this research considers the insight of expert reviewers, as presented in the evaluation activity (section 2.4.5). This was done to assess the relevance and effectiveness of the HISIG-CF and the potential value it could add to healthcare management.

In completing the evaluation process, it was necessary to determine the expert reviewers for this research. According to Allam, Flowerday and Flowerday (2014), expert reviewers possess a great understanding of a subject matter and can offer more valuable knowledge than individuals without a similar skillset. Therefore, this definition was deemed relevant for guiding the evaluation process. Expert reviewers also participated in the second phase of the research and contributed to the final HISIG-CF.

2.8. Criteria for Selecting Expert Reviews

An essential requirement for gaining expert insights was defining and outlining the criteria for selecting individuals to contribute to the research. In addition, it was imperative to determine the number of reviewers deemed adequate to share sufficient insights. For the purpose of this research, experts were mainly selected among knowledgeable professional and academics. Gaining insights from academia and industry would ensure that evaluations balance differing perspectives to obtain a richer view. Therefore, expert reviewers considered included individuals in management positions with experience in:

- health systems or information management,
- health systems research, and
- senior medical experts with experience in using health systems

2.8.1 Selection of Expert Reviews

Selecting experts relevant for this research was done using a purposive sampling technique. Purposive sampling is a form of judgment sampling whereby a researcher chooses the participants to consider based on their qualities and linkage to a study (Etikan, 2016). For the purpose of this research, purposive sampling was driven by addressing the main reserach and the overall objective of the research, which are deemed valid for any researcher that uses this approach (Saunders, Lewis and Thornhill, 2016).

Fundamental to non-probability sampling is to gain as many meaningful insights as possible that will help develop a study (Saunders, Lewis and Thrnhill, 2016). Owing to the limited guidance on establishing a sample size for qualitative data collection techniques, the solution lies in inductively selecting a sample till the point where data saturation is reached (Bradshaw, Atkinson and Doody, 2017). The focus then shifts from establishing a sample size and ensuring that appropriate measures are in place to obtain relevant data and meet the study objectives (Symon and Cassell, 2012). It was imperative to note that although following an inductive approach up to a point of data saturation presented an alternative to selecting an exact sample,

this approach is ambiguous and presents the following challenges (Saunders, Lewis and Thornhill, 2016):

- Imposes time constraints on collecting data.
- Has implications in terms of the costs that may be incurred as a result.

For these reasons, this research followed the guidance of Holbrook *et al*. (2007), who recommend using between two to five participants to evaluate qualitative research. This is further supported by Nielsen (2000), who indicats that two to five expert reviews are an adequate number to detect possible errors. According to Bradshaw, Atkinson and Doody (2017, p.4), qualitative samples are guided by the need to gain "intensive contact with participants" and rely on smaller samples. This notion is presented in Figure 2-4 below, which indicates that the expert results become constant beyond this (2-5) range and yield minimal benefits (Nielsen, 2000). To align with the recommendations by Nielsen (2000) and Holbrook *et al*. (2007), the research considered healthcare professionals as well as academics in the evaluation of the HISIG-CF.

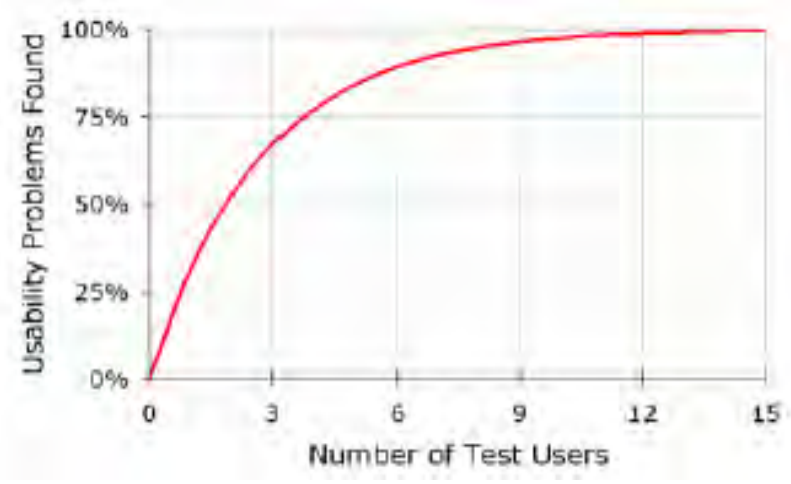


Figure *2-4*: Problems detected by experts per the number of tests conducted (Nielsen, 2000)

2.8.2 Expert Review Instrument Development

The questionnaire used to gather insights from the expert reviewers comprised both close and open-ended questions. Questionnaires enable researchers to collect data from a selected sample through a set of pre-defined questions (Ekinci, 2015). Additionally, the questionnaire aimed to gain insights to ascertain the value of the initial conceptual framework and whether what exists

in the literature correlates with what is currently being done in the healthcare environment. It was crucial to ensure that each question critically determined the research question (and SRQs).

To assist in developing the questionnaire, the researcher explored various measures that could be used to determine and design the key variables and themes of interest. Saunders, Lewis and Thornhill (2016) provide the following three ways in which questionnaire can be developed:

1. By *adopting* other research instruments – which involves using questions developed in another study with little to no modifications.
2. *Adapting* other questionnaires – where a researcher draws questions from other studies; however, adjustments are made to suit a particular research context.
3. By *designing a new questionnaire*.

To ascertain the instrument's reliability, the research *adapted* instruments from other studies to address the research question for this study (section 1.3). The motivation for adapting instruments from other studies was to ensure that there was alignment between the overall purpose of the research and further similar research in the field of study. The process of adapting questions developed from other studies assisted the researcher to "compare findings" and assert the reliability of each question developed (Saunders, Lewis and Thornhill, 2016, p.452). Where necessary, the researcher tailored the questions to suit the context of this study – South African HISs; however, the fundamental aspects of the instruments were similarly adapted. Table 2-5 is an overview of the rationale for each section of the expert reviewer questionnaire (see Appendix A for the schedule used).

Table 2-5: Rationale for expert review instrument

RATIONALE	ADAPTED FROM
SECTION A: DEMOGRAPHICAL & BACKGROUND INFORMATION	
Questions were posed to gain information on the expert reviewers' demographic information and their experiences in their respective domains. The purpose was to determine whether the expert reviewers' experiences aligned with the predefined selection criteria.	Self-developed
SECTION B: HISIG-CF EVALUATION	
This section was included to enable the identified expert reviewers to evaluate the constructs of the HISIG-CF. This was done in two parts:	Informed by the literature review and the research themes

1. The first part of this section provided an overview of the context of the constructs extracted from literature and their application to HISIG-CF. 2. The second part required the expert reviewers to evaluate the constructs of the conceptual framework, using a Likert scale, from 1 to 5.	
SECTION C: HISIG-CF DIAGRAM EVALUATION	
This section provides a diagrammatic representation of the conceptual framework, bringing together the constructs defined in Section B to idicate how they communicate as a unit. The evaluation of the conceptual framework was based on the following: Utility (extended to validity); quality; efficacy and efficiency.	The basis of the evaluation was adapted from the evaluation of DSR guidelines, introduced by (Gregor and Hevner, 2013) and further discussed by Van der Merwe, Gerber and Smuts (2020).

2.9. Research Ethics

It was also important for the researcher to gain various gatekeepers permission before targeting any of the healthcare institutions. Therefore, an application was made to the North West Provincial Department of Health to request permission to conduct this research across the various districts. Once approved, the researcher approached the CEOs and managers of the various institutions to request permission to administer the questionnaire with the relevant professionals. The process of obtaining data from the various experts was guided by the human ethical guidelines regulated by the Rhodes University Human Ethics Committee (RU-HEC) and the conditions set out by the NW Provincial Department of Health (approval letters are included in Appendix A).

2.10. Summary

The purpose of this chapter was to discuss how this research was developed. The methodology used for this research was Design Science, accordingly adopting the DSRM process as delineated by Peffers (2007). Table 2-6 below summarises the aspects considered for the development of the methodology chapter.

Table 2-6: Research methodology summary

Research Methodology Aspect	How it was applied in this research	Methods employed
Philosophy	Pragmatism and Interpretivism	
Approach	Design Science Research	
Strategy	Design Science Research Methodology (DSRM) Process	
	FEDS for evaluating the artefact of the research	**Evaluation:** • Constructs to evaluate were defined following the FEDS steps. • Properties to evaluate were defined as per Hevner (2004) guidance.
Data collection	Secondary data: • Literature Review	Scoping Reviews
	Primary data: • Expert Review	Questionnaire
Data analysis	Scoping reviews results	Thematic Analysis
	Questionnaire results	Hermeneutics

Chapter 3 : The Role of IT Governance in Interoperating Health Information Systems

3.1. Introduction

The increasing reliance on information technology in the health sector necessitates a sturdier implementation of IT governance (ITG) mechanisms. The purpose of this chapter is to discuss recent advances in the field of ITG mechanisms and how these advancements can be applied to improve the interoperability of Health Information Systems (HISs). This chapter begins by defining ITG and then discusses how ITG implementation can be accomplished using a combination of structures, processes, and relational mechanisms. Finally, this chapter of the literature review will discuss some of the established ITG standards and frameworks. The overarching theme of the chapter is SRQ 1, formulated as follows,

What IT governance mechanisms can be used to support the development of interoperable health information systems?

3.2. What is IT Governance (ITG)?

Health systems require significant IT investments to operate effectively. However, such investments will be in vain without a well-defined ITG structure. To address one of the National Department of Health's (NDoH) priorities – governance and leadership – it is critical that the health environment takes the role of ITG into account (South African National Department of Health, 2019). The application of ITG was initially introduced to help organisations align their operations with their information technology (De Haes and Van Grembergen, 2015). The objective was to enlist senior management's support to the visibility and use of the tool in organisations.

Since its inception, ITG has garnered considerable attention (Van Grembergen, De Haes and Guldentops, 2004; Wu *et al.*, 2015; Levstek, Hovelja and Pucihar, 2018). However, its development has not been without obstacles, as evidenced by the lack of a unified understanding of the concept (Levstek, Hovelja and Pucihar, 2018). Therefore, before delving into the significant contribution made by ITG, it was important to establish what the concept (ITG) means in the context of this research.

In their pursuit to narrow the diverse meanings of ITG, Levstek, Hovelja and Pucihar (2018) stress the importance of classifying ITG definitions across three perspectives, identified as follows:

- ITG can be viewed as a decision-making enabler for defining the rights and role of accountability in an organisation's IT domain.
- ITG can act as an intermediary to create alignment between IT and an organisation's IT strategy.
- Finally, ITG can be defined as the IT structures and processes that seek to support an organisation's overall strategy.

To strengthen the ITG component of this research and the theoretical underpinnings of the initial HISIG-CF, ITG was considered holistically by integrating the three distinct perspectives introduced above. In a study by De Haes and Van Grembergen (2015, p.3), ITG is thoroughly defined as, "*Enterprise governance of IT is an integral part of corporate governance, exercised by the Board, overseeing the definition and implementation of processes, structures and relational mechanism in the organisation."* It is on this comprehensive view of ITG that this research is founded.

Whether knowingly or unknowingly, each organisation operates within the purview of established structures and processes. The above definition shows that ITG is focused on enhancing already-existing fundamental areas within organisations. This therefore, demonstrates the importance of ITG and recommendations made regarding its alignment with organisations. It is against this backdrop, that the following section discusses the implementation of ITG using a combination of different ITG mechanisms.

3.3. IT Governance Mechanisms

At the core of ITG implementation, is the need to establish an appropriate context for its utilisation. Aligning ITG with a certain context facilitates the generation of tailored responses that lead to concerted actions (Joshi *et al.*, 2018). In this research, ITG was investigated within the scope of the healthcare environment, focusing particularly on contributing to the advancement of HIS interoperability interventions.

Along with defining the context of usage, it is essential to note that meaningful value can be achieved by establishing pragmatic approaches to implementation. According to Van Grembergen, Haes and Guldentops (2004), the deployment of ITG is facilitated by a mix of structures, processes, and relational mechanisms. Selig (2016) adds to this by stating that ITG mechanisms are introduced as the critical enablers in the implementation of ITG. As a response, ITG mechanisms simplify the role of ITG into more practical and manageable arrangements

that organisations can understand. The following sections discuss the ITG mechanisms that could be implemented in the construction of interoperable HISs.

3.3.1 Structures

At the start of an ITG endeavour, there is a need to formulate and specify accountability channels. The formalisation of an identifiable ITG structure that ensures the establishment of an adequate ITG enabling environment demands a clear definition of *who* the key stakeholders are and their respective responsibilities (Wu, *et al.*, 2015). The central theme of the structure mechanism is leadership and ensuring that this is determined from the outset. In sum, structures are an essential ITG mechanism that ensures that ITG implementation and the channels for following it through are outlined to promote successful ITG.

Numerous structures may be adopted to define the roles and responsibilities necessary for the formalisation of the ITG structure mechanism. For example, a potential structure could be a board that would be in charge of overseeing implementation. According to Caluwe *et al.,* (2021), a board is a formal body established to guide a set of activities in an organisation driven by the objectives of the organisation it serves. ISACA (2018) also recommends implementing boards, defining these stakeholders as those capable of evaluating, directing, and monitoring governance objectives. Additionally, a board would assist to foster the incorporation of ITG by engaging in the following major roles and activities (ISACA, 2018):

- Setting the direction or agenda for ITG.
- Assuring that adequate resources are available to manage the facilitation of ITG.
- Providing direction and overseeing the stakeholders and procedures involved in ITG delivery.
- Establishing and maintaining the agenda and goals for ITG.
- Ensuring that initiatives or programmes undertaken are consistent with an organisation's overall strategy.

After establishing a clear mandate for the board, the next step would be to determine who (stakeholders) will serve on the board and contribute to its direction. Board members would need to represent a diverse range of stakeholders who contribute to ITG, depending on the organization’s design. These actors may include members who hold senior executive positions such as Chief Information Officer (CIO), Chief Digital Officer (CDO), or a position of comparable stature (De Haes and Van Grembergen, 2008; ISACA, 2018; Levstek, Hovelja and

Pucihar, 2018). The executive's primary responsibility on the board would be to steer the ITG programme toward defined IT-goals (ISACA, 2018). To further strengthen the structure mechanism, a board could include advisory members such as IT auditors, an IT risk manager, or a compliance officer. Such advisory roles would contribute insight into critical issues identified in an ITG program by reviewing implementation processes and advising on the best strategy (ISACA, 2018).

Another possible ITG structure is the establishment of a steering committee. IT steering committees enable organizations to align their IT activities and decisions with their strategic objectives (Dawson *et al.,* 2016). This is accomplished by incorporating strategic representatives who align the organization's IT and business strategies.

Boards and steering committees are just two examples of structures. It is critical to note that additional structure types can be defined based on an organisation's capabilities and objectives. In their study, Levstek, Hovelja and Pucihar (2018) discuss alternative structures that can be adopted.

Organisations can employ a variety of methods and tools to illustrate how various roles and responsibilities might be presented. A RACI matrix is one such tool that can be used to define who is **R**esponsible, **A**ccountable, **C**onsulted, and **I**nformed (RACI) for executing ITG activities, as shown in Table 3-1 below (ISACA, 2018). Selig (2016) notes in a study outlining a roadmap for organising ITG projects that the RACI could be ideal, as part of communicating agreed key roles and responsibilities. In this instance, the chart is used to summarise a typical board's roles and responsibilities in relation to the set of activities outlined above, as guided by COBIT 2019 (ISACA, 2018).

Table 3-1: RACI matrix charting roles and responsibilities for ITG activities, adapted from ISACA (2018)

ITG Deliverables (Activities)	Roles and Responsibilities				
	IT Governance Board	Senior Executives (CIO, CDO)	IT Managers	IT Auditors	IT Risk and Compliance
Setting IT governance direction.	R	R	C	C	C
Resourceavailability to manage and facilitate IT governance.	A	R	C	R	R
Overseeing stakeholders and processes.	A	C	I	I	I
Establishing and maintaining the ITG agenda.	A	R	C	I	I
Ensuring approaches align with the overall approaches of the organisation.	A	R	C	C	C

In summary, structures are critical to ITG's success and are used to outline the roles and responsibilities associated with delivering ITG (Wu, *et al.,* 2015). At the structural level, decision-makers or other key stakeholders define ITG initiatives and their alignment with the organization's overall information technology strategy. Depending on an organisation's capacity and specified IT goals, the following primary structures may be formed: IT organising structures; CIO on board; IT steering committee; and IT strategy committee. It is critical to bear in mind that the structures defined in this research are not exhaustive, and additional variations may be investigated.

3.3.2 Processes

Creating an environment conducive to the implementation of ITG extends far beyond defining the roles and responsibilities. It also entails setting the practices that may be followed to reach the desired end goal. This section aims to provide a set of processes that are necessary for undertaking ITG. *To* begin, it was vital to outline the definition of processes that underpins this research. Levstek, Hovelja and Pucihar (2018) define processes as an arrangement of formalities involved in decision-making. Additionally, the process mechanism guides designing the forms of monitoring that are to take place during the rollout of an ITG

programme. In essence, processes are created to ensure that the most effective measures to guide ITG implementation are in place and that systems to evaluate IT related concerns have been set out.

Numerous guiding methods can be adapted to direct the ITG process mechanism. Adaptive frameworks, standards and monitoring tools include the: Information Technology Infrastructure Library (ITIL) which can be used for planning and the support of IT services; VAL IT, which is useful for identifying and defining connections between functions of an organisation and IT; as well as COBIT etc., (Levstek, Hovelja and Pucihar, 2018). An organisation's IT goals primarily drive the selection of an appropriate framework, standards, or tool. For instance, an ITIL framework may be adopted if an organisation's IT goal is to standardise IT delivery because it offers the relevant tools.

a) Continuous Improvement Life Cycle Approach

This research defines the implementation process using the Continual Improvement Life Cycle Approach as determined in COBIT 2019 (ISACA, 2018). The approach identifies three interconnected areas of development necessary to make ITG a reality, progressing from the outer to the inner ring of the design represented in Figure 3-1. These rings include programme management, change enablement, and continual improvement life cycle.

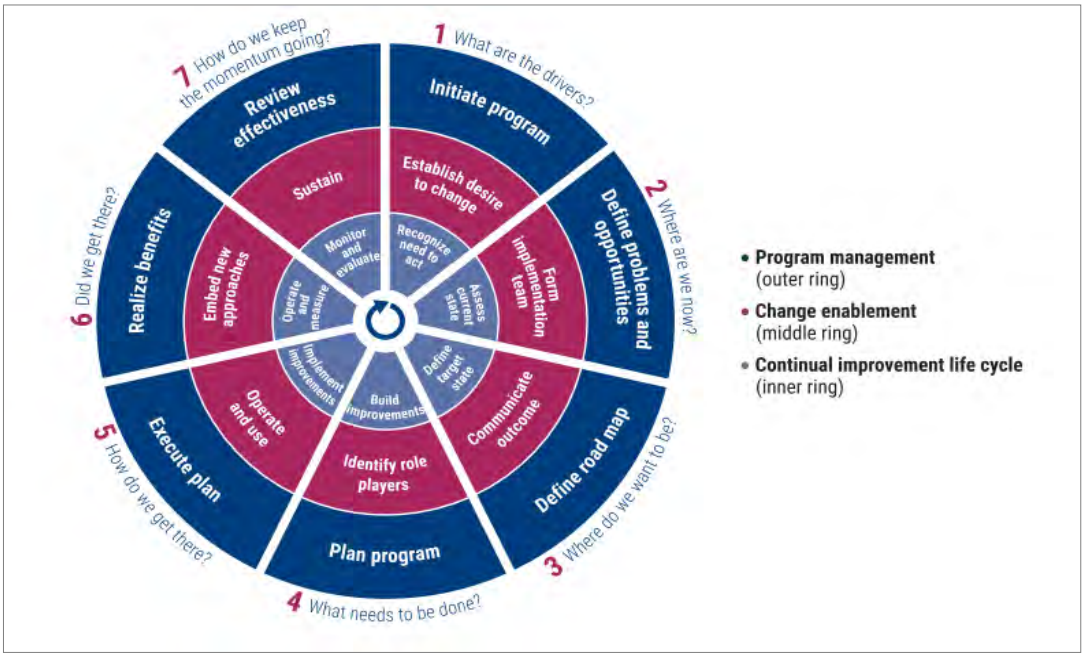


Figure 3-1: Continual Improvement Life Cycle *approach overview, adapted from* ISACA (2018, p.24)

Programme management defines the strategic objectives that will guide the structures in place to carry out ITG activities (ISACA, 2018). This is done with the intent of instituting an ITG programme. Change management, on the other hand, is concerned with identifying the extent to which an organisation requires a change in its pursuit of ITG implementation and determining the appropriate steps to be taken as a response (ISACA, 2018). Subsequently, the continuous improvement lifecycle concentrates on areas that require intervention, such as present IT pain points, the governance environment within an organization, and IT priorities (ISACA, 2018). In the healthcare context, combining these layers may assist in selecting the most suitable areas to focus on while developing interoperable HISs.

Implementation is, however, influenced by a variety of contributing factors that need to be considered. These factors include the environment in which the organisation operates, an organisation's level of IT maturity, the scope of implementation, and the capacity of the organisation to adapt to changing IT needs (ISACA, 2018). Furthermore, to define the approach outlined in Figure 3-1, the activities associated with each ring are described in Table 3-2 below.

Table 3-2: Programme management application procedure adapted from ISACA (2018)

Programme Management Component	Programmme Management Component Definition
What are the drivers?	
Initiate programmme	The initiation process is driven by a need for change as informed by an organisation's internal or external stimulus.
Where are we now?	
Define problems and opportunities	This phase aims to ensure an alignment between the IT objectives of the organisations, associated risk, priorities, and the organisation's goals. The outcome of this phase involves an assessment by management that views the organisation's current capabilities and deficiencies.
Where do we want to be?	
Define roadmap	This phase involves identifying the intended solution and prioritizing each solution based on the expected impact. The focus should be on solutions that will minimize the time towards attainment with an anticipated high value.
What needs to be done?	
Plan programmme	This phase relates to the preparation involved in defining feasible solutions for implementation. An excellent technique for planning and

	monitoring would include using business cases to identify the project's benefits.
How do we get there?	
Execute plan	In this phase, the daily activities and monitoring systems are defined to ensure an alignment between the programme and business goals. This success of this phase includes engagements (including a commitment from senior management) through awareness and communication.
Did we get there?	
Realise benefits	The successful implementation of this phase is defined by transitioning the new IT governance solution into day-to-day tasks. Through the use of performance metrics, the viability of the solution can be monitored.
How do we keep the momentum going?	
Review effectiveness	This phase aims to report on and review the success of the IT governance project. Other activities involve reinforcing governance requirements to continue improving the implementation of the defined solution.

b) Change Management

Making improvements to current health systems may necessitate some form of change, which is not an instantaneous process. Complexities exist between people and systems due to varying influences (Kruse *et al.*, 2014). These complexities are attributed to changing health needs which force health systems to improve and adjust as needed. This has mainly been prevalent during the COVID-19 outbreak that has put an even more tremendous strain on health systems, requiring a swifter approach to meeting people's health needs (Lal *et al.*, 2021).

With any form of change, organisations should make provisions for dealing with the potential implications. One of the primary obstacles to improving the coordination within HISs has been the resistance to change by stakeholders and healthcare institutions, who each use health systems for varying purposes (Han *et al.*, 2019). However, in the South African context, difficulties are not only limited to resistance but can also be extended to the disconnect between what is proposed or designed and how it is actually received in reality (Myllyoja *et al.*, 2016). Additionally, the distinct nature of South Africa's health environment may constitute another obstruction. What this means is that the fragmented health systems operating across different layers and sectors may act as a further hindrance to change. For this reason, change should be anticipated and measures defined to support the associated effects.

As previously stated, this research aims to contribute to ITG knowledge to aid the development of interoperable HISs. The researcher acknowledges that the introduction of HIS

interoperability in different healthcare organisations may disrupt current norms and require a substantial shift in perspective across organisational structures (Kotter and Cohen, 2015). Therefore, the approaches provided by (Kotter, 1995) are considered in this research for guiding change. Additionally, these will be relevant in prescribing some key aspects worth noting when change occurs to provide a greater chance for success, as described in Table 3-3 below. These components of change management have also been incorporated into the Continuous Lifecycle Approach (ISACA, 2018).

Table 3-3: Change enablement application adapted from ISACA (2018)

Change Enablement Component	Change Enablement Component Definition
Establish desire to change	The purpose is to understand the change an organisation intends to achieve. Good indicators for establishing change are the challenges and pain points that are affecting an organisation.
Form an implementation team	This phase's key focus is to assemble a team from relevant areas of the organisation and IT to use their expertise to guide the change process. The team's role is to pool resources and expertise to deliver a clear vision successfully.
Communicate outcome	This phase focuses on communicating the development of a change enablement plan. The communication should primarily detail the rationale for embarking on the change journey.
Identify role players	Throughout the development of a solution, organisations should equally aim to empower the various relevant role players. The scope may be defined by outlining changes to team structures, process flows, and logistics for operational changes and training to assist stakeholders through the change journey.
Operate and use	As the programme's core implementation progresses during its lifecycle, change response plans must be used accordingly. The success of this phase involves building on the achievements of the change while addressing the cultural aspects that influence change. Mentoring and coaching are crucial to ensuring that users are adapting well. Another pointer to success involves ensuring that measures used to track employees' response to change are considered.
Embed new approaches	As implementation of the core programme continues, there should be considerations of new approaches. This can be

	made possible be supported by appropriate policies and procedures. The success of this phase is achieved through communication, raising awareness of the program.
Sustain	This phase ensures an ongoing commitment to reinforce change through constant communication and support from top management. Success in this phase is maintained by implementing corrective action where necessary and sharing knowledge across the organisation.

Processes are an essential contributor in defining how decision-making occurs across the different structures of the organisation (Levstek, Hovelja and Pucihar, 2018). Their role is to ensure that the activities to drive out ITG align and serve the organisation's IT strategy. The Continual Improvement Lifecycle model provides one perspective of what processes intend to achieve. Along with the frameworks, standards, and tools discussed previously in this chapter, other ITG processes such as Strategic Information Systems Planning, Service Level Agreements, COBIT and ITIL, and IT Governance Maturity Models can be adapted (De Haes and van Grembergen, 2008; Levstek, Hovelja and Pucihar, 2018). Furthermore, when considering which processes to adapt for ITG implementation, it is essential to anticipate change and plan for its management.

Along with structures and processes, ITG implementation necessitates an additional mechanism to ensure that the two work in conjunction. According to Smits and Hillegersberg (2015), previous ITG literature has mainly concentrated on structures and processes, omitting the social dimension of governance. As a result, ITG's potential may be constrained solely by this focus. To supplement the discussion of structures and processes, the following section focuses on the significance of relational mechanisms in implementing and advancing ITG.

3.3.3 Relational mechanisms

Relational mechanisms can be identified as a significant cohesive tool that enables structures and processes to operate efficiently (Levstek, Hovelja and Pucihar, 2018). Through relational mechanisms, the emphasis moves from strictly technical aspects of ITG and towards the integration of socio-technical factors. According to Wu, *et al.,* (2015), a range of crucial factors is necessary to implement ITG. These include (but not limited to) the active involvement of senior or critical stakeholders in an organisation, the use of well-coordinated communication processes to promote ITG, and the establishment of a relational culture to foster collaboration.

Additionally, relationship-building efforts can be introduced, rewards and incentives programmes implemented, IT co-location an organisational functional unit, and so on. In essence, relational mechanisms enable structures and processes to assist in the attainment of ITG objectives.

Literature on the effects of relational mechanisms in organisations demonstrates that, when considered as a foundation for ITG development, relational mechanisms can successfully guide well-defined structures and processes (Tonelli *et al.*, 2017). There has also been a positive correlation between relational mechanisms (such as senior management involvement, IT training, communication between various units) and IT (Ali and Green, 2012). Therefore, the contributions of relational mechanisms could be considered when determining the optimal method for implementing ITG, not only for their social value but also for the promotion of ITG implementation. Figure 3-2 below provides a high-level view of the ITG mechanisms and the targeted aspects of an organisation.

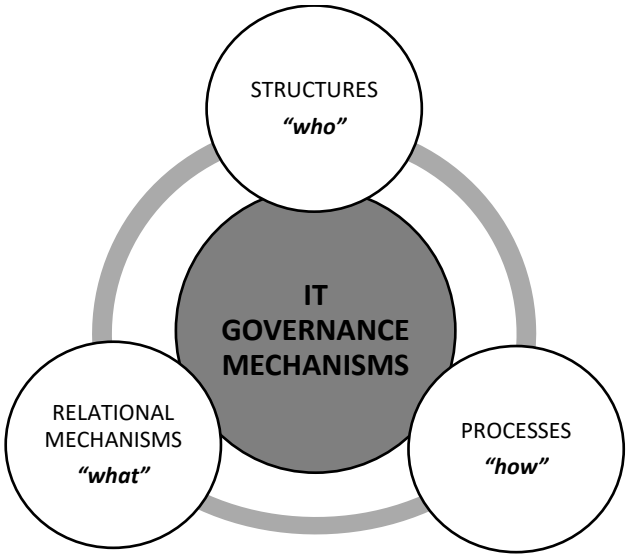


Figure 3-2: Summary of IT governance mechanisms and organisational aspects targeted

The mechanisms deployed are specific to each organisation depending on their strategic IT goals and IT investments. When determining how best to design ITG implementation strategies, it is essential to note that the specific mechanisms considered are unique to an organisation and need to consider the contextual setting (Wu, *et al.*, 2015). Such a consideration allows adequate knowledge to be shared across the different skillsets as informed by the defined structures.

3.4. IT Governance in the Public and Private Sector

The origins of ITG can be traced back to the private sector. According to Al Qassimi and Rusu (2015), ITG was founded to increase the profitability of IT investments while providing new services. Recognising the benefits of ITG in the private sector, the public sector has slowly followed suit, steadily intensifying its ITG efforts (Tonelli *et al.*, 2017). The public sector's focus has been to leverage ITG to create public value and provide essential services. However, progress has not been as significant as that in the private sector. This has also been evidenced by the paucity of research on ITG in the public sector, particularly in developing countries (Campbell, McDonald and Sethibe, 2010; Ali and Green, 2012; Tonelli *et al.*, 2017).

Organisations in both sectors are constituted by distinct sectoral regulations that govern their operations. When intending to guide ITG implementation, organisations need to comprehend and consider the sector they operate. This requirement is well addressed by Misuraca and Viscusi (2015), who argue that the domain in which organisations function guides the deployment of ITG implementation efforts. Therefore, it is vital to examine pre-existing norms and standards to qualify adequate ITG procedures. The two main sectors in which organisations can operate are discussed in this research as the private and public sectors (Campbell, McDonald and Sethibe, 2010; Winkler, 2013; Misuraca and Viscusi, 2015*)*. The following section distinguishes the key characteristics that differentiate public and private sector organisations, followed by a discussion of their implication for the healthcare setting.

3.4.1 Comparison of Sectors

Private sector organisations are defined by their commitment to generating positive profit margins to increase economic value (Tonelli *et al.*, 2017). This is primarily motivated by the need to ensure that shareholders receive a return on their investment. On the other hand, public sector organisations orientate their functions towards providing value to the public due to their multi-faceted nature (Campbell, McDonald and Sethibe, 2010). The objective of delivering social and political goals that guide operation is at the centre of public sector functions.

The nature of private organisations is structured to allow for less stakeholder input regarding IT-related decisions as opposed to the public sector that often requires the approval of multiple individuals to sign off on decisions. This provides private organisations with increased decision-making flexibility by allowing activities to be altered as needed to maximise potential IT investment returns (Campbell, McDonald and Sethibe, 2010). However, while the private sector can benefit from this form of decision-making, it is critical to note that the public sector

serves a considerably wider population than the private sector. Therefore, haphazard decision-making processes may have ramifications for the greater civil society.

Moreover, public organisations are characterised by more stringent controls to mitigate the risk posed by IT investments (Misuraca and Viscusi, 2015). In comparison to private organisations, the public sector is often denoted as more risk-averse, which impacts the level of IT investments made (Winkler, Rusu and Viscusi, 2013). This adds another layer of complexity to the public sector's ability to reap the benefits of ITG. In addition to the distinctions discussed above, Campbell, McDonald and Sethibe (2010) propose additional contextual factors contributing to ITG sectoral differentiation. The basic characteristics between private and public sector organisations addressed in this research are summarised in Table 3-4 below.

Table 3-4: Differences between private and public organisations (Campbell, McDonald and Sethibe, 2010)

	Private Sector Organisations	Public Sector Organisations
Main drivers	Profit-driven	Citizenship / Public interest
Structures	Flexible	Rigid and more stringent
Goals	Shareholder value	Social/Politically driven
Decision making	Fewer collaboration	Requires wider stakeholder engagement.
Risk	Less formal/ Higher risk tolerance	Formal constraints/ Risk-averse

In this section, contextual differences that exist between the public and private sectors were discussed. In summary, ITG cannot be generalised across sectors due to the systemic differences between them (Tonelli *et al.*, 2017). It was critical for this research to better understand the extent to which sectoral differences influence the healthcare environment. As such, the following section focuses on the extent to which private and public healthcare differences affect healthcare.

3.4.2 Impact of Sectoral Differences in Healthcare

South Africa's quest to transform the current health systems continues to be burdened by the fragmentation of health information resulting from legacy health systems (Iyawa, Herselman and Botha, 2019). Furthermore, evidence of such systems has perpetuated a further divide towards accessing much need health services. In an effort to improve ITG to inform HIS

interoperability interventions, the complexities that continue to influence the health sector cannot be ignored. Fusheini and Eyles (2016) further suggest that the intricate nature of the South African health sector is a result of the large proportion of health services delivered through the private sector and the current political climate rooted in liberation ideologies. On these grounds, this section examines the impact of sectoral disparities in the use of ITG to develop HIS interoperability interventions.

3.4.3 Parallel Healthcare Sector Challenges

South Africa's healthcare system is divided into two large and parallel systems, namely the private and public healthcare sectors (Nicol *et al.*, 2021). The former accounts for a large proportion of resources used to deliver health services. Over 80% of the population is reliant on public healthcare, further straining an already frail health system (Brauns, 2016). Additionally, 60% of resources are directed towards the private sector, which is only accessible to approximately 20% of the population (Katuu, 2016). These disparities not only continue the cycle of unequal access to quality healthcare but also infringe on a fundamental human right that "everyone has the right to have access to healthcare services" (South African National Department of Health, 2020, p.4).

The discrepancies between these two sectors highlight the staggering inequalities that citizens encounter. Additionally, it lays bare the harsh reality that individual wealth influences access to high-quality healthcare even after the transition to democracy (Brauns, 2016). This is further depicted by a sizeable fraction of those who rely on public healthcare being uninsured, hindering their opportunity to acquire private healthcare (Brauns, 2016), substantially widening the inequality gap. Therefore, significant progress is required to overcome existing imbalances and fulfil the moral responsibility to provide decent healthcare to all (Alunyu and Nabukenya, 2018). Against this backdrop, this research studies how ITG can be used to improve HISs through interoperability.

3.4.4 Influence on the National Health Insurance

In recent years, UHC has become an overarching goal for low and developing countries seeking to improve the distribution of health services (Fusheini and Eyles, 2016). UHC forms part of the sustainable development goals (SDG) and aims to increase access to quality and effective healthcare (United Nations, 2021). In the South African context, the health ministry has already begun piloting the National Health Insurance (NHI) scheme to contribute to transforming

existing HISs across provinces and districts (Matsoso and Fryatt, 2013). Through this, the goal is to enable accessible healthcare, regardless of people's economic status (South African National Department of Health, 2015). To better understand how ITG can guide the development of HIS interoperability interventions, it was important to situate this research within the broader NHI context as discussed in literature.

UHC will only result in false expectations through the NHI program if the primary focus is not providing quality healthcare through strengthening local systems (Fusheini and Eyles, 2016). Brauns (2016) argues that progress towards UHC has been hampered not simply by the presence of disproportionate resources. Disparities are reinforced by inconsistencies between what policies and theories define and implementation in the healthcare setting. For instance, the healthcare environment is rich with policies and legislature articulating distinct objectives (Nicol *et al.*, 2021). However, the challenge is how such policies and legislature are enacted and applied effectively (Nicol *et al.*, 2021). The absence of clear practices that remain ambiguous on how they should be implemented will only undermine the success of healthcare interventions.

As noted earlier in this research, one of the primary issues that have affected HISs is fragmentation, which occurs when multiple health systems function in silos. The fragmentation of HISs has been amplified by how health services were previously geographically and administratively organised to favour a small minority (Brauns, 2016). This was a result of political mechanisms that maintained inequitable access to healthcare services. In an attempt to redress the imbalance presented, the democratic government attempted to resolve this issue through a process of decentralization (Brauns, 2016). This was done by coordinating healthcare activities and responsibilities across the national, provincial, and local levels to increase accessibility (Brauns, 2016). However, these levels of governance are not without their own challenges. The following sections discuss the various governance levels and how these further contribute to the current lack of coordination across HISs.

3.5. Level of Governance in Healthcare

In studying ITG mechanisms across contexts in the private and public healthcare domain, it is imperative to understand how this influences the coordination and functioning of the healthcare environment. In the South African context, health systems are composed of bureaucratic structures that consist of top-down management structures (Brauns, 2016). These are demonstrated through national frameworks that define and develop strategies; then transmit

these to provincial management structures, which in turn are translated to district (local) level management.

The key challenge with following such rigid structures is that front-line management is affected by the influence of top management in the public sector, which often communicates multiple and conflicting directives (Gilson and Daire, 2011). Furthermore, this creates barriers in implementing new policies. Through a simple top-down approach, the assumption is that health provision objectives and policies can be implemented through controlled conditions (Boak *et al.*, 2015). Additionally, a linear approach to implementation is the optimal technique of delivery theoretically. However, following such linear approaches does not consider the complexities and challenges faced at the lowest level of government.

According to Boak *et al.* (2015), effective healthcare delivery cannot rely solely on routine approaches. Interactions between several levels of governance are necessary. Furthermore, Tonelli *et al.* (2017) emphasise the critical role of guidance and central direction to set clear implementation parameters. This, however, should be done jointly across the different levels of government to cultivate more engagement. According to Martin *et al.*, (2015), distributed leadership may be considered to facilitate improved implementation.

As noted earlier in this section, governance is administered at national, provincial and local (district) levels in the current South African landscape. National-level governance defines the highest level of government by establishing long-term strategic visions which set the tone for all subsequent levels (Wimmer, Boneva and Di Giacomo, 2018). Furthermore, Wimmer, Boneva and Di Giacomo (2018) identify this level of governance as executed by political and legal stakeholders. On the other hand, provincial governance determines how best to transfer national objectives into practice within the province's objectives. At this level, strategic decisions and policy documents are prepared to allow implementation (Wimmer, Boneva and Di Giacomo, 2018). At the local level, the emphasis is on executing the vision communicated from the provincial level. In the health environment, the focus is on translating and providing health services across different municipalities.

A recommendation by Martin *et al.* (2015) has thus been made for the engagement of the public sectors with both civil members and the private sector is an important aspect to increasing operational success. This will allow the public sector, which contributes largely to the provision of health care to the overall public, to strengthen policy implementation and service delivery.

3.6. Summary

This chapter addressed the research's SRQ 1, which focuses on the ITG theme. This was accomplished by introducing the concept of ITG and its implications for this research. Studying how ITG could be used to guide HIS interoperability interventions was done by discussing ITG mechanisms by outlining the various structures, processes, and relational mechanisms that can be used for ITG. This chapter demonstrates how implementation could be directed drawing from an ITG framework – COBIT 2019. Due to the sectoral differences in the health environment, this chapter looked into the distinct differences between the private and public sectors and how they affect the development of the health sector. This was done in light of the NHI program and the potential impact of these disparate sectors. The chapter concludes with a discussion of the health sector's governance structure and the effect on initiatives undertaken. Furthermore, the concepts discussed were used to contribute to the ITG aspect of the conceptual framework.

3.7. Literature Constructs from Chapter 3: Informs the Design of the Initial Conceptual Framework

In the previous year, the COVID-19 pandemic has taught us that there is a need to move beyond policy and actively seek implementation methods that will allow health systems to cater for changing and new health needs (Nicol *et al.*, 2021). In light of this revelation and the literature addressed in this chapter, Table 3-5 below, synthesises the most crucial constructs relevant for addressing ITG in the initial conceptual framework design.

Table 3-5: Chapter 3 constructs for the design of the initial conceptual framework

Number in initial HISIG-CF	Constructs	Key Focus Areas
[A]	IT governance mechanisms	Defining IT governance by focusing on structures, processes and relational mechanisms.
[A1]	Level of governance	Demonstrates the different levels of governance from national, provincial to district levels and how these influence the delivery of health services.
[A2]	Sectoral differences	Differentiate between the private and public health sectors; How the differences impact health systems and the NHI.
[A3]	Implementation Lifecycle (Improvement Lifecycle)	Adapated from COBIT 2019, this model looks at how ITG can be implemented; The model emphasises program management; change management.

Chapter 4 : Context of South African Health Information Systems

4.1. Introduction

The quest for quality healthcare is one no country is exempt from, including South Africa and developing countries alike. Unfortunately, South Africa continues to be confronted with poor health outcomes rooted in inequalities that burden current HISs (Herselman and Botha, 2016; Myllyoja *et al.*, 2016). The World Health Organisation (WHO) further notes that at the falilure in health systems contributed to this humanitarian crisis (WHO, 2010). Maintaining the current patterns will result in ineffective health systems that will erode healthcare quality and social value (Kruk *et al.*, 2018). In light of this, it is necessary to investigate approaches for improving current operational HISs to prepare for well-governed interoperability interventions.

At the heart of defining ITG mechanisms that can define interoperability interactions across HISs is the need to consider the impact of associated contextual factors. Kobusinge (2020) asserts that understanding contextual factors increase the likelihood of interoperability implementation success. As such, this chapter examines South African HISs and the role of interoperability in this context.

This will be accomplished by first defining health systems in relation to this research. Upon establishing a working definition, this chapter will provide an overview of health systems and their relationship to HISs currently operating in South Africa and their impact on interoperability. This will be done to better understand the health system climate and to discuss how interoperability fits into the broader eHealth environment. Additionally, the chapter will review some of the challenges confronting current health systems and conclude by outlining several building blocks that have been identified to aid in strengthening health systems. By assessing the context of South African HISs, this chapter aims to address SRQ 2, outlined as:

How should health information systems align with interoperability practices?

4.2. What are Health (Information) Systems?

The use of information to provide high-quality healthcare is a critical function of health systems. Prior to delving into the role of HISs, it is vital to understand the difference between health systems and HIS. To ensure that the concepts of health systems and HISs were articulated clearly and avoid using the terms interchangeably, it was necessary to differentiate

the two. Firstly, health systems are comprised of organisations and individuals who work together to provide and promote healthcare to a given population (Ojo, 2018). A health system acts as a basis within which other health care efforts are defined and implemented. Through their respective role, various health systems beneficiaries can collaborate to meet health objectives. The following beneficiaries make use of the information stored across health systems to attain healthcare objectives (South African National Department of Health, 2019):

- Patients/ end users – health systems are built with the needs of patients in mind. Their primary function is mainly to gain access to healthcare services for their individual health needs.
- Citizens – concentrate on improving their ability to manage and navigate their health.
- Healthcare workers – gaining access to data and information that will aid in providing the necessary health services to patients.
- Healthcare managers – are responsible for planning, managing, and monitoring functions that ensure adequate and secure health services.

On the other spectrum, HISs are the bedrock on which health systems operate and play a pivotal role in generating quality healthcare data (English, Masilela and Barron, 2011). HISs are purposed with the role of (English, Masilela and Barron, 2011):

- Collecting health data stored across health systems.
- Analysing health data to make more meaningful sense of its use.
- Reporting on analysis results to enhance the efficiency of health services.

An important aspect of understanding how health systems function is the role and impact of Information Communication Technology (ICT). In the next section, the influence of eHealth in the delivery of health services is discussed.

4.3. The Role of eHealth

As health needs change, it is equally important that the health systems can adapt accordingly. eHealth presents the opportunity for such an improvement. What eHealth aims to achieve is to address healthcare challenges through ICT (Adebesin *et al,*, 2013). It is concerned with supporting health information delivery, using electronic methods, and improving how information flows across different systems (Katuu, 2016). This can occur through, but not limited to, the treatment of patients, educating the workforce in the health environment,

tracking and monitoring various diseases (Herselman and Botha, 2016). In sum, the inclusion of eHealth will improve the delivery of healthcare services to meet health needs as they occur.

4.3.1 Different forms of eHealth Implementation

The implementation of eHealth is multidimensional and can further be implemented in different forms, including:

Table 4-1: Forms of eHealth implementation (Herselman and Botha, 2016)

Forms of eHealth	Description
Electronic Medical Record (EMR)	Stores admin-related and clinical data of each individual's health information. This includes diagnosis, the previous medication used, tests, various medical treatment plans, etc. In most instances, a patient's EMR would be accessible to the health facility providing care.
Electronic Health Record (EHR)	Stores the history of an individual's health information accessible to authorised users. Similar to EMRs, admin and clinical data can be stored; however, the information is not restricted to a single health provider's facility.
Personal Health Record (PHR)	Record of health information that allows individuals (or other authorised individuals) to manage their personal health information. Examples include immunizations, the medication used, hospitalisation records, health information on various diseases.
Computerised provider order entry (CPOE)	The process of healthcare providers sending instructions related to patient's treatments using a computer application as opposed to telephonic or paper requests. These may include laboratory tests, medication orders, radiology orders, etc.
Laboratory/ Radiology systems	These systems can be used to support the workflow between a health facility's EMR system to gain information about patients.
Pharmacy system	These types of systems would be used in a health facility's pharmacy or an independent pharmacy. This system would be used to support all activities related to pharmacies. These could include administering medication, keeping track of patients' previous prescriptions, and keeping track of medication dosages and use.
Electronic Prescribing (e-Prescribing)	Enables healthcare providers to electronically capture prescription-related information and send this to pharmacies or

	a pharmacy system. Once a pharmacy receives a request, medication can be dispensed accordingly.
Clinical decision support system (CDSS)	It is aimed at supporting clinical workflows by providing healthcare providers with relevant information or specific filtered knowledge to generate and provide appropriate healthcare to address a patient's health needs. Examples include order sets that are condition-specific, diagnostic or healthcare reports, electronic alerts, and reminders.

In essence, the possibility of eHealth takes place in a variety of forms. In most instances, some or a combination of the various implementations could be present in a single health facility. In section 4.5, the different levels of maturity are discussed. This is where a combination of the different systems are considered to encourage and enable interoperability.

4.3.2 Value and Downsides of eHealth Implementation on Health Systems

More importantly, the use of eHealth could improve the delivery of health services in various ways. It reduces the restrictions imposed by using traditional forms of data storages (e.g., paper-based filing) and communication (e.g., send letters and faxes) when interacting across networks. Furthermore, it will allow healthcare to go beyond geographical boundaries to reach more people who require health services (Bergmo, 2015). Through this, the value of eHealth plays a critical role in promoting more accessible health services.

On the other hand, the delivery of eHealth services does not come without its challenges. The possibility of an efficient eHealth system is dependent on several factors. These factors may include fiscal policies determined at the highest level of government, security policies, and national regulations that direct the health sector (Benedict and Schlieter, 2015; Iyawa, Herselman and Botha, 2017). Additionally, the use and implementation of eHealth could be affected by infrastructure barriers such as electricity, connectivity in remote areas, lack of appropriate hardware (Herselman and Botha, 2016). This is primarily a challenge in developing countries that still lag behind in delivering various services. Additionally, health services that are focused more on curative rather than preventative service provision continue to cripple existing systems (Katuu, 2016). Moreover, legacy systems have contributed to the fragmentation of health information and continue to burden the health systems in place.

4.3.3 Health Systems Transformation Progress

The current democratic government has pursued initiatives to transform the health sector. However, the remains of legacy systems are still apparent. More so, across the different health

systems present. For instance, one would find that innovations integrated into a single facility remain confined to a single institution with no ability to scale up (Adebesin and Kotzé, 2017). Furthermore, where there is evidence of EMR systems, a considerable fraction of the systems cannot share crucial information needed to provide healthcare (NDoH and CSIR, 2014). For eHealth systems to provide quality services, health systems need to exchange health information. However, this remains a challenge in South Africa due to the number of systems across the different provinces (NDoH and CSIR, 2014). In Figure 4-1 below, a breakdown of the number of systems across different provinces is presented (NDoH and CSIR, 2014).

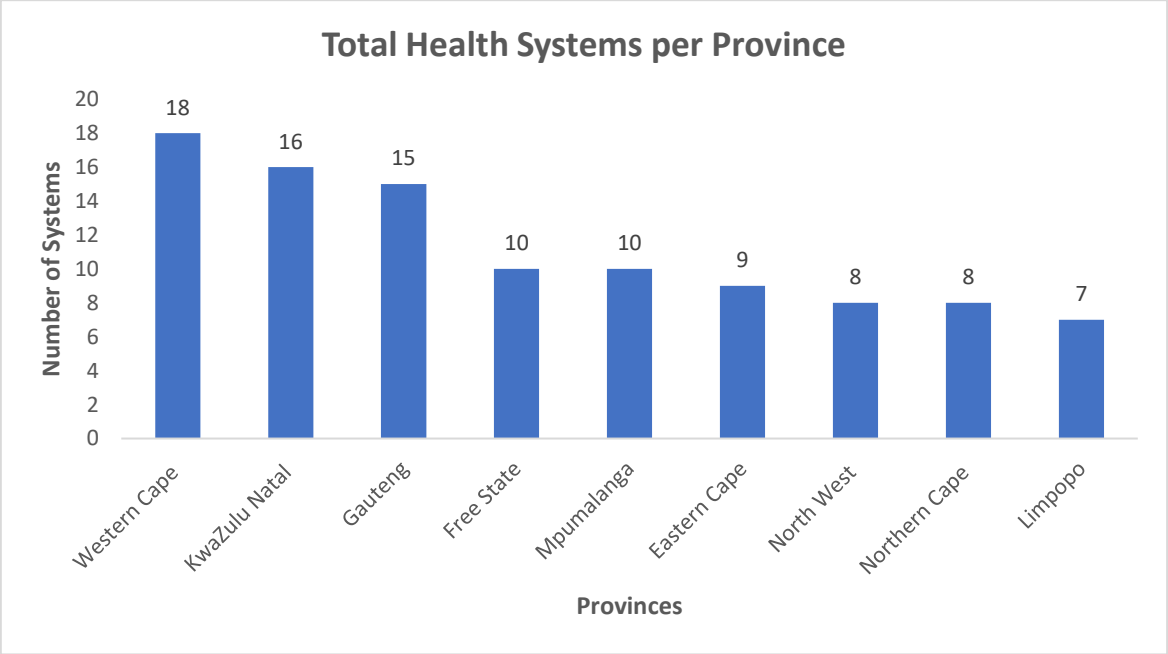


Figure 4-1: Number of health systems in each province (NDoH and CSIR, 2014)

The different systems are spread across different healthcare facilities, where they are unable to share information both across the local system and across other systems. Where interoperability is present, only about 30% are able to exchange information (NDoH and CSIR, 2014, p.127). Furthermore, most health systems do not adhere to any standards at both a national and international level (Adebesin *et al.,* 2013). Without a standardised guide that can be implemented across the different systems, the lack of quality healthcare provision will remain a far-fetched goal. In defining HISs interoperability interventions, it is essential to pool diverse expertise while drawing from previous developments. The South African NDoH has since welcomed the guidance of the National Health Normative Standards Framework for Interoperability in eHealth (HNSF) to improve interoperability across health systems (NDOH, 2014).

In defining HISs interoperability interventions, it is imperative to learn from the challenges that have impacted the health sector to inform present and future interventions. In recent years, one of the largest projects the health ministry intends to introduce to provide UHC is the National Health Insurance (NHI) program. Although the program is still being piloted in various districts, it is still in its developmental stages requiring collaboration across disciplines (Nicol *et al.*, 2021). In order to assist in the successful attainment of the NHI program and aid HIS interoperability interventions, various activities need to be considered to strengthen health systems. As a start, the various building blocks of health systems could be considered

4.4. The Six Building Blocks of Health Systems

To define how health systems operate, a health framework defining six building blocks of provides the aims and desired outcomes of well-functioning health systems has been developed (WHO, 2010). The six building blocks details features to consider for strengthening health systems. Additionally, the building blocks can also be used as a measure of progress made to improve health systems currently in place, and these include:

Table 4-2: Building blocks of health systems (WHO, 2010; Iyawa, Herselman and Botha, 2019)

Building Block	Description
Health service delivery	Quality health services delivery is a vital component for health systems. Health systems need to deliver efficient and quality health services while doing so in a secure manner.
Health workforce	A sound health system relies on human capital, skills, and knowledge set to deliver quality health services while efficiently utilizing the available resources.
Health information system	Reliable and timely information is the foundation required for decision-making related to health systems. Useful HISs needs to achieve the following: • collect relevant health data, • analyse information to ensure and maintain quality and reliability, • then convert the data to information that can be used to make decisions.
Access to essential medicines	Health systems must provide access to essential medication of quality that is safe and cost-effective.

Health financing	At the centre of health, financing ensures that health services can be received by any individual who requires health care. Additionally, health systems need to accumulate funds that can be used for the supply of health services.
Leadership and governance	Strategic policy frameworks coupled with effective oversight, the building of partnerships, regulation, and accountability are essential for efficient health systems.

Leadership and governance cuts across the other building blocks (WHO, 2010). To transform and bring about much needed advancements in health systems, leadership has been acknowledged in the World Health Report as the means of reforming and dealing with challenges being faced across heath systems (Gilson and Daire, 2011). It plays an important role in ensuring accountability in the different dimensions. In the South African context, the National Department of Health (NDoH) has outlined leadership, governance, and multi-sector engagement as critical components to creating an enabling environment for eHealth. The component further describes the "use of mechanisms, expertise, coordination, and partnerships to implement the eHealth strategy and develop or adopt eHealth components (e.g., standards)" as a priority in implementing the eHealth strategy (NDoH and CSIR, 2014, p.1). Although governance has been acknowledged to be of great significance, its value within the health environment is yet to be realised (Benedict and Schlieter, 2015). Therefore, there is a need to improve governance in the healthcare environment as it sets the foundation for all the building blocks.

4.5. eHealth Systems Maturity Levels

Considering the presented challenges, it is also crucial to understand the different eHealth systems' maturity levels. Embarking on a journey to change any health system requires a clear understanding of the state of functionality characterising each system. According to NDoH and CSIR (2014), eHealth systems maturity levels assist in the decision-making processes to determine the best course of action.

NDoH and CSIR (2014) defined the four eHealth maturity levels as the most basic, paper-based approach to the most advanced, fully functional eHealth maturity level that fully integrates technology and enables knowledge-sharing networks. Figure 4-2 below illustrates the ultimate

goal of interoperable eHealth systems, depicted as a fully electronic health system.

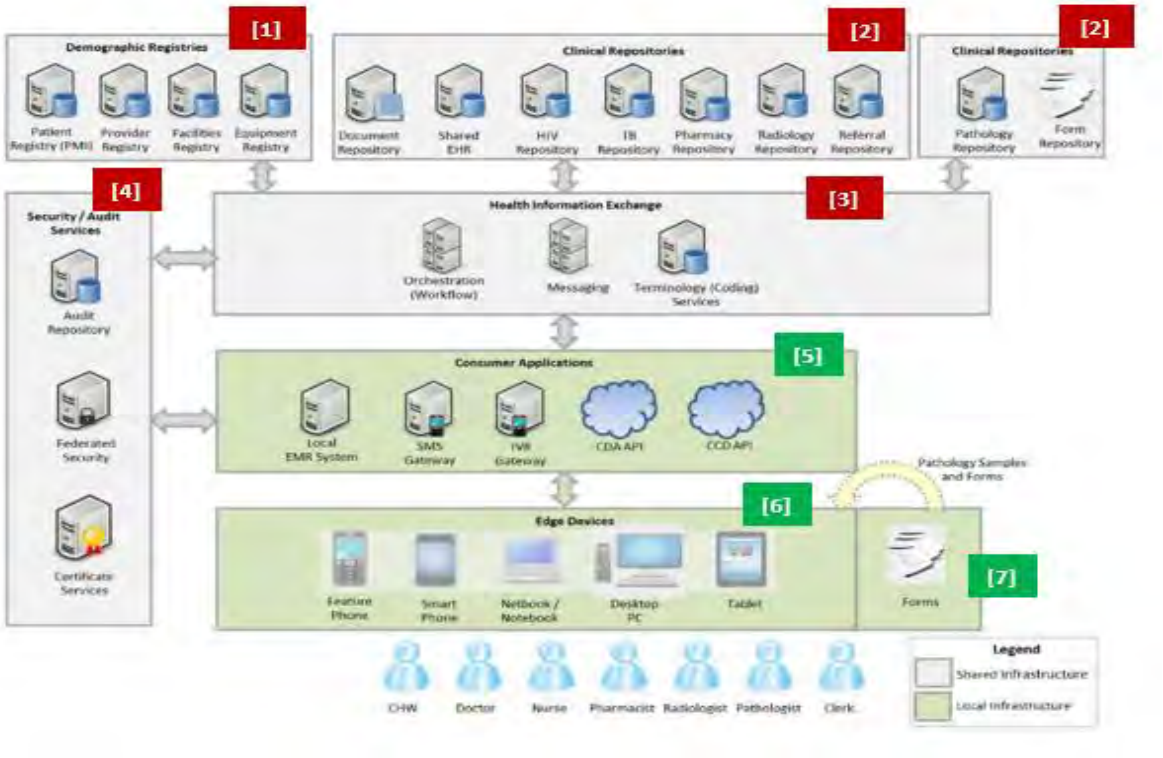


Figure 4-2: Example of a fully integrated national shared health system (NDoH and CSIR, 2014)

This level of eHealth maturity represents the desired end goal for a fully electronic-based IT system that enables HIX to occur. At this level of eHealth maturity, patients' health records are stored at the localised healthcare facility's EMR. The relevant aspects of a patient's health record are then stored onto a shared EHRs system, accessible across different networks.

A fully integrated electronic health system utilises shared infrastructure (sections displayed in a lightly shaded grey in Figure 4-2 to complete different tasks across various health systems. The local infrastructure (indicated in green) provides a view of how local healthcare facilities use to gain access to relevant health information. The red numbered markers represent aspects of shared infrastructure, whereas the green tags relate to the elements of the local infrastructure (see Figure 4-2). The following section details the various components(as shown by the red and green tags in Figure 4-2) that can contribute to the architecture of a fully functional electronic system and its relevant aspects (Fyfe, 2012; NDoH and CSIR, 2014):

[1]: Demographic Registries

In the shared infrastructure, demographic registries store healthcare entries that all partake in various healthcare events. To assist in maintaining and gaining access to relevant information, demographic registries contain:

- *Patient registries*: Using the PMI (Patient Master Index) to uniquely identify patients, this type of registry contains information related to patients in the health system, e.g., name, gender, age. When requesting information about the patient, a healthcare worker can search by the patient's particulars (e.g, search by name) to gain access to their medical record.
- *Provider registries*: provide details of healthcare providers and the role they have in the healthcare systems.
- *Facilities registries*: is responsible for maintaining the search facilities, i.e., where various data is stored across the system, by providing a register of all the different healthcare facilities.
- *Equipment registries*: is responsible for keeping and maintaining records of healthcare equipment and where it can be found across a healthcare institution. Attributes of data related to equipment may include equipment type, equipment model, location of use, etc.

[2]: Clinical Repositories

Primarily exist to store all the data related to healthcare events that occur and have been stored on the health system. Clinical repositories may contain general data (stored in document repositories) or data related to specific events related to various system programmes (e.g., HIV repositories). In addition to the document and specific repositories, clinical repositories may contain:

- *Electronic Health Record*: gathers patients' information and documents the care they have received throughout their lifetime**.**
- *Terminology repository*: maintains concepts across systems that are used for queries, validations, mapping etc. and enables the use of different coding systems and how they are mapped to gain relevant information.

[3]: Health Information Exchange (HIX)

Provides a coherent interface that can be used to enable communication between consumer applications, registries, and clinical repositories. Operates as a middleware that additionally serves to manage the workflow across the relevant registries and clinical repositories.

[4]: Security/ Audit Services

The nature of sensitive data stored across the shared infrastructure poses security threats that may compromise the patients and other relevant information. It is for this reason that security and audit measures are needed to monitor data, which can be done using the following:

- Audit repository: contains audit information that keeps track of all the services in a health facility. Information stored may include persons who performed various activities, when such activities took place, what and how data was used.
- Federated security system
- Certificate services.

[5]: Consumer Applications

In order to handle the various messages needed to record and access information in the shared infrastructure, consumer applications may be used. In this component, the management of consumer applications is made possible through various gateways, application programming interfaces and relevant channels to enable communication to occur.

[6]: Edge Devices

Relates to the different devices that enable end-users to gain access to consumer applications e.g. mobile devices.

Although the fully integrated health records system presents the ideal state of how health systems should function efficiently to interoperable health information, different realities exist across different systems. The fragmentation of health information is a result of the different eHealth maturity levels. For this reason, research into the interoperability of health systems must be cognisant of the various systems that are present before attempting to make any improvements. The following four different maturity levels exist across HISs in South Africa (NDoH and CSIR, 2014):

4.5.1 Level 1: Local Paper-Based Systems

Local paper-based HISs is the lowest level of recording patient information. At this level, medical records are manually recorded and stored with no use of any eHealth features. Paper-based repositories in this level function in isolation, and the Patient Master Index (PMI), used to identify individuals uniquely, can often not communicate with external healthcare providers. More so, the information stored in a single local facility may be captured more than once due to the lack of an integrated system. Figure 4-3 below presents how a typical paper-based system functions.

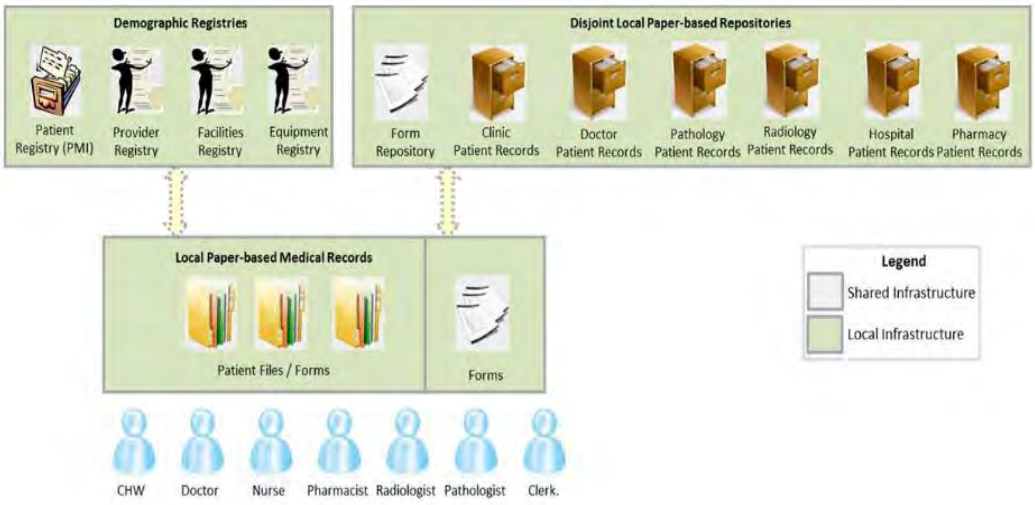


Figure 4-3: Example of a local paper-based record system (NDoH and CSIR, 2014)

4.5.2 Level 2: Local Paper-Based Systems with Limited IT Support

HISs in this category is predominantly paper-based however, provision is made for limited IT use. Similar to level 1, HISs in level 2 medical records are stored in a single facility with repositories that lack the ability to communicate across facilities.

The IT system is mainly used to capture patient identifiers and demographics. Clerks with access to the local facility where the information is recorded would use the patient identifier and their demographics to produce patient cards and record details to interactions that have taken place between a patient and a health facility. The system would also be used to edit and update patients' demographical information when required. Advanced systems would make provisions for mobile technology to enable information to be retrieved and updated. The limitation with IT in these systems is that messages sent by one system may not be shared or

stored across other facilities, further posing challenges for interoperability. Figure 4-4 below depicts how HISs in level 2 typically function.

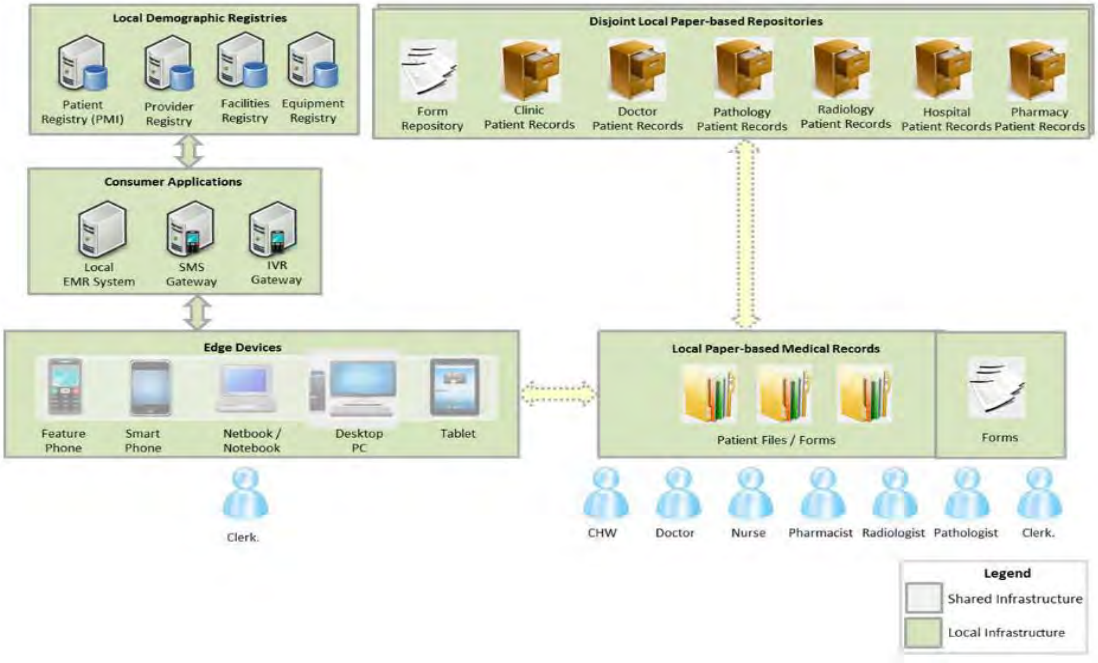


Figure *4-4*: Example of a local paper-based record system with limited IT support *(NDoH and CSIR, 2014)*

4.5.3 Level 3: Centralised Electronic System with Paper-Based and Electronic Features

Health systems that operate in level 3 are a combination of both paper-based and electronic functions. The HISs use a local infrastructure found in various healthcare facilities and a shared infrastructure accessible across different facilities. Figure 4-5 below provides a synthesized view of centralised health systems.

In this instance, the use of a paper-based system would occur when a healthcare worker records a patient's health information and medical record in a patient's file. To maintain consistency, standardised forms are used to record patients' information. Furthermore, paper-based functions would also be used to record samples, e.g., blood tests sent to pathologies; however, the results obtained would then be electronically recorded.

Once recorded on paper, a healthcare worker would electronically input relevant medical records data onto the local IT system, stored across shared clinical repositories and EHRs. The records of patients' health information would be accessible by appropriate local systems,

including clinics, general practitioners, pharmacies, laboratories, and other facilities. Furthermore, health facilities across hospitals and districts may also use centralised IT systems at a provincial or national level.

Authorised users across different healthcare facilities can make use of the shared clinical repository to perform various tasks. To further manage workflow activities, a health information exchange (HIX) may be used. Additionally, the system's security and audit services would facilitate authentication activities across the centralized infrastructure. Specialised consumer apps would be used at a local healthcare facility to manage information recorded on devices and stored on shared repositories.

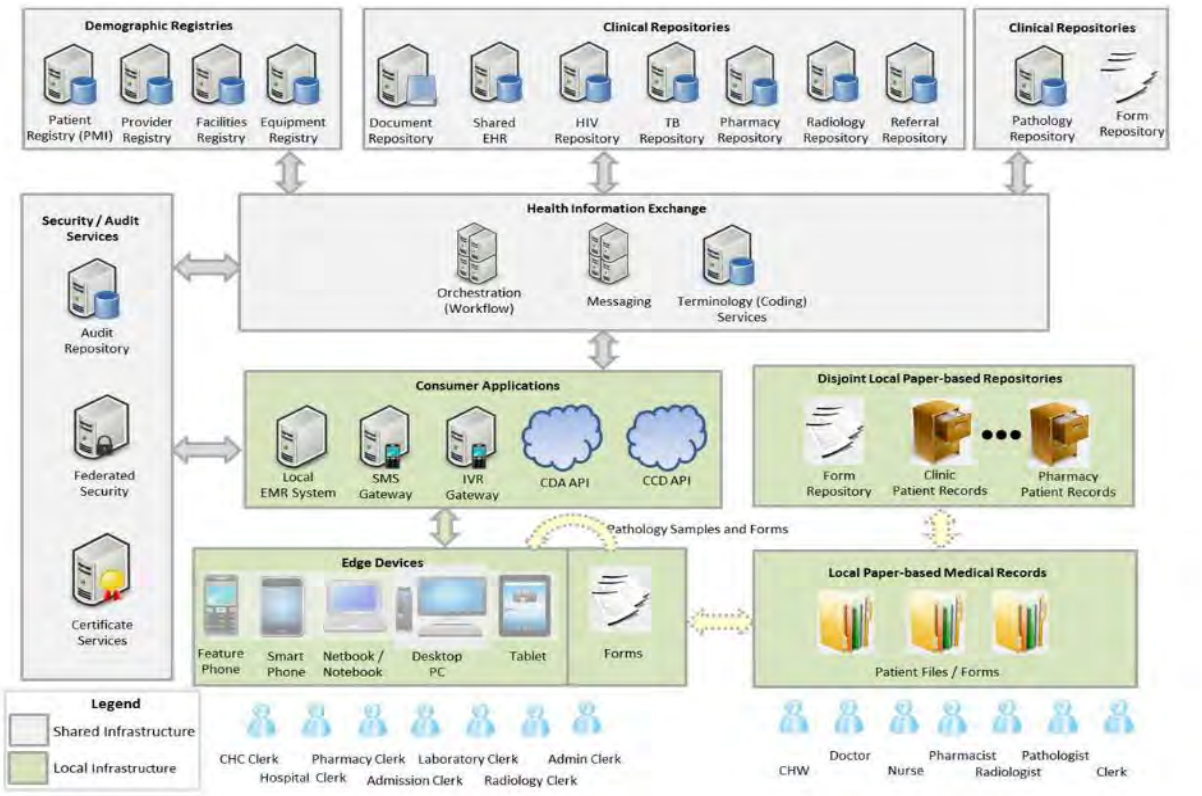


Figure 4-5: Example of a centralised health record system with hybrid features *(NDoH and CSIR, 2014)*

The NDoH has additionally developed strategic priorities that they have set to meet in 2030. Of the nine priorities, strengthening health systems has been noted as one of the key objectives (National Department of Health, 2011). Doing so cannot be done without a clear direction or focusing on redress's central areas. The WHO has developed six building blocks that can be considered when attempting to strengthen health systems, and the following section provides details in this regard

4.6. Summary

Understanding the context of South African HISs was critical in determining how best to advance HIS interoperability. In response to SRQ 2, *How should health information systems align with interoperability practices?*, this chapter focused on defining HISs and the value they seek to deliver to the various beneficiaries. Furthermore, eHealth and the associated implementation forms are discussed, followed by the current state of transformation in the South African health care environment. Upon identifying the challenges encountered by current operational HISs, the chapter examined the various building blocks that can be used to strengthen HISs. Due to the differing progress made by different health facilities in instituting HISs, this chapter also discussed the maturity levels at which HISs may operate and discusses the importance of acknowledging this before assuming interoperability interventions. Through this chapter, the researcher was able to identify the essential areas to consider as part of addressing the HIS theme of this research, consequently, the constructs that would be used to inform the conceptual framework.

4.7. Literature Constructs from Chapter 4: Informs the Design of the Initial Conceptual Framework

The effective detection of epidemics in resource constrained countries such as South Africa will rely on decision makers being able to access relevant health information from health systems as it is needed (Alam et al., 2021). This will require comprehensively built health systems to cater for future needs. Against this backdrop, Table 4-3 below, synthesises the knowledge in chapter 4 towards the design of the initial conceptual framework. The table outlines the most important constructs related to HISs considered relevant for the conceptual framework.

Table 4-3: Chapter 4 constructs for the design of the initial conceptual framework

Number in initial HISIG-CF	Constructs	Key Focus Areas
[B]	eHealth Maturity Levels	The concept of eHealth; The different maturity levels at which HIS operate which includes: Local paper-based systems, Local paper-based systems with limited IT support, Centralised electronic system with paper-based and electronic features, fully integrated national shared health system.
[B1]	eHealth Buidling Blocks	The strength of HIS is not only reliant on its technical attributes but draws from a range of contributing building blocks which include: health service delivery, health workforce, health information systems, health financing, access to essential medication, leadership and governance.

Chapter 5 : Interoperability and standards in eHealth

5.1. Introduction

This chapter will focus on the interoperability aspect of SRQ 2 in addition to addressing SRQ 3, coined as:

What is the role of interoperability standards on health systems?

In addition to the previous context on health systems, this second chapter will define the concept of interoperability. Moreover, the section will outline how interoperability can be established across different layers. The current progress that has been made in creating interoperable health systems in South Africa, further drawing from some of the key learnings through developing MomConnect, will be addressed in this chapter.

5.2. What is Interoperability?

The term interoperability may mean or relate differently depending on the context in which it is used. For instance, the Healthcare Information and Management Systems Society (HIMSS) dictionary provides various definitions pertaining to interoperability, which considers social, political, and organisational domains (HIMSS, 2017). However, interoperability's commonly used description is outlined as - how systems (or components thereof) communicate towards mutual goals through exchanging and sharing information (Benson and Grieve, 2018).

In context to the health industry, interoperability defines how healthcare information can be interchanged to enable knowledge-sharing networks amongst healthcare providers (Desai, 2015). The purpose of this is to improve the accessibility of patient health records and information required to guide decisions towards providing quality health services (European Commission, 2017).

The healthcare environment is complex as it is comprised of numerous intricate components that are all connected to people. Therefore, it is plausible that interoperability is challenged by a variety of factors that could be improved. The following section discusses some of the constraints to the development of interoperability.

5.3. Interoperability Challenges

The healthcare environment is presented by different challenges that impede healthcare provision, more so the possibility of interoperability. Considering the number of different health systems across South Africa, the main issue that cannot be ignored is the extent to which

the heterogeneous platforms operate. According to Amin *et al.* (2020), the critical factor that affects the integration of data or information across systems is that different systems operate within the borders of their specifications. Therefore, creating barriers to seamless HIX.

Healthcare systems are additionally attributed to interrelated components that intensify their complexity (Han *et al.*, 2020). Furthermore, different actors (doctors, healthcare providers, pharmacies) all participate in healthcare delivery and may require information relevant to their specific needs (Iroju *et al.*, 2013). Without a clear outline to determine how different actors and systems can be integrated to communicate as a unit, the complexity of health systems will continue affecting the realization of interoperability in eHealth systems.

5.4. Layers of Interoperability

Adding to the complexity of interoperability, Amin *et al.* (2020) note that four different layers enable interoperability facilitation. The importance of these layers is such that a multi-faceted approach to interoperability is pursued to facilitate implementation. This further allows organisations to prepare well for some aspects that need consideration to start an interoperation journey. The following section defines the layers of which interoperability can occur (European Commission, 2017):

5.4.1 Organisational Interoperability

Focused on ensuring that business goals, processes, and collaboration can be integrated beyond a single organisation's scope. Organisational interoperability is primarily concerned with transferring meaningful information across different facilities using a range of Information Systems (IS). For organisational interoperability to be successfully applied, it depends on technical, syntactic, and semantic interoperability foundations.

5.4.2 Technical Interoperability

This layer relates to the technical matters that enable information exchange, including protocols, interfaces, and related features. Furthermore, technical interoperability concerns hardware and/or software aspects of systems to ensure that data transfers are secure. The environment in which they operate supports uninterrupted information flows (Benson and Grieve, 2016). In the eHealth environment, technical interoperability relates more to the communication protocols to ensure that relevant information can be transmitted.

5.4.3 Semantic Interoperability

Information and its meaning are of paramount importance in this layer of interoperability. Semantic interoperability ensures that a common set of descriptions and interpretations are consistently maintained across communication channels. Its focus is skewed towards the meaning obtained from shared information. In eHealth, semantic interoperability often relates to creating consistent coding standards.

5.4.4 Syntactical Interoperability

Focuses on facilitating the exchange of information using predefined messaging and data formats. Well-established syntax and encoding are required to ensure that data is communication occurs simultaneously across systems.

Considering the different layers at interoperability can materialize, there is a need to level out the complex field by ensuring that a common set of rules and procedures are followed. The following section investigates the mutual relation between interoperability and standards.

5.5. The Role of Standardisation in Healthcare

The deployment of interoperability cannot exclude the vital role played by standards. Standards define specifications that have been mutually agreed upon to create or maintain consistently (Han *et al.*, 2020). Furthermore, standards are necessary to ensure that regulations set at both national and international are taken into account to allow safe operations (Katuu, 2016). Central to the facilitation of interoperability in the healthcare environment is a need to understand what standards exist and are best utilised to develop suitable standards. Importantly, standards promote effective HIX, create co-existing environments, and ensure that the systems are interoperable (Alunyu and Nabukenya, 2018).

5.5.1 Standardisation Challenges

Throughout literature, the role of standards in aiding interoperability has been well documented (NDoH and CSIR, 2014; Alunyu and Nabukenya, 2018). Nevertheless, even though standards are noted as fundamental to enabling interoperability, their adoption remains low (Adebesin *et al.,* 2013). This is primarily due to the number of eHealth standards available, which complicates selecting and adopting relevant standards.

Before attempting to implement the use of standards, it is crucial to understand the type of technical infrastructure in place. The lack of adequate infrastructure affects the ability of systems to participate in employing the right standards.

Secondly, the duplication of standards also impedes the ability to select appropriate standards effectively. This is mainly due to overlapping standards that may not offer sufficient support at the most crucial system points (Hammond, 2017). There is a need to ensure that an in-depth analysis of standards is performed to address any incompatibility issues that may arise.

Another issue with standards may be the lack of fully addressing all communication levels. Standards may be developed with assumptions of the type of infrastructure present, which may not provide an accurate representation (Alunyu and Nabukenya, 2018). For this reason, specific standards that relate to the exact nature of required services are needed to ensure that all communication levels are comprehensively considered.

5.5.2 Comparison of Standards Specifications: HNSF and FHIR

To establish the foundations that would steer the adoption of standards relevant for supporting interoperability in the South African healthcare environment, the CSIR, alongside the Nelson Mandela University (NMU), created the National Health Normative Standards Framework for Interoperability in eHealth in South Africa (HNSF) (NDoH and CSIR, 2014). The framework was developed to answer the call of the National Department of Health (NDoH) to improve eHealth at a national scale. The HNSF further provides the foundation that would set precedence for interoperability through its standards-based approach.

At the core of the HNSF, is the gaols to guide for achieving network effects representing a desired complete healthcare environment through the specifications defined (NDoH and CSIR, 2014). The framework presents a practical view of implementing interoperability and plays a pivotal role in the South African health landscape. Reviews of international eHealth standards are provided and considered in context to South Africa, and further use cases are developed to define the applicability of the specifications outlined.

On the other hand, the specification of a standard defined as Fast Healthcare Interoperability Resources (FHIR) is gaining prominence in healthcare (Fogwill, Barron and Benjamin, 2016). FHIR has been developed to provide standards for exchanging healthcare information electronically. Though it has not been considered much in the South African healthcare environment, the standards may significantly contribute to industry and research in the future

(Saripalle, Runyan, and Russell, 2019). FHIR specifications are driven by the need to provide a more coherent and simplified approach to the standardisation in healthcare (HL7 FHIR, 2017). The additional advantage presented is that existing logical and theoretical models are not entirely disregarded but are considered to align with pre-existing best practices future (HL7 FHIR, 2017).

Considering the standards specifications discussed, the following sections explore the complex nature of the healthcare standards environment.

5.5.3 Categories of Standards

The eHealth standards landscape is challenged by the plethora of standards that complicate selecting suitable standards. Therefore, a thorough examination of each standard is crucial to determine the best fit in a set environment (NDoH and CSIR, 2014; Katuu, 2016). To organise each of the standards in order of relevance, a range of standards categories are identified as being applicable in the South African context include: Identifier Standards, Electronic Health Records Standards, Health Smart Cards Standards, Messaging Standards, Structure and Content Standards, Clinical Terminology and Classification Standards, Security And Access Control Standards, General eHealth Standards, General IT Standards (NDoH and CSIR, 2014).

5.6. Mitigating Standards Complexities using Standards Stacks

In a study done by Adebesin and Kotzé (2017), it was noted that the implementation of interoperability could be attained by combining several standards. However, utilising different poses the risk of deploying a mixture of standards that may result in incompatibility. In order to mitigate against potential incompatibility issues, three (3) standards stacks are defined.

5.6.1 Health Level Seven (HL7) Version 3

Developed by the Standards Development Organisation (SDO), Health Level Seven (HL7), is a messaging standard that has been developed with the purpose of exchanging, managing, and integrating healthcare-related information (HL7, 2017). Moreover, HL7 is a standard best used for clinical and administrative purposes in the healthcare environment.

Version 3 of the HL7 can be used in the context of interoperability as it is developed to provide trigger events, interaction designs, and a domain object model rooted in the Reference Information Model (RIM) that depicts semantic and grammatical use messaging (HL7, 2017). However, HL7 has tremendously contributed to the exchange of health information by

addressing digital challenges using information modelling standards (HL7 FHIR, 2019). FHIR specifications have been built on the different versions of HL7 (i.e., HL7 v2, HL v3).

5.6.2 International Standards Organisation (ISO) 13606

A standard developed to address semantic interoperability by defining the information architecture for communication can be used for EHRs between different systems. Developed by the European Commission of Standardisation, ISO 13606 comprises five parts developed to support the standard's basic implementation (ISO, 2008).

5.6.3 Integrating the Healthcare Enterprise (IHE)

An initiative developed by healthcare professionals assists users in creating health systems interoperability (NDoH and CSIR, 2014). This is done by defining the task needed to deliver healthcare tasks, advising on standards-based specifications that need to be adhered to, and supporting the facilitation of communication between systems. IHE does not necessarily define standards that can be used (NDoH and CSIR, 2014). It merely intends to act as a means of profiling and aid the conformance testing of organisations to integrate existing standards and achieve set tasks.

The available expertise would guide a choice of which stack to utilise in a given country or context. In the South African context, the IHE profile is the most relevant as it provides a thorough breakdown of how to address a given interoperability need. Furthermore, the process of using IHE profiles is well documented in the HNSF, which has been used to define interoperability standards of relevance (NDoH and CSIR, 2014). Figure 5-1 below provides the process that has been followed in selecting interoperability standards relevant for South Africa. Based on IHE profiling of standards, subsets of IHE profiles are developed to determine the interoperability standards for use.

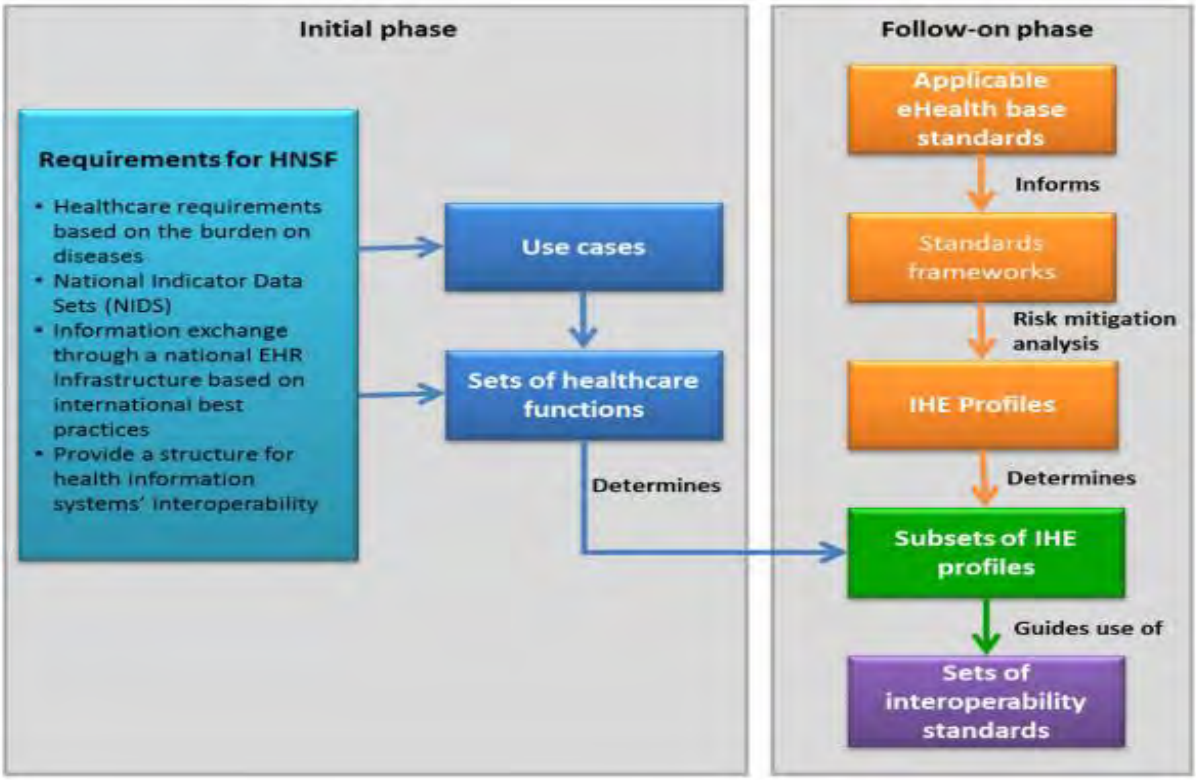


Figure* 5-1*: Process for selecting interoperability standards* adapted from *NDoH and CSIR (2014)

5.7. Using Module Sets to Implement Standards.

Once the standards environment has been thoroughly examined, how to implement the most relevant and appropriate standard(s) remains. According to the specification set out by FHIR (HL7 FHIR, 2019), sets of modules are instrumental in identifying functional areas and what each specifies in an effort to guide implementation. The following sets of models are identified (HL7 FHIR, 2019): Foundation, Implementer Support, Security and Privacy, Conformance, Terminology, Linked Data, Administration, Clinical, Medications, Diagnostics, Workflow, Financial, Clinical Reasoning. In Figure 5-2 below, a diagrammatic representation of how each of the modules and the related content would function across five (5) various layers.

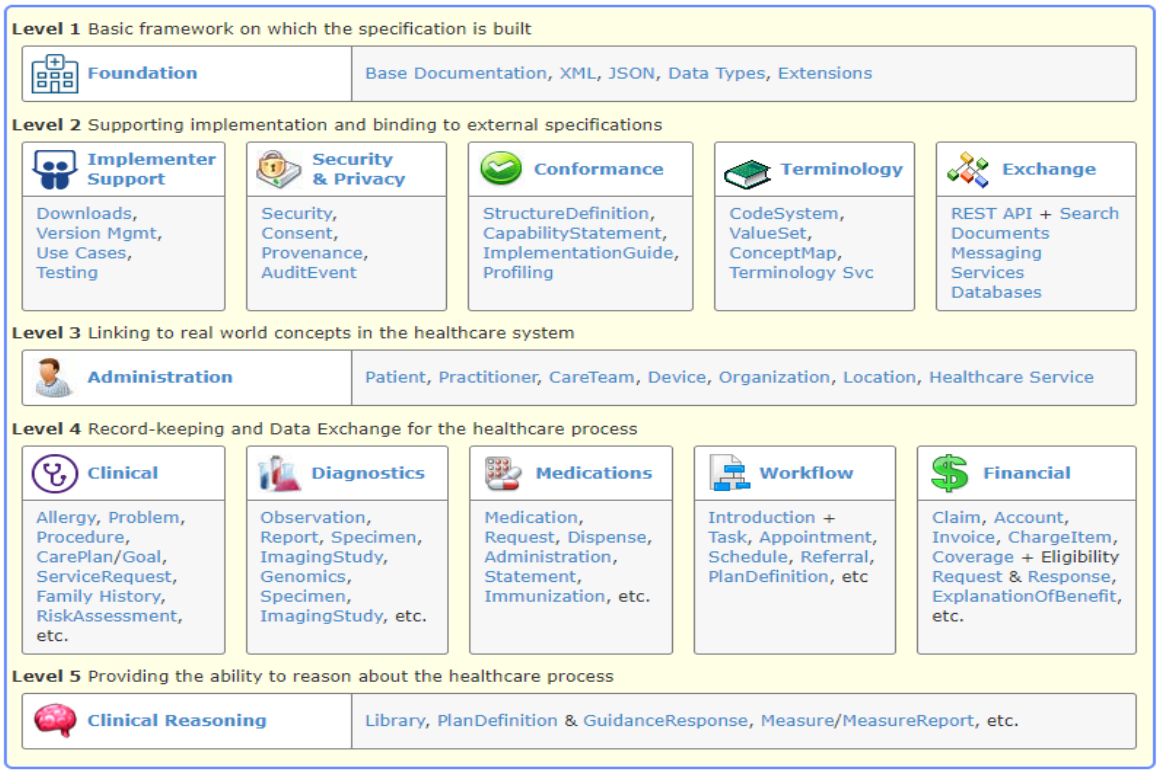


Figure 5-2: Integrated view depicting the implementation of module sets (HL7 FHIR, 2019)

5.8. Lessons from Past Interoperability Interventions

The process of guiding interoperability and standardisation across HISs provides a learning opportunity to inform other similar interventions. This involves drawing lessons from programs that have successfully integrated standards in the past in order to improve the provision of health services. MomConnect is one such initiative that has served as a reference point for research on standards adoption and interoperability in developing countries (Ojo, 2018).

MomConnect is a nationally scaled digital health initiative focused on the delivery of maternal health information. Its functions include registering pregnant women using unique identifiers, providing targeted maternal health information, and facilitating clients' access to help desk services for additional assistance or feedback (Seebregts *et al.*, 2016). This was the NDoH's first investment in developing an interoperable HIS. MomConnect is built on the premise of mobile health (mHealth), which is defined as the use of mobile phones or wireless technology to deliver health services (Fogwill, Barron and Benjamin, 2016). In South Africa, approximately 89% of people have access to mobile devices. The NDoH leveraged this advantage to provide maternal services to women to reduce infant illnesses and death.

Additionally, registration has been facilitated primarily through the use of Unstructured Supplementary Service Data (USSD), which is compatible with all mobile devices (Mehl *et al.*, 2018). By removing potential barriers to access and optimizing the resources accessible to people, MomConnect has grown to over 1.5 million registered users (Mehl *et al.*, 2018). Consequently, this demonstrates the possibility of universal access to health care across the country.

The possibility of MomConnect as an interoperability intervention drew from a range of technical architectural designs and standards to deliver on the different activities that contribute to interoperability. These included the following (Mehl *et al.*, 2018):

- District Health Information Systems, version 2 (DHIS2) was considered the main distribution centre to facilitate the storage of data related to MomConnect.
- The Open Health Information Mediator (OpenHIM), later upgraded to Seed, was considered in the architectural design to facilitate HIE. Furthermore, this aided the USSD application for the sharing of messages at different stages of pregnancy.
- Integrating the Healthcare Enterprise (IHE), particularly the standards profile related to the Patient Demographics Query, was used to manage the demographic data. In contrast, clinical data use was considered the Mobile Health Document profile and Clinical Document Architecture (HL 7).
- The messaging profile is mainly considered a custom JavaScript Object Notation (JSON) to cater to the enrolment and notification attributes of MomConnect. Additionally, the support of specific clinical messaging considered HL7 FHIR.

These technical architectural and standards considerations show that the possibility of interoperability requires the grounding of different standards across different implementation layers (i.e., messaging, storing data, etc.). Furthermore, the standards used are consistent with those defined in the HNSF and that of international initiatives. As a result, it provides an opportunity for replicability, as demonstrated by Uganda in its design of Family Connect. Family Connects follows the MomConnect approach through the use of client registration, messaging initiatives and has been extended to digital systems (Mehl *et al.*, 2018). Thus, to carry out HIS interoperability at a much larger scale, MomConnect serves as a good starting point.

5.9. Summary

The purpose of this chapter was to address SRQ 3, outlined as, *What is the role of interoperability standards on health systems?* To fully address this question, this chapter reviews the literature on the definition of interoperability and the challenges posed by its lack of adoption across various HISs and health care facilities. This chapter then discussed the various layers at which interoperability can occur to better understand how interoperability can be achieved. The chapter's final two sections discuss literature that focuses on the impact of standards when attempting to implement interoperability. Additionally, we will draw on the lessons learned from MomConnect, which has integrated standards into its approach to mHealth interoperability. This chapter addressed the research's interoperability theme and the theoretical underpinnings of the concepts discussed.

5.10. Literature Constructs from Chapter 5: Informs the Design of the Initial Conceptual Framework

The integration of digital healthcare systems offers an opportunity to improve the quality of healthcare provided to patients (Kobusinge, 2021). Moreover, in the quest of introducing interoperability, it is important that collaborative health systems focus on creating knowledge sharing network. As such, Table 5-1 below synthesises the knowledge in chapter 5 relevant for the interoperability aspect of the initial conceptual framework. The table provides an overview of the most important interoperability constructs relevant for the conceptual framework.

Table 5-1: Chapter 5 constructs for the design of the initial conceptual framework

Number in initial HISIG-CF	Constructs	Key Focus Areas
[C]	Interoperability Layers	Founded on the need to examine the capabilities of their health facilities current hardware resources (addressing the technical and organisational layers) and software resources (semantic and syntactical use) before embarking on an interoperability journey.
[C1]	Standards of Interoperability	The value of standards in interoperability; Focuses on using the National Health Normative Standards Framework for Interoperability in eHealth in South Africa (HNSF) and the Fast Healthcare Interoperability Resources (FHIR) to guide interoperability using standards based approaches.

Chapter 6 : Design of Initial Conceptual Framework

6.1. Introduction

As initially indicated, this research aims to develop a conceptual IT governance framework that can aid in the interoperability of health information systems. In chapters three (3) to five (5), the key research themes were discussed to understand the phenomenon this research aims to enhance. As previously discussed in the methodology chapter, the outcome for phase 1 of the research is to design an initial conceptual framework as informed by the literature, as depicted in Figure 6-1 below. Therefore, this section outlines and defines the constructs considered in the development of the initial conceptual framework.

Taking into account the qualitative nature of this research, this chapter outlines how the Scoping Reviews approach was used to guide the process of developing the theoretical foundation of the conceptual framework. This is conducted following the guidelines and framework by Arksey and O'Malley (2005). The results of the process are analysed using Thematic Analysis, with the assistance of CAQDAS, namely NVIVO.

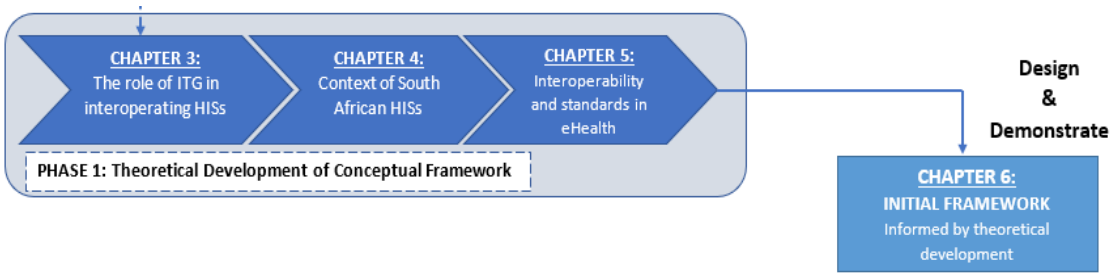


Figure 6-1: Phase one of initial conceptual framework design

As a start to developing the conceptual framework for this research, the following section outlines what a conceptual framework is and how the theoretical background contributed to its design.

6.2. Conceptual Framework

The contribution and value presented by studies are defined by how the concepts addressed are interpreted. This notion is supported by Peters (2014), who posits that regardless of the area of study, the interpretation of a research's results leads to a model, whether imp Qlied or stated upfront. Furthermore, the value in such models is to present the relationships formed across related entities. As such, this research develops a conceptual framework to synthesise

the knowledge across the broader research themes in ITG, HISs, and Interoperability to contribute to the development of the health environment.

The ability to use the different themes identified in this research to contribute to the health environment is associated with systems thinking. The core purpose of systems thinking is founded on establishing how parts of a concept are connected to a whole (Peters, 2014). This is driven by the intent of drawing connections to determine how one aspect of an area can affect the other on a much larger scale. Essentially, through systems thinking, the quality of interactions can be established by studying interactions between parts that contribute to a whole.

Motivated by the research problem, a conceptual framework is deemed appropriate in synthesising the knowledge gathered in this research. The conceptual framework is developed to demonstrate the researcher's understanding of the concepts studied and further evaluated by the various experts that participate in the research. Furthermore, the conceptual framework of this research establishes how best to address the problem of HISs operating as silos and the impact ITG could contribute on improving HIS interoperability interventions.

Conceptual frameworks are further informed by the theoretical background obtained from the findings of a study (Bharti, Agrawal and Sharma, 2015). For such purposes, the initial conceptual framework of this research is informed by the literature review, conducted across chapters three (3) to five (5). Moreover, the Institutional Theory guides the design of the conceptual framework to ensure that it is adequately contextualised within the broader healthcare environment.

6.3. Theoretical Grounding

The dimensions of isomorphism as influences on institutions were specified in the methodology chapter of this research. These were identified as coercive, normative, and mimetic isomorphism. These dimensions outline influence from a "regulative, normative and culturally-cognitive" perspective, respectively, as defined by Scott (2005, p.44). It is on these grounds that the dimensions are considered in the design of the initial HISIG-CF across the perspectives presented below:

Regulative (coercive)	Considers the political or regulative influence on institutions. This research is done by considering the objectives set out by the highest level of

	governance in the health sectors through various strategic documents.
Normative perspective	Focuses on the organisational actors and how professionalisation is perceived. This is done by viewing the healthcare environment based on rules governing private and public health care operations.
Mimetic (culturally cognitive)	Stems from imitating how other institutions function when faced with uncertainty and reducing the potential impact of risk. This is done by drawing lessons from other interoperability interventions across other healthcare contexts.

The Institutional theory contributes to this research by defining the setting and contextual influences present in the healthcare environment. Through this theory, the research was able to understand the complexities associated with integrating an IS/IT-based solution (through the conceptual framework) in context to the health environment. However, the actual design of the conceptual framework required further theoretical guidance. For this reason, the DSRM process, rooted in DSR and related design theory, was used to guide the development of the conceptual framework.

6.4. Scoping Reviews

The protocol used in this research to define the theoretical foundation was developed using the Scoping Reviews approach. This approach was relevant in Phase 2 of the DSRM to demonstrate the HISIG-CF. Scoping Reviews of prior literature were conducted in IT governance, Health Information Systems, and Interoperability in the health sector. The scoping review method guides the synthesis of knowledge through the systematic mapping of literature (Levac, Colquhoun and O'Brien, 2015). It provides an overview of the literature in a discipline and creates an opportunity for studying a broader range of conceptual themes (Booth, Sutton and Papaioannou, 2016).

6.4.1 The Objective of Scoping Reviews

A mere selection of a literature review approach is not sufficient to provide a comprehensive review. Although it is a step in the right direction, it is necessary to outline the rationale that

reinforces the selected approach's use (Peters *et al.*, 2015). In their study of advancing the use of scoping reviews, Arksey and O'Malley (2005) identify the most common reasons researchers may be more inclined to use the scoping approach as:

- Not providing in-depth findings of a research study but only consolidating the range of information.
- The mapping of literature may form the basis of a full systematic review.
- Providing a summary of findings in a particular research area. The intention of which is to outline the range of information obtained.
- Identifying gaps in literature where there is minimal to no research in a particular area.

In context to this research, the scoping review approach is used to "summarise and disseminate research findings" as a means of identifying how ITG mechanisms can be used to guide the interoperability of Health Information Systems (HISs). Furthermore, the scoping reviews process was undertaken with the end goal of designing research output through a conceptual framework.

Research on HISs interoperability is mainly conceptual in the South African healthcare industry and has not been fully implemented yet (South African National Department of Health, 2019). It is an emergent area that still requires more work to inform improvement across different health systems. Scoping reviews are favourable for emerging fields where "the paucity of randomized controlled trials makes it difficult for researchers to undertake systematic reviews" (Levac, Colquhoun and O'Brien, 2010, p.1). Furthermore, a scoping of reviews is relevant for fields with no comprehensive review in a particular area (Peters *et al.*, 2015).

6.4.2 Steps for Conducting Scoping Reviews

Conducting a thorough review that could be replicated for future studies required a detailed account of the process undertaken. The following steps guide the development of this literature review using the framework developed by Arksey and O'Malley (2005), which has been modified by Levac, Colquhoun and O'Brien (2010).

a) Focus the review process by identifying the research question

The identification of the research questions was aimed at defining the bounds of the literature that was considered. This was crucial in providing a blueprint for review and ensuring that progress does not deviate from the research purpose. As a result, the motivation for this

research is driven by the RQ introduced in section 1.5: *What should constitute the components of a conceptual framework that outlines IT governance mechanisms to support the development of an interoperable health information system?* To further map the literature and address the research phenomenon, Chapters 3 to 5 focused on addressing each SRQ, which informed the extraction of the themes considered. Table 6-1 below summarises the themes that were extracted, guided by the SRQs.

Table 6-1: Extracted research themes

Chapter	Relevant SRQ	Extracted Themes
Three (3)	*SRQ1: What IT governance mechanisms can be used to support interoperable health systems?*	**Theme 1:** IT governance
Four (4)	*SRQ 2: How should health information systems align with interoperability practices?*	**Theme 2:** Health Information Systems
Five (5)	*SRQ3: What is the role of interoperability standards on health systems?*	**Theme 3:** Interoperability

b) Identify studies of relevance

The purpose of this step was to identify appropriate literature. As a start, a comprehensive literature search was conducted across the following electronic databases: Scopus, Science Direct, and Google Scholar. The documents considered included: conference papers, journal articles, and books. In addition, grey literature was searched across government websites, mainly the South African National Department of Health's website, to access strategic documents and COBIT 19 documents published by ISACA to gain more context into the area of ITG.

c) Select studies of relevance

Once the researcher established the platforms that would be used to source the relevant literature, it was essential to establish an eligibility (inclusion and exclusion) criterion for the literature considered, which included:

- Studies published in English
- Studies that refer to either or a combination of the terms *IT governance, Health Information Systems,* and *Interoperability*
- Studies that elaborate on the *IT governance mechanisms*
- Studies that consider *Interoperability* in the healthcare domain
- Studies that consider *Health Information Systems* in the healthcare domain
- Studies that consider *Health Information Systems* in the South African context
- The search for literature was defined for studies between the years 2015 – 2021
- Government strategic documents published before 2015 but consider addressing objectives between 2015-2021

Taking the above criteria into account, the researcher considered studies that used the terms:

1. IT governance
2. Health Information Systems
3. Interoperability

The challenge with using generic strings such as IT governance and Interoperability resulted in many studies that consider various contexts and industries, some of which were relevant for this research. As a result, to align the search strings with the purpose of this research and remove studies that would not contribute to the research, the search strategy was narrowed to consider the following areas:

- Literature that refers to IT governance across both public and private healthcare sectors
- Literature that studies HISs in South Africa and developing countries alike
- Literature that focused on Interoperability in the healthcare environment.

Potential papers were obtained using a combination of search strings, including: "IT governance" in combination with "private sector" and "public sector" and "healthcare" "Health information systems" in combination with "Interoperability" and "South Africa." "Interoperability" in combination with "Layers" and "Healthcare." The results obtained from the search string combinations were screened to determine their appropriateness based on the title, keywords or phrases, and reading through each paper abstract (da Luz Júnior *et al.*, 2020). Once the first screening process was complete, full-text papers aligned to the research's eligibility criteria were narrowed to 32 papers that were then considered for review. Figure 6-2 below provides a summary of the process used to select relevant studies.

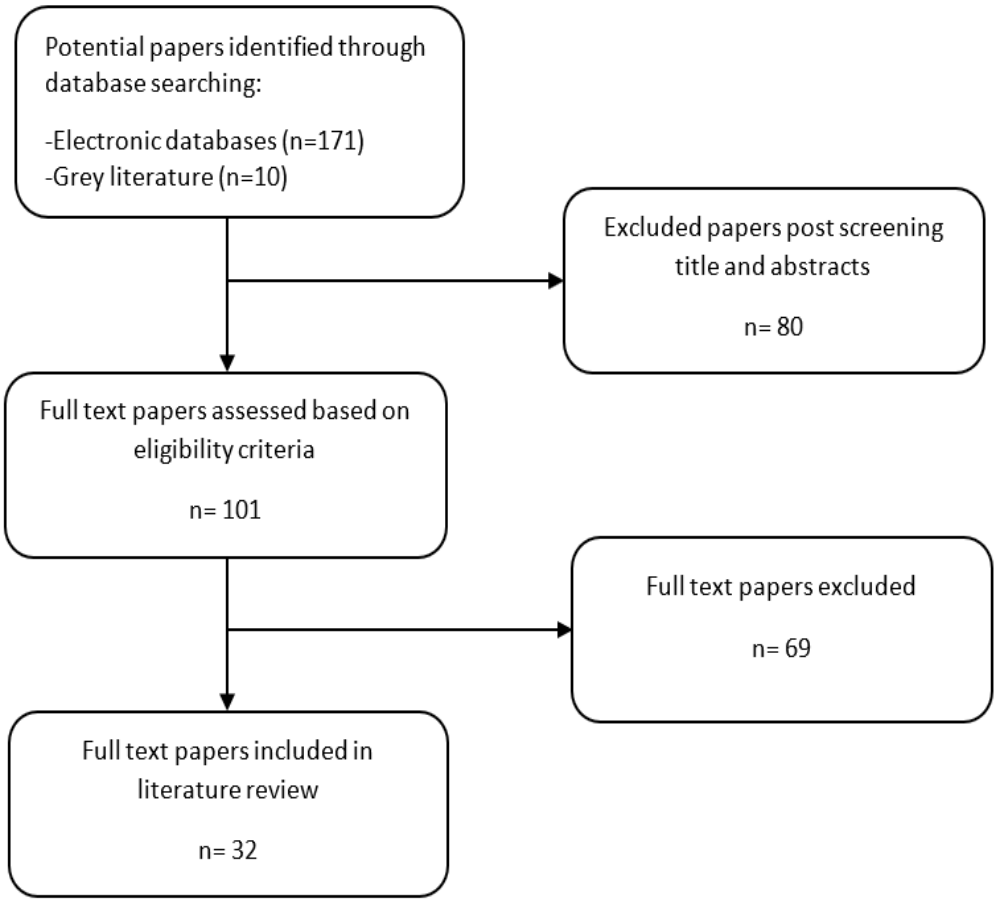


Figure 6-2: Literature search process

The primary objective of the scoping review process is to "map the literature on a particular topic rather than provide an exhaustive explanation" (Schmidt *et al.*, 2020, p.2). In so doing, many relevant studies are expected, and this has the advantage of allowing insight to be drawn from multiple sources that address a phenomenon broadly. However, even with the added benefit of guiding future development through a variety of perspectives, large numbers could potentially impair the study's quality during analysis (Saunders, Lewis and Thornhill, 2016). For such reasons, it was essential to manage the results of the studies obtained to ensure that this research does not deviate from its intended purpose. Furthermore, the literature considered was purposively sampled (Schmidt *et al.*, 2020), which was reflected across the literature search process to identify the range, contrasts, and similarities of the concepts related to ITG, Health Information Systems, and Interoperability presented by each paper. This process took place between August 2020 – June 2021.

d) Chart data obtained from studies

The charting of data is a technique that involves synthesizing crucial information obtained from studies. This can be achieved by recording critical information across different themes that will aid the research. Therefore, to narrow down the scope of inquiry to address areas related to the research, a combination of strings was used, as indicated below. For this research, the core literature used for review was charted on Excel, which extracted the following information: Author, Publication Year, Title, Key Findings, and Research Theme. The key findings were used to determine the significance of each study and assess its eligibility in context to this research. Furthermore, each paper considered needed to align with the broader research themes. In sum, 32 core papers that contributed to Phase 2 of this research were considered, as presented in Figure 6-3 below (see Appendix C for complete literature chart).

	A	B	C	D	E	F
1	**Core Literature Review Papers**					
2	**Paper Number**	**Author**	**Publication Year**	**Title**	**Key Findings**	**Research Theme**
3	1	De Haes and Van Grembergen	2015	Enterprise governance of IT	Examines how enterprise governance can be deployed through a mixture of structures, processes and relational mechanisms	IT Governance
4	2	Wu, S. P., Straub, Detemar, W. and Liang, T.-P.	2015	How Information Technology Governance Mechanims and Strategic Alignment Influence Organizational Perfromance: Insights from a Matched Survey of Business and IT Managers	The impact and linkage between IT governance mechanisms and strategic alignment. Further showing how these infleunce organisational performance	IT Governance
5	3	Manda and Backhouse	2016	An analysis of the barriers to e-government integration, interoperability and information sharing in devloping countries: a systemaic review of literature	The barriers to e-government integration and interoperability in developing countries	Interoperability
6	4	Levstek, Hovelja and Pucihar	2018	IT Governance Mechanism and Contingency Factors: Towards an Adaptive IT Governance Model	Introduces ITG mechanisms crucial for the implementation of ITG. Additionally identifies contingency factors that infleunce	IT Governance
7	5	Nicol *et al.*	2021	Is routine health information system ready to support the planned national health insurance scheme in South Africa?	Analyses the level of preparedness of the NHI in South African hospitals in the public sector	Health Information Systems

Figure *6-3*: Summary of core literature for review

e) Summarising and reporting on the outcomes obtained

Arksey and O'Malley's (2005) framework concludes with a reflection on the results and outcomes of the scoping review process. This activity was initiated in the previous step, where the relevant primary literature was summarised. This allowed the researcher to ascertain the key findings presented in each paper. Additionally, the full-text versions of the papers considered for review were used and translated onto CAQDAS. The subsequent analysis forms part of the outcomes obtained from the literature review process.

6.5. Thematic Analysis Results

Thematic analysis forms part of the qualitative method of inquiry. It is a method helpful in searching data sets to identify and report on possible patterns established (Saunders, Lewis and

Thornhill, 2016). It is also a practical approach to consider when constructing related themes and codes in research. In addition to the theoretical foundation (chapters 3 to 5), Thematic Analysis contributed to the creation of the constructs of the initial HISIG-CF.

6.5.1 Data Analysis Process

The final 32 full-text papers obtained at the end of the literature search process (see section 6.4.2) were used as the input source for analysis. The papers were imported onto NVIVO with the intent of establishing any patterns across the study. Furthermore, this was done to validate the theoretical foundations defined in phase 1 (chapters 3 to 5). The data analysis process used to carry out thematic analysis involved the following activities (Creswell and Poth, 2016):

Data organisation	Involved managing the sample data (literature) by storing it into folders that relate to the research themes based the title of each paper. The folders were created to reflect the core research areas/themes i.e. IT governance, Health Information Systems and Interoperability.
Reading using memos	Involved taking notes of the important aspects of the literature to understand the informaton conveyed by each paper.
Describe data into codes	Concerned with creating descriptions for each code generated. Decriptions were done in alignment with the concepts discussed across the literature review chapters (3 to 5).
Classify data into codes	Concerned with categorising the generated code. This was done by aggregating the code based on the descripitions provided e.g. codes generated from literature related the sectoral differences was sectioned across private and public sector folders.
Interpreting data	This process involves making sense of the code in order to establish meaning in the broader research area.
Data visualization	Visualization enables researchers to obtain a consolidated view of the codes generated. This was done

by generating the word cloud presented in Figure 6-4 below.

In summary, to organise and classify the papers considered for review, the various literature was stored into folders based on the research's themes, which included literature on ITG, HISs, and interoperability. Following that, the literature was reviewed, and concepts associated with these were utilized. The codes were then used to identify the 30 most frequently occurring words in order to ascertain which concepts were more common throughout the literature reviewed. The results are shown in Figure 6-4.

Figure 6-4: Most frequently used words across the selected literature

With the assistance of NVIVO, various concepts were generated using the theoretical foundation (literature studied across chapter 3 to 5). The word cloud in Figure 6-4 above illustrates a consolidated view of the most commonly used concepts in the literature. These contributed to the research themes and considered as part of the initial conceptual framework.

As illustrated by the word cloud in Figure 6-4, the most imminent words correspond with the theoretical foundation of the research and the aspects that were considered part of the research themes. These are evidenced by the presence of concepts such as "information governance", "interoperability", "standards," etc. However, it is also important to note that the word cloud extends to terms that go beyond this research's boundaries. This is mainly due to literature that broadly considers ITG, HIS, and Interoperability, regardless of the context studied. For

purposes of this research, the constructs of the initial HISIG-CF was developed in alignment with studies in the healthcare context.

Additionally, the constructs defined took into account the study's objective, which is to create an ITG conceptual framework for developing interoperable health information systems. Although newer terms were introduced, they needed to be aligned with the research's purpose if they were to be considered part of the initial HISIG-CF. Those that were ineffective in advancing the design of the conceptual framework were excluded.

6.6. HISIG-CF Constructs

Informed by the theoretical foundation (literature studied), the scoping reviews process, Table 6-2 below combines the constructs developed to inform the initial conceptual framework, across chapters 3 to 5 (Tables 3-5, 4-3 and 5-2). In the following table, the researcher considers how each constructs relates to the initial conceptual framework across the research themes: ITG, HIS, and Interoperability. These constructs are used as the input for the initial design of the HISIG-CF.

Table 6-2: Conceptual framework constructs

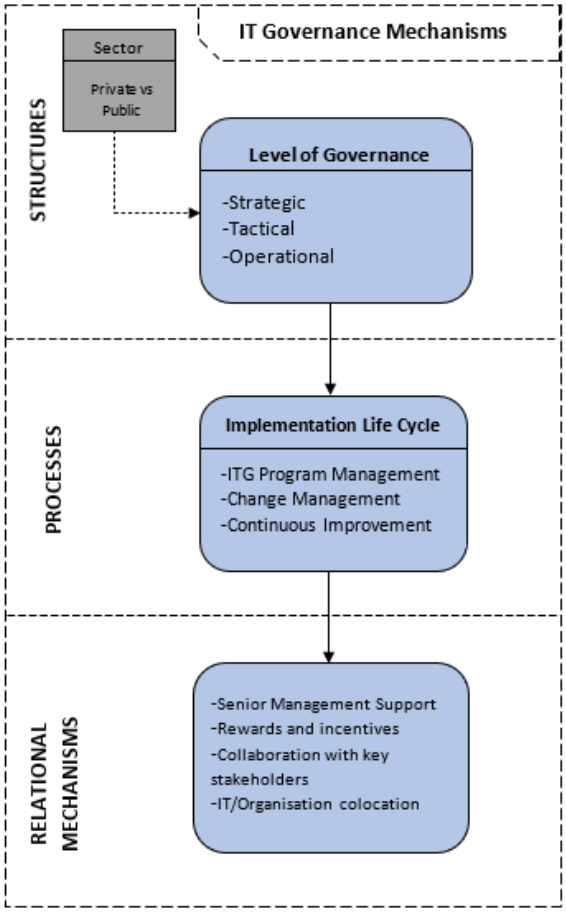
Number in initial HISIG-CF	Constructs	Relation to Initial Conceptual Framework
Theme 1: IT governance (Based on literature addressed in Chapter 3)		
[A]	IT governance mechanisms	The premise of this construct is founded on the acknowledgment of the government's call to improve governance in health care. To enhance the delivery of healthcare services through the current health systems, the researcher posits that health systems could be improved through a combination of ITG mechanisms. This can be done by first examining the present organisational capacity (on a structural, process, and relational attributes basis) to assess the as-is state. Based on a healthcare facility's oganisational IT strategy, improved ITG mechanisms can then be defined.
[A1]	Level of governance	This construct underscores the notion that governance in the health care environment is primarily the responsibility of individuals at the apex office of the health sector. The researcher argues for "distributed leadership" (Martin *et al.*, 2015). Distributed leadership requires coordination and collaborative effort from the different levels of governance.

		This enables practically effective contributions across the various governance levels.
[A2]	Sectoral differences	At the core of each sector is the objective to deliver quality health care. With this goal in mind, a multi-sector engagement between the private and public sectors could potentially improve how facilities function. This will enable both sectors to collaborate and draw valuable lessons from each other. Moreover, a successful engagement between both sectors could serve as a good foundation for the envisioned National Health Insurance (NHI) to create accessible and affordable quality health care.
[A3]	Implementation Lifecycle (Continuous Improvement Lifecycle)	Improving health systems across health facilities cannot be done haphazardly. Using models such as the Continual Improvement Life Cycle will enable health care management to follow an iterative approach to reaching the desired end goal. Furthermore, this model/process acknowledges the complexities involved when engaging various stakeholders. Therefore, the change enablement dimension provides guidelines that can be considered to affect interoperable health systems. The last layer notes the importance of continuous improvement. Essentially, once the program management and change enablement aspects have been defined, an opportunity to scrutinise the changes effected.
Theme 2: Health Information Systems (Based on literature addressed in Chapter 4)		
[B]	eHealth maturity levels	The success of interoperability (or any similar improvements) to health systems requires a great understanding of the maturity level at which the various health facilities operate. Through this construct, the researcher proposes understanding the current state of the health systems and place. As individual health facilities expand and the capacity of their services improve, a move to the level above its current. This will allow health facilities to assess their health systems realistically. Then consider the requirements necessary to advance to the proceeding levels.
[B1]	eHealth building blocks	Interoperability exists in the broader eHealth environment, which influences each of the aspects of the environment. Therefore, it was essential for the researcher to consider these building blocks and their impact on interoperability. The researcher posits that the strength of health systems relies on the governance in place. Through this construct, the researcher asserts governance can be strengthened across the different building blocks from an ITG perspective, following the guidelines of the ITG mechanisms (refer to the first construct).

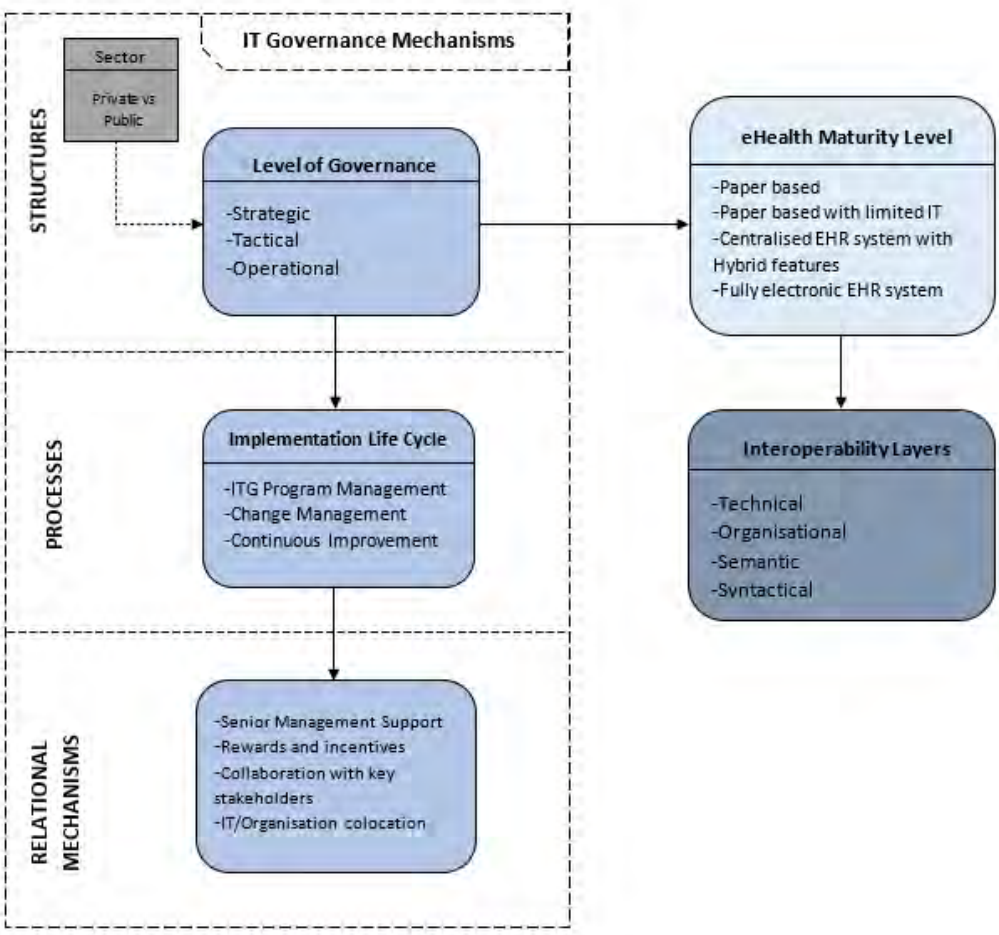
Theme 3: Interoperability (Based on literature addressed in Chapter 5)		
[C]	Interoperability layers	The success of interoperability is reliant on the creation of an enabling environment that will allow information exchange. To pursue interoperability, healthcare organisations may examine the capabilities of their current hardware resources (addressing the technical and organisational layers) and software resources (semantic and syntactical use). This will provide a comprehensive vision of the foundation on which interoperability may be investigated (either hardware or software). Furthermore, it will assist in determining which areas to emphasize for further development. The researcher further proposes exploring interoperability using a multi-faceted approach to facilitate the process of implementation. Through a multi-layered approach, each basic layer of interoperability will be considered, improving the impact of knowledge-sharing networks.
[C1]	Standards of interoperability	Creating the National Health Normative Standards Framework for Interoperability in eHealth in South Africa (HNSF), provides a foundation that sets precedence for interoperability using a standards-based approach (NDoH and CSIR, 2014). The framework presents a practical view of implementing interoperability and plays a pivotal role in the South African health landscape. Reviews of international eHealth standards are provided and considered in context to South Africa, and further use cases are developed to define the applicability of the specifications outlined. On the other hand, the specifications of a standard defined as Fast Healthcare Interoperability Resources (FHIR) is gaining prominence in healthcare (Fogwill, Barron and Benjamin, 2016). FHIR has been developed to provide standards for exchanging healthcare information electronically. Though it has not been considered much in the South African healthcare environment, the standard offers an opportunity that may significantly contribute to industry and health research in the future (HL7 FHIR, 2019). FHIR specifications are driven by the need to provide a more coherent and simplified approach to the standardisation in healthcare (HL7 FHIR, 2019). Drawing from present logical and theoretical models, best practices are defined in alignment with existing standards (HL7 FHIR, 2019).

6.7. Initial HISIG-CF Design

Informed by the constructs in section 6.6, the initial HISIG-CF is designed below. The initial HISIG-CF starts with the ITG perspective by focusing on the structures, processes, and relational mechanisms that aim to understand the management of the healthcare environment. On the structure layer, the level of governance is influenced by the sector of operation. The goals set at the structure level are then implemented using the process layer. Finally, as depicted in the figure below, varying relational mechanisms make the enactment of both structures and processes possible.



Considering the ITG perspective across the three broader mechanisms, to establish how best ITG can impact HISs, it is essential to determine at what level of maturity a healthcare facility finds itself or the type of HIS in place. Understanding the maturity level will first enable the relevant stakeholders to understand the kind of ITG mechanisms and combinations to deploy and the layer at which interoperability needs to be defined. The layer of interoperability is context-driven, given the capabilities and needs of a given healthcare facility, as shown in the figure below.



Moreover, in establishing the interoperability layer to address, the HIS needs to consider the various interoperability standards required. Furthermore, provision for the multiple factors that contribute to health systems' building blocks needs to be considered when defining interoperability. Finally, an overall view of how the construct holistically functions is presented through the conceptual framework, which concludes Phase 1 of the DSRM process.

The conceptual framework in Figure 6-5 below synthesises the literature and theoretical foundations. This is done to map out how the different concepts for each theme communicate as a collaborative. Figure 6-5 below aligns with the constructs detailed in Table 6-2. The coloured tags, labelled A to C1, are each discussed in Table 6-2.

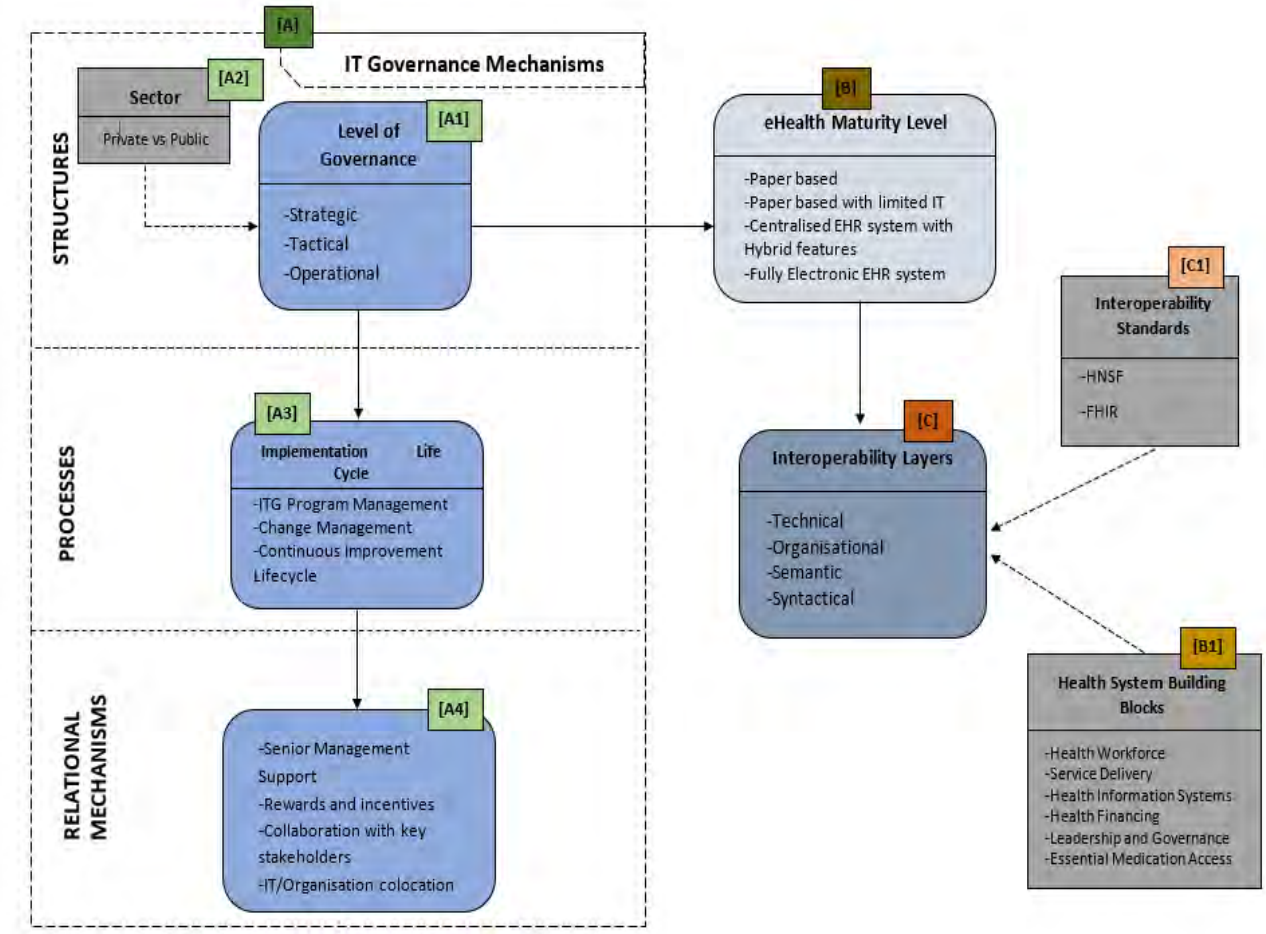


Figure 6-5: Synthesised initial HISIG-CF design

6.8. Summary

The central purpose of this chapter was to define the process by which the initial conceptual framework was designed. The theoretical foundation informs the development of this chapter of this research (Chapters 3 to 5). This chapter began by defining the constructs of the initial conceptual framework using the scoping review and a sample of the core literature considered as part of the theoretical foundation. The researcher used CAQDAS during the scoping review process to validate the concepts addressed in the literature reviewed for the theoretical foundation aspect of the research. After identifying the constructs, the researcher provided a synthesised view of the conceptual framework and how it can be viewed holistically. The chapter concludes with a visual representation of the HISIG-CF in its initial state.

Chapter 7 : Evaluation of Initial HISIG-CF

7.1. Introduction

In the development of DSR, evaluation plays an important role. Unlike conventional design endeavours, solely concerned with providing solutions for utility in context to their environments, DSR transcends this approach (Baskerville *et al.*, 2018). DSR offers a dual approach to evaluation by ensuring that an artefact not only considers the context of utility but also lends to the body of knowledge through following a rigorous process of development (Venable, Pries-Heje and Baskerville, 2016). It is on these grounds that this chapter addresses the expert reviews evaluation of the conceptual framework, which forms part of Phase 2 of the DSRM process depicted in Figure 7-1 below.

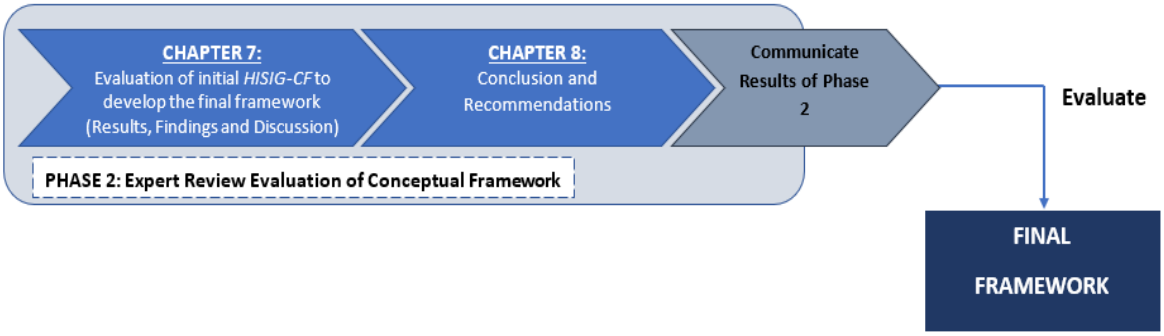


Figure 7-1: Phase 2 of DSRM process (Expert review evaluation)

This chapter begins by outlining the evaluation strategy employed. Following this, the results of the feedback obtained from various experts using the administered questionnaire are presented and further interpreted. Lastly, this chapter concludes by synthesising the insights obtained from the evaluation activity and to considers new discoveries to inform and present the final HISIG-CF.

7.2. Evaluation Strategy and Criteria

The purpose of evaluation in DSR is to present a balancing effect that ensures that the design artefact contributes appropriately to its environment against a set of guiding principles. The effective evaluation of DSR involves determining its reasoning by establishing: *why* evaluation is being conducted, *when* evaluation occurs, *how* the evaluation will be done, and; *what* is being evaluated (Venable, Pries-Heje and Baskerville, 2016). To address these areas, this research uses the guidance of the FEDS as a strategy for evaluation (Venable, Pries-Heje and Baskerville, 2016). Furthermore, this research follows the criteria established by Gregor and

Hevner (2013) to evaluate the utility of the HISIG-CF, which is founded on the belief that the usefulness of a DSR artefact should demonstrate: validity, utility, quality and efficacy. The FEDS is an evaluation strategy that provides a framework that focuses on two main concepts as presented in Figure 7-2 below.

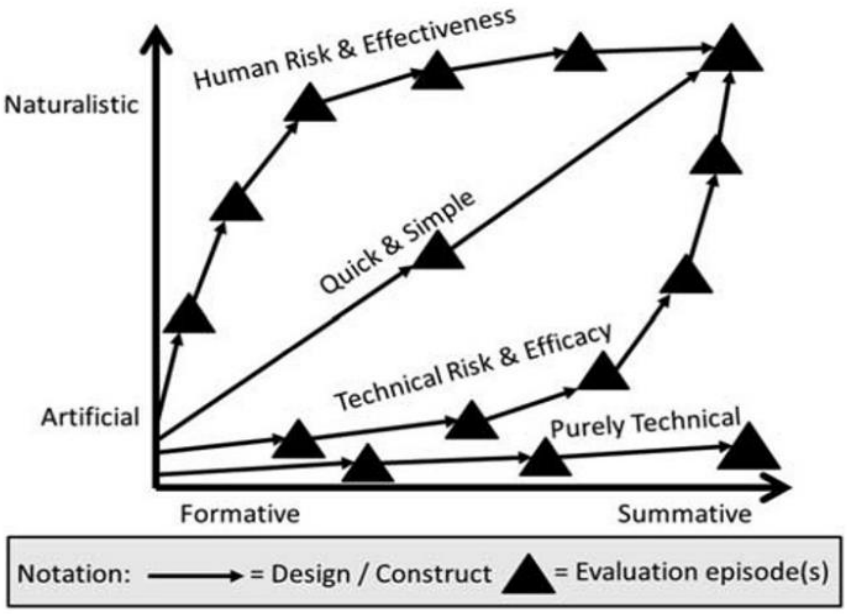


Figure 7-2: Framework for evaluation in Design Science Research (FEDS) adapted from Venable, Pries-Heje and Baskerville (2016)

Firstly, the framework describes evaluation as either formative or summative. Formative evaluations are iterative and are used to measure improvement during the life cycle of development, while the latter is used to measure the results obtained once development has been completed (Venable, Pries-Heje and Baskerville, 2016). Secondly, the framework differentiates between artificial and naturalistic evaluation. Artificial evaluation is mainly used to test hypotheses that have been developed with regards to a design theory (e.g., lab experiments); while naturalistic evaluation focuses on studying the solution developed in context to its natural or real context (e.g. engaging people during the development of a project to gain their insights) (Venable, Pries-Heje and Baskerville, 2016). Based on the needs of a project, a range of strategies can be pursued: Purely Technical; Technical Risk & Efficacy; Quick & Simple; Human Risk & Effectiveness (Venable, Pries-Heje and Baskerville, 2016). For purposes of this research, the Human Risk and Effectiveness strategy used.

7.3. Process of Conducting Evaluation

Essentially, the evaluation strategy of this research is informed by FEDS, using the steps provided in Table 7-1 below:

Table 7-1: Evaluation process using FEDS (Venable, Pries-Heje and Baskerville, 2016)

Step	Description	Application in this research
Explicate the goals	Informs the basis of evaluation by defining the end goal beforehand	**Uncertainty and Risk reduction** -By using formative evaluation across the different phases of the research to reduce the potential risk of the conceptual framework not being relevant.
Choose a strategy for evaluation	Used to guide why, how, and when to guide the process of evaluation following the evaluation goals.	**Human Risk and Effectiveness** -It is essential to determine the benefit/utility of the HISIG-CF in context to the health environment.
Determine the properties to evaluate	Focused on determining what features of an artefact should be evaluated through a practical approach.	The evaluation criteria are used to evaluate the constructs of the conceptual framework (Gregor and Hevner, 2013): -Validity -Utility -Effectiveness -Quality
Design individual evaluation episodes	Based on the evaluation strategy defined and knowledge of the features to be evaluated, actual evaluation can commence.	Using the guidance from the preceding steps, evaluation was administered using a questionnaire shared with various experts (see appendix B).

In summary, the human risk and effectiveness strategy was considered appropriate for evaluating the HISIG-CF. This was primarily motivated by the need to assess the rigour of the conceptual framework and to determine if it will be beneficial for the health environment (Venable, Pries-Heje and Baskerville, 2016). At first, a more artificial evaluation was used (as the design of the constructs of the HISIG-CF design are evaluated in Phase 1 of the DSRM process). A combination of artificial and naturalistic assessments was conducted in Phase 2

(expert review evaluation) of the research to determine the overall utility of the health environment.

7.4. Data Analysis Using Hermeneutics

In addition to the evaluation strategy, it was essential to understand the results obtained from the expert reviews and how these contribute to this research. To achieve this, the data collected from the various experts were analysed and interpreted using hermeneutics. Hermeneutics is rooted in the interpretive paradigm with the intent of understanding various parts that contribute to the functions of a whole (Herselman and Botha, 2016). For purposes of this research, hermeneutics functioned as a valuable analysis approach that enabled the researcher to gain an in-depth understanding of the varying actors and systems involved in the healthcare environment (Kroeze and Van Zyl, 2015). This was done by using the contribution of the experts to improve the researcher's perceptions of the healthcare environment and determine how ITG can be used to contribute to the interoperability of HISs. The analysis outcome was further used to guide the refinement of the initial HISIG-CF design.

Interpretation can become ambiguous without clear guidance. Klein and Myers (1999) define a set of principles that can guide the evaluation of interpretive research. As such, Table 7-2 below, outlines how the evaluation principles developed by Klein and Myers (1999) were applied across this research.

Table 7-2: Evaluation principles for interpretive studies (Klein and Myers, 1999)

Principles	Application in this research
The fundamental principle of the hermeneutic circle	Applied through thematic analysis in chapter 6 (section 6.5). This principle was also considered in this chapter by using hermeneutics to analyse the data collected from the experts.
Principle of contextualisation	The context in which this research was conducted relates to the South African public and private healthcare environment.
Principle of interaction between researchers and subjects	Interactions between the experts and the researcher occurred when expert reviews were administered. The results are reflected in section 7.6.
Principle of abstraction and generalisation	The output artefact (final HISIG-CF*),* presented in section 7.7, could be replicated by other developing healthcare environments similar to South Africa.

Principles of dialogical reasoning	The interpretation in this research was informed by the theoretical foundation in Chapters 3 to 5 and the insights obtained from expert reviewers contributions (results presented in section 7.6).
Principle of multiple interactions	The interpretations made by the researcher considered the constructive feedback obtained from supervisors to improve the outcomes presented.
Principle of suspicion	In addition to the multiple sources considered in the literature review (chapters 3 to 5), numerous experts participated in this research, and the results are presented in section 7.5.1.

7.5. Expert Review Considerations

Once a clear evaluation strategy and data analysis approach was defined, it was important to determine how the evaluation would be conducted. Expert reviews were used through a questionnaire to critique and validate the conceptual framework's functional and practical use. The questionnaire used a combination of both closed and open-ended questions, as presented in Appendix B. The open-ended nature of the questionnaire was primarily used to elicit additional feedback and insights from the experts. The insights drawn from the data collection process was considered to refine the initial conceptual framework into the final research artefact.

To increase the validity of the insights obtained, it was crucial to ensure that the questionnaire was shared with knowledgeable experts. In selecting the experts that would partake in this research, purposive sampling was used. Purposive sampling is a non-probability, judgment sampling that involves being deliberate about who to consider to partake in a study (Etikan, 2016). Furthermore, it involves selecting participants based on a set criterion that would aid the research. For purposes of this research, experts were selected based on the knowledge and experience in line with this research; willingness to partake in the study; and availability (Etikan, 2016).

Prior to conducting the study, it was critical for the researcher to establish rapport with the experts. As a result, before conducting the study, the researcher contacted the appropriate gatekeepers for the various institutions to introduce the research and explain its background. This was done to gain assistance in reaching the relevant experts to partake in this research. The questionnaire was then distributed virtually via email to each participant who subsequently responded to the questions.

7.6. Expert Review Results

The following sections summarise the findings of the evaluation conducted through expert reviews. The findings employ descriptive statistics to represent the data, which are then interpreted to reveal their meaning.

7.6.1 Experts' Demographical Information

The experts consisted of five individuals in management positions that have either practical or academic experience with health systems. The selection of five expert reviewers was guided by Nielsen (2000), who explains that the point of saturation can be met when evaluating an artefact or research beyond five individuals. For this reason, the expert reviewers selected for this research included five experts with management experience in the health environment of expertise in health systems.

Three of the five experts that took part in the questionnaire were female, while the remaining two were male. In addition, 60% of the participants were between the ages of 36 and 45, while the remaining 40% was ranged between 46 and 60. Further analysis revealed that 60% of the experience of the experts lies in the public sector, while 40% has both public and private sector experience.

A wide range of skillsets was identified regarding their occupation. 80% of the professionals operate in the healthcare environment, while 20% are from academia. A majority of the experts in this research had over ten years of experience in their respective domains. As such, it is evident that they are knowledgeable in their areas of expertise, deeming them appropriate candidates for this research.

The expert's occupation and roles vary with experience, and a summary of the experts' demographical information and background is presented in Table 7-3 below.

Table 7-3: Expert reviewers demographical information summary

Expert Reviewer ID	Gender	Age Range	Sector of operation	Occupation	Domain	Years of experience
Expert 1	Female	36 – 45	Public	Health Information Officer	Healthcare	7 – 10
Expert 2	Female	46 – 60	Mixed	Researcher	Healthcare	>10
Expert 3	Female	46 – 60	Mixed	Senior Lecturer	Academia	>10
Expert 4	Male	36 – 45	Public	Information Officer	Healthcare	>10
Expert 5	Male	36 – 45	Public	Medical Practitioner; Clinical Manager	Healthcare	>10

7.6.2 Alignment of Sub-Research Questions to HISIG-CF

In order to determine the rigour of the HISIG-CF and the constructs used in its development, it was essential to gain the experts' views on whether there is an alignment between the conceptual framework and the sub-research questions (and the research themes thereof). A background of each construct was provided, which the experts needed to assess using a Likert scale of 1 to 5. The scale was used to determine whether the experts' responses to determine if they: Strongly Disagree (1); Disagree (2); Neutral (3); Agree (4); Strongly Agree (5). The questions were posed as follows and the results revealed:

a) *Do the* HISIG-CF *constructs align with the sub-research questions?*
b) *Do the* HISIG-CF *constructs align with the research themes?*

The results for both questions revealed that 3 out 5 of the experts strongly agreed that the constructs and the research questions are aligned, while the remaining 2 agreed. None of the respondents disagreed with any of the questions. This demonstrates a positive relation between the background and themes of the research and how these were translated in defining the constructs of the HISIG-CF. The results are further illustrated in Figure 7-3 below.

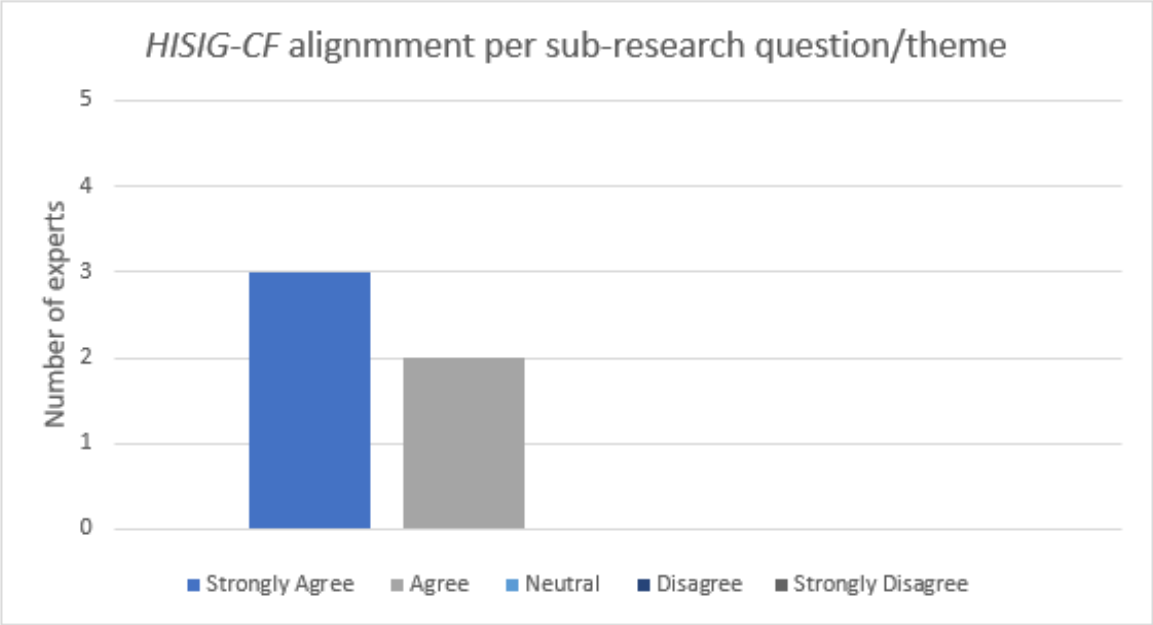


Figure 7-3: Alignment of sub-research questions and themes to HISIG-CF

As stated in the methodology chapter (Chapter 2), each question was developed according to the research questions and themes identified through the literature review. The following sections present the findings from the responses gathered in response to each of the research themes.

7.6.3 IT Governance

In order to gain the experts views on the themes of IT Governance, the following question was posed, *how strongly would you consider the following construct related to* ***IT Governance*** *relevant in the development of interoperable health information systems?* This question intended to determine which items considered for IT Governance were relevant for guiding interoperable HISs interventions. In Figure 7-4, the results are presented, followed by an interpretation of what the results indicate.

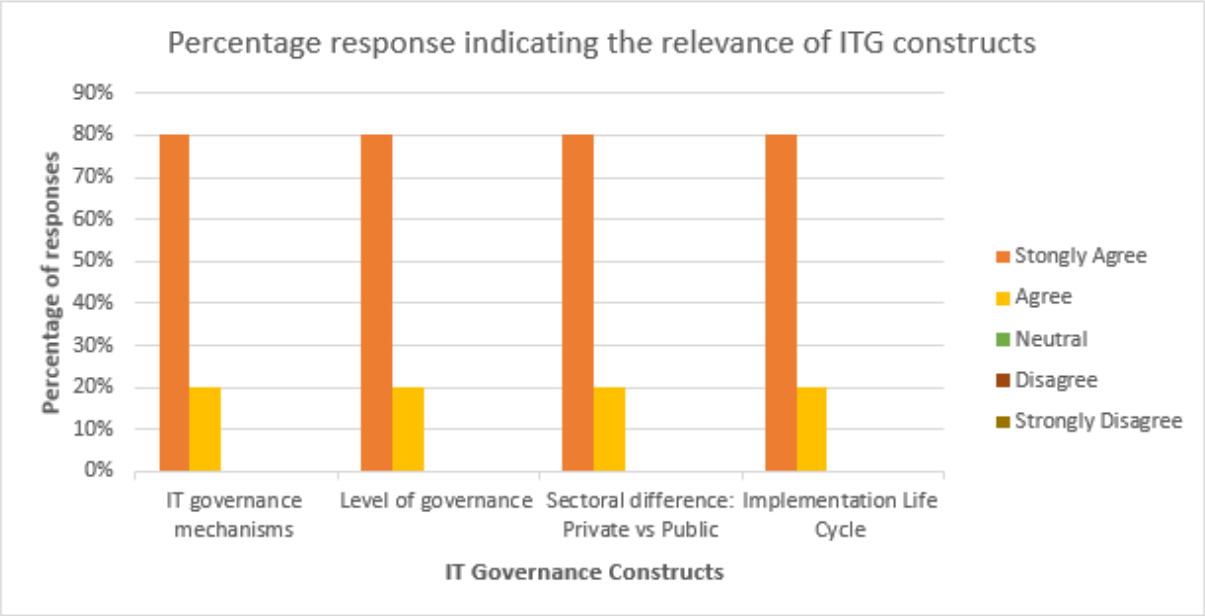


Figure 7-4: IT Governance constructs evaluation results

The results reveal that 80% of the respondents strongly agreed with the ITG constructs included, while 20% agreed. This was an indication that the experts generally noted the value of IT governance mechanisms, level of governance, sectoral difference, and implementation life cycle as being important constructs to represent the IT governance theme of the research. Through these findings, the IT governance construct of the HISIG-CF was validated as crucial for improved implementation.

7.6.4 Health Information Systems

The experts were requested to answer the question, *how strongly would you consider the following construct related to* ***Health Information Systems*** *relevant in the development of interoperable health information systems.* This question aimed to determine whether the Health Information Systems constructs defined, as informed by literature, are relevant and appropriate to consider when defining interoperability interventions.

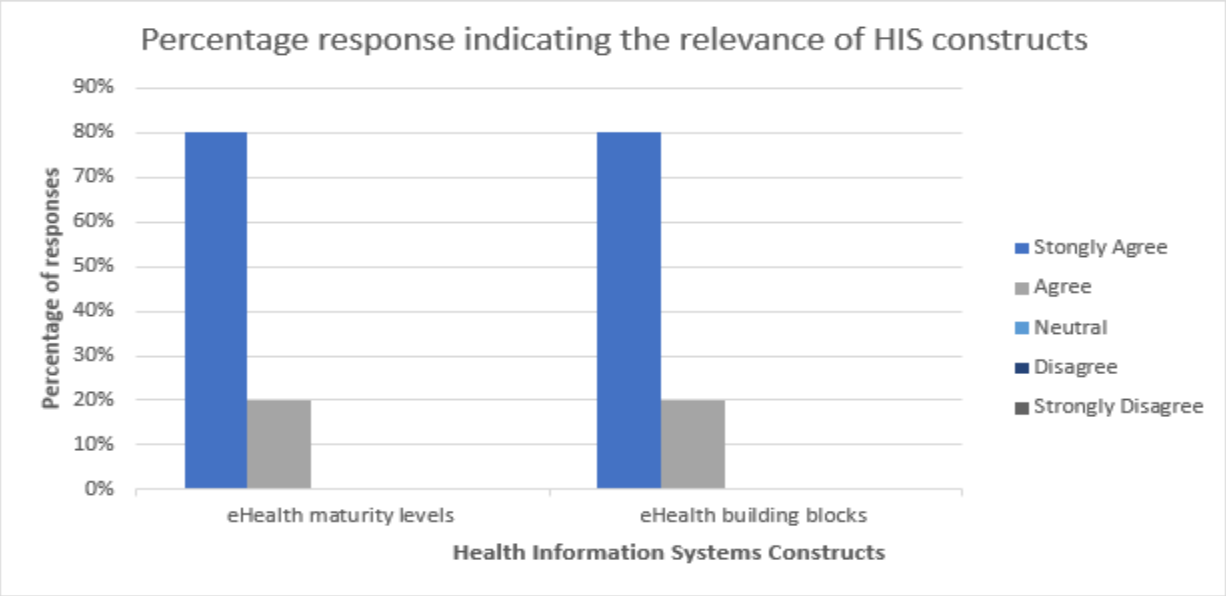


Figure 7-5: Health informtion systems constructs evaluation results

The results presented in Figure 7-5 above reveal that 80% of the experts strongly agreed that eHealth maturity levels and eHealth building blocks were essential for the Health Information Systems theme of the HISIG-CF. In comparison, 20% of the experts indicated that they agreed. None of the experts disagreed or were neutral about the constructs included. Based on these outcomes, eHealth maturity levels and eHealth building blocks were validated and considered relevant to represent the Health Information Systems construct of the initial conceptual framework.

7.6.5 Interoperability

Through this question, the researcher intended to determine how strongly the experts would consider the identified construct related to Interoperability relevant in developing interoperable health information systems. The results are presented in Figure 7-6 below and subsequently interpreted.

Based on these results, the experts agreed with interoperability layers and interoperability standards as a relevant aspect of the design HISIG-CF. 80% of the experts supported this, strongly agreeing with the interoperability constructs, while 20% agreed. These results indicate that interoperability layers and standards are valid for this research and the broader health context.

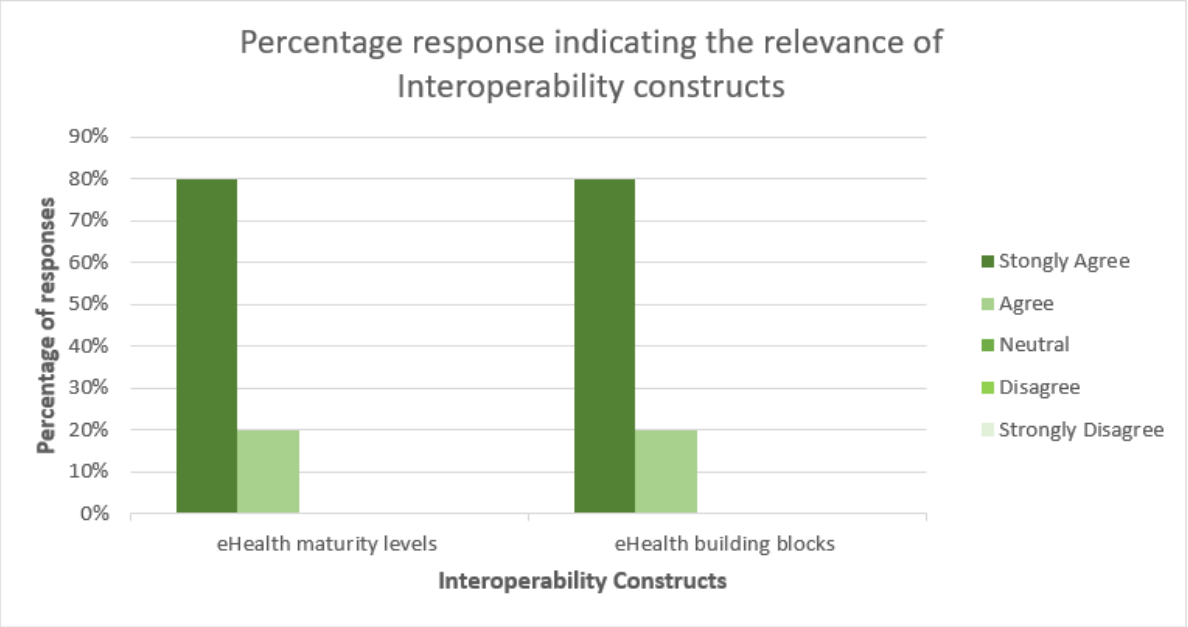


Figure 7-6: Interoperability constructs evaluation results

7.6.6 The Overall Significance of the Constructs Considered

To assess the foundations upon which the HISIG-CF was defined, it was necessary to ascertain the holistic significance of the constructs used. This was done to demonstrate how the experts perceived the design of the conceptual framework. As a result, the experts were requested to respond by indicating (using a Likert scale) which HISIG-CF they would consider significant for developing interoperable HISs. According to the feedback obtained, none of the experts disputed, disagreed, or was indifferent about any stated constructions.

To further understand how the data was distributed across the participants, variance and mean were calculated for the overall sample. Based on the results presented in Table 7-4 below, the variance is relatively low. Variance is used to determine the average distance or difference between the values in a data set (Saunders, Lewis and Thornhill, 2016). As such, the average difference between the results in this questionnaire was 0.2. Furthermore, the mean was calculated to determine the average results obtained from the data collected from the various experts. Considering the sample size used, the average mean was relatively high in terms of the agreeability between the respondents. Both variance and mean results depict a positive outcome across the data set, which further validates the constructs that have been identified as being relevant for HIS interoperability intervention using ITG.

Table 7-4: Variance and mean distribution

	Sample size	Variance	Mean
Overall results per HISIG-CF construct	5	0.2	4.8

As presented in Figure 7-7 below, 80% of the experts strongly agreed with the overall constructs included for the initial conceptual framework. The remaining 20% indicated that they agreed. Based on the outcome of this question, the responses revealed that the background of this conceptual framework was well defined within the healthcare context. Furthermore, this was evidence that the HISIG-CF balanced what was found in literature and what is deemed appropriate in practice.

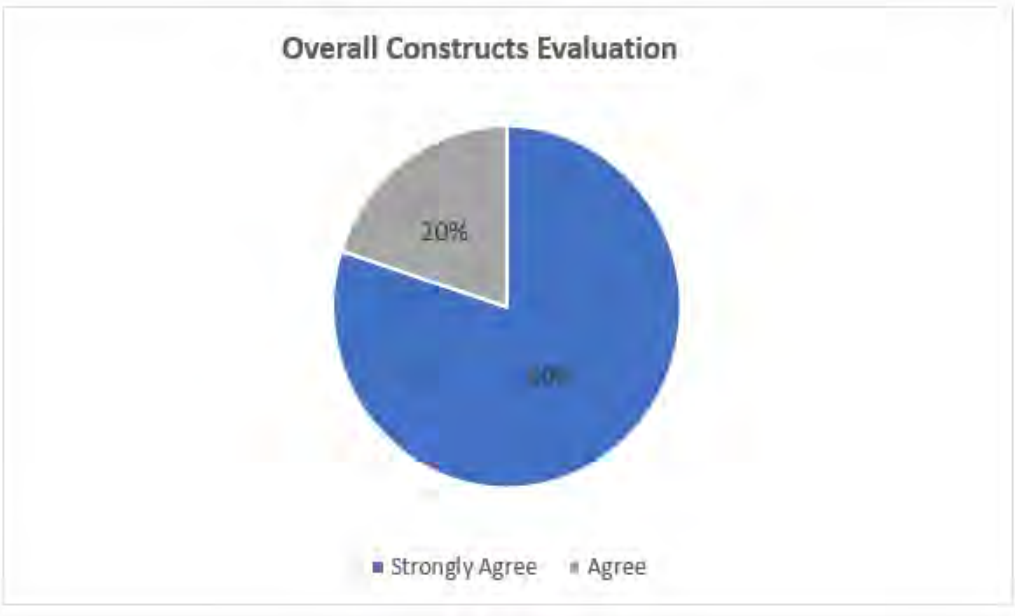


Figure 7-7: Overall constructs evaluation results

7.6.7 Evaluation of HISIG-CF Design Results Guided by Hevner *et al.*, (2004)

As part of evaluating a DSR artefact Hevner *et al.*, (2004, p.82) propose that outputs need to demonstrate "utility, quality, and efficacy." It is on this foundation that the questions in the proceeding sections are posed. Furthermore, to probe into the experts' responses obtained during the evaluation of the constructs of the conceptual framework, open-ended questions were used.

The experts were requested to share their insights on whether they deemed the conceptual framework would contribute to the healthcare environment in its current state. The consensus was that the conceptual framework would be valid in its current state. One further expressed

that the conceptual framework presents a balanced approach to implementation, such that both external and internal factors are considered. On the other hand, another expert revealed that the framework provides a clear roadmap that would guide implementation, providing clear guidance for healthcare institutions.

a) Utility evaluation results

To further evaluate the conceptual framework, the experts were required to assess its utility to determine whether it addresses a real need in the healthcare environment. Based on the feedback obtained, all the experts agreed that the conceptual framework addresses a real need in the healthcare environment. One of the experts indicated that "*it presents the top-down IT governance realities that have to be in place as the core of health system integration*." This suggests that the use of ITG is considered relevant in healthcare to address pressing healthcare needs. In addition to the experts seeing the conceptual framework as necessary for the healthcare environment, another expert indicated that the conceptual framework "*acknowledges the other challenges experienced, namely the varying levels of eHealth maturity, which is a major challenge when considering that also the key decision-makers in healthcare are exposed to and familiar with different levels of eHealth maturity*." As such, the framework's utility goes as far as considering the contextual influences of the health environment, which could be an essential contributor towards further development.

b) Efficacy evaluation results

To further evaluate the efficacy of the designed framework, the experts needed to determine whether the HISIG-CF would produce results for the healthcare environment. Generally, all the experts agreed that the framework would lead to useful results. One of the experts further supported this, indicating that the "*differentiated interdependence of the aspects related to structures, processes, and relational mechanisms provides a powerful contribution to the body of knowledge"*. The reviewer further asserted that they could already identify aspects of the framework that could be used to provide direction and structure from the provincial departments of health to the CEOs of hospitals in the district. This further solidifies the potential value that the HISIG-CF could deliver in the healthcare environment.

c) Quality evaluation results

Another aspect of evaluating DSR is based on quality. The experts were requested to provide their views on the rigour of the conceptual framework and how it has been developed. Of the expert that took part, they expressed that the framework was rigorously done. One of the experts revealed that the linkage of the SRQs to the constructs and how these have been applied

to the actual conceptual framework demonstrates a logical outline of its use and further enabled the constructs to be critically synthesised.

d) Efficiency evaluation results

The last aspect of evaluation related to the efficiency of the conceptual framework. The experts were requested to provide their view of the efficiency of the conceptual framework and determine whether the constructs used were simplistic enough to understand in their current form. The consensus was that the conceptual framework was simple to follow through and to make sense of. One of the experts expressed their opinion regarding the efficiency by stating that, *the order of the structures and the differentiation between structures, processes, and relational mechanisms provide a logic of sequence and causality.* This served as a confirmation that the constructs were well presented to depict the essence of the conceptual framework.

7.7. Evaluation Results Discussion to inform the final HISIG-CF

As initially outlined, the purpose of conducting expert reviews was primarily to gain feedback that would be used to assist in the refinement of the initial HISIG-CF. In this section, the researcher reflects on the results obtained from the evaluation activity. This is followed by a discussion on how the results were incorporated to design the final HISIG-CF.

Based on the feedback documented across sections 7.6.3 to 7.6.5, the results of the evaluation of the constructs related to IT governance, Health information systems and Interoperability demonstrate a positive response from the experts. The constructs were assessed and deemed relevant by the various experts. Moreover, the design of the initial conceptual framework was further evaluated as guided by Hevner *et al.*, (2004), who propose evaluating DSR outputs on the basis of, quality, utility, efficacy and efficiency. Based on the feedback received with regards to the constructs and how these were used in the design of the initial conceptual framework, the core design of the initial HISIG-CF was maintained.

However, the two additional comments provided revealed new insights over and above the pre-determined questions. The first comment was provided with regards to the sectoral differences,

> *"Should there be a private versus public health sectors or maybe public and private health sectors? I am asking myself if the NHI doesn't necessitate a stronger collaboration between these sectors? Maybe private & public health sectors".*

The researcher considered this feedback relevant for the research and the refinement of the HISIG-CF. This recommendation was further found to be suitable as literature by Wimmer,

Boneva and Di Giacomo (2018) suggests more improved engagements between civil society, the commercial sector, and the public sector in improving the implementation of policy. Through multi-sectoral engagements, the relationship between the two sectors (private and public) can be strengthened to contribute to the NDoH's efforts to attain UHC using the NHI. The sector aspect of the initial HISIG-CF was adjusted to Private and Public to reflect the new change (see Figure 7-9 below).

Another expert provided the following comment for further improvement,

> *"When presenting the six building blocks for a well-functioning health system that can ensure quality healthcare, leadership and governance is presented here as one of the blocks – yet, more and more empirical evidence indicates that leadership and governance is the most important block to consider. Maybe if leadership and governance can be the first building block, maybe also bolded to be more visible, because it should be more prominent".*

Although the building blocks – Health information systems, Health workforce, Service delivery, Health financing and Access to essential medication, are crucial to strengthening health systems, it is important to consider the purpose of this research. The purpose of this research is rooted in ITG to create an artefact as the outcome of this research, placing more emphasis on governance will better align with what this study aims to achieve. As discussed in the literature, leadership and governance are essential for the facilitation of each building block. Additionally, the NDoH has also set out to improve the role of leadership and governance as part of their strategic objectives (NDoH and CSIR, 2014). Therefore, leadership and governance have been adjusted to demonstrate their importance in supporting the various health systems building blocks.

Based on additional feedback provided by the experts, the initial HISIG-CF was refined into the final HISIG-CF. The red arrows in Figure 7-8 are used to indicate the areas of the conceptual framework that were improved. This is followed by Figure 7-9, which presents the final HISIG-CF, reflecting the changes made based on the new insights.

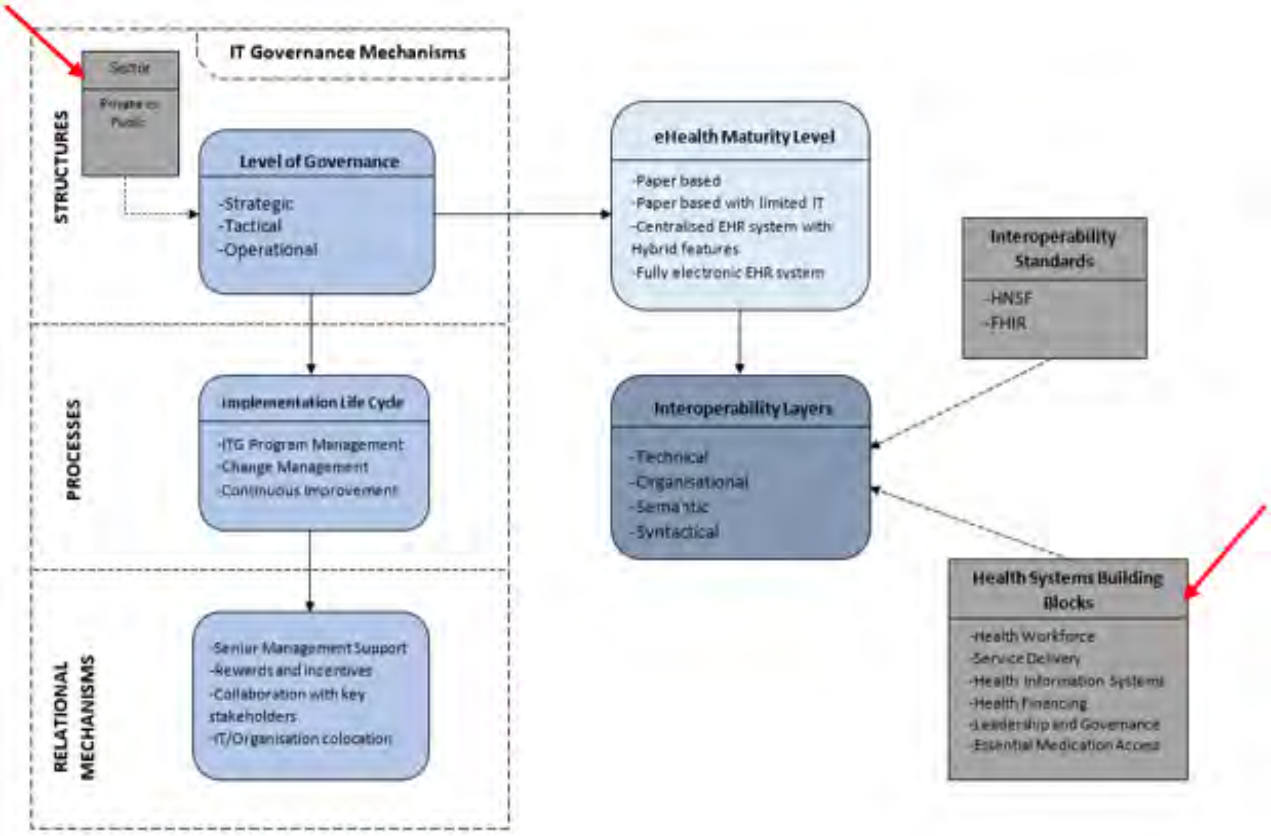


Figure 7-8: Initial HISIG-CF

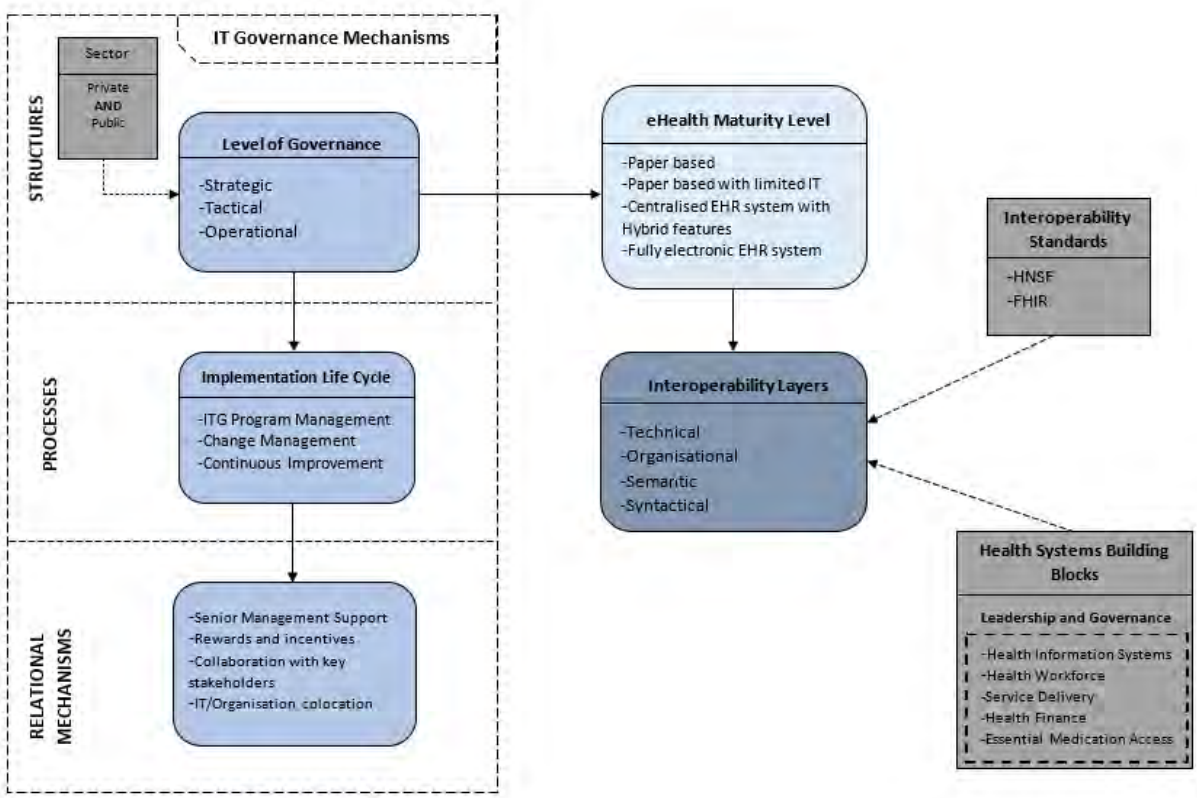


Figure 7-9: Final HISIG-CF

7.8. Summary

In this chapter, the researcher considered expert reviewers' input to review and evaluate the constructs and design of the initial conceptual framework. A strategy for conducting evaluation was defined in accordance with the FEDS. Through this, it was established that the intent of evaluation was to determine the benefit/utility of the HISIG-CF in context to the health environment. Along with the evaluation strategy, this chapter employed hermeneutics and descriptive analysis to interpret the results communicated by the various experts, thus enabling the researcher to draw meaning from the information gathered. The consensus was quite optimistic regarding the constructs and design of the initial conceptual framework and its utility for advancing HISs interoperability in the health environment. Over and above the predefined questions, the additional comments provided led to new insights that were considered to refine the conceptual framework and incorporated into the final HISIG-CF.

Chapter 8 : Conclusion, Reflection and Recommendations

8.1. Introduction

Society's changing health needs call for an improvement in HISs that can adapt to ensure that efficient health services are provided. HISs operating across different health facilities with no ability to share the most crucial health information require solutions to improve operation. However, in seeking ways to improve and strengthen current operational health systems, a multi-faceted approach to development is required. In light of the NHI, which is currently being piloted across South Africa, and the need for overall improved healthcare, this research sought to develop an ITG conceptual framework that would assist in this regard. The purpose of the conceptual framework, referred to as the Health Information Systems Interoperability and Governance - Conceptual Framework (HISIG-CF*)*, is to assist management in the health sector's quest to strengthen HISs.

To reflect on the process undertaken to design this conceptual framework, this chapter provides an overview of the research. This is done first by providing the objectives and research questions that informed this research. Following that, this chapter reflects on the DSRM process used to guide the development of the HISIG-CF. This is followed by the limitations of the research and the recommendations for future studies.

8.2. Research Overview

As part of the NDoH's drive to improve the provision of health services, the interoperability of HISs has been noted as one of the key strategic interventions requiring attention. However, to guide the process of interoperability, there is a need to improve the ITG of HISs. Therefore this research uses the ITG lens to study how best to contribute to the development of interoperable HISs.

7.2.1 Research Questions Addressed

Based on this background, the main research question this study aimed to address was: *What should constitute the components of a conceptual framework that outlines IT governance mechanisms to support the development of an interoperable health information system?* To investigate the main ressearch question a lot further, the following sub-research questions were formulated. These were addressed across chapter 3 – 5, which informed the constructs of the theoretical foundation of the initial HISIG-CF designed.

a) SRQ 1: What IT governance mechanisms can be used to support interoperable health systems?

Through this question, the theme related to IT governance was addressed in Chapter 3. As a result of the varying views of ITG with no consolidated view of what it means, this research employed the all-encompassing view by Van Grembergen (2004), which provided the basis for exploring the concept of ITG. To further address SRQ 1, the chapter investigated ITG mechanisms and how these could be used to better understand how implementation could occur. This included a discussion that studied how a combination of *structures, processes, and relational mechanisms* could serve as the basis for ITG implementation. The chapter went on to discuss the private and public sector differences in driving ITG. These were an important consideration as the health sector is guided by the parallel sector differences in healthcare delivery. The chapter concluded with a discussion on how such differences need to be considered in the delivery of the NHI program. The expert reviewers agreed with this background that informed the constructs of the ITG aspect of the HISIG-CF. A recommendation, which was considered in the final HISIG-CF, was further made, suggesting the integration of the differences from both sectors (private and public) instead of presenting these against each other to necessitate the better implementation of the NHI program.

b) SRQ 2: How should health information systems align with interoperability practices?

Addressed in Chapter 4 of this thesis, the purpose of this question was to investigate the context of the different HISs in operation across South Africa to advocate for the value that can be added by aligning interoperability. This was done by defining the concept of HIS regarding this research, followed by a discussion on how eHealth implementation occurs. Furthermore, the chapter presented a view of how fragmentation occurs across the various HIS in the different provinces and provides the building blocks recommended by the WHO to strengthen HISs. An investigation into the different maturing levels at which interoperability can occur was provided.

c) SRQ3: What is the role of interoperability standards on health systems?

There is a need to ensure that standardised processes are in place for more effective health care delivery in defining interoperability interventions. On this basis, chapter 5 focused on examining the impact of standards when defining HIS interoperability.

In order to achieve this, the main focus of this chapter was on identifying the layers at which interoperability can occur. Furthermore, the different standards that could be used in this regard were considered. The chapter was concluded with drawing lessons from MomConnect, which has been highlighted as one of the most successful interoperability interventions that also uses a standards-based approach.

Through these chapters, the various research themes were extracted (section 6.6) to determine how the development of interoperable HIS can take place. These informed the theoretical foundation on which the research was developed.

8.3. Research Contribution

This research aimed to develop a conceptual framework (HISIG-CF) that will guide management in the healthcare environment towards integrating interoperability across various health information systems. Figure 8-1 below provides the final HISIG-CF, which serves as the contribution and output design made by this research.

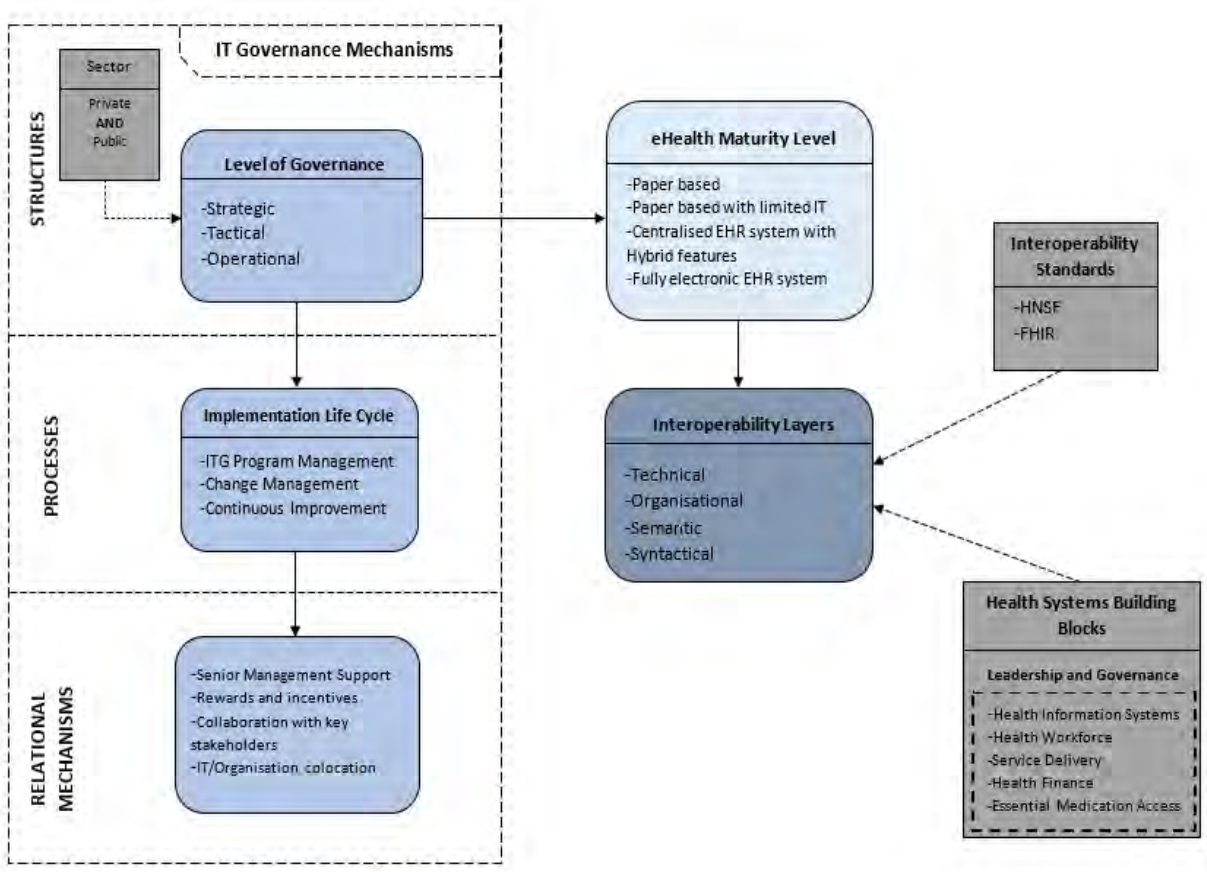


Figure 8-1: Final HISIG-CF

7.3.1 Methodological and Theoretical Contribution

The development of the conceptual framework contributes to DSR using the DSRM process, defined by Peffers *et al.* (2007). This contribution is made using a two-phased approach described as (and illustrated in Figure 8-2 below):

- **Phase 1:** Defined the theoretical foundation of the conceptual framework by studying literature related to the themes of *IT governance, Health Information Systems,* and *Interoperability* (across Chapters 3-5). Furthermore, this phase used the results obtained from the Scoping Reviews process of the literature to design the initial conceptual framework. The output was presented as the design of the initial conceptual framework (Chapter 6).
- **Phase 2:** Review and evaluate the constructs and design of the immediate conceptual framework in preparation for the final HISIG-CF (Chapter 7).

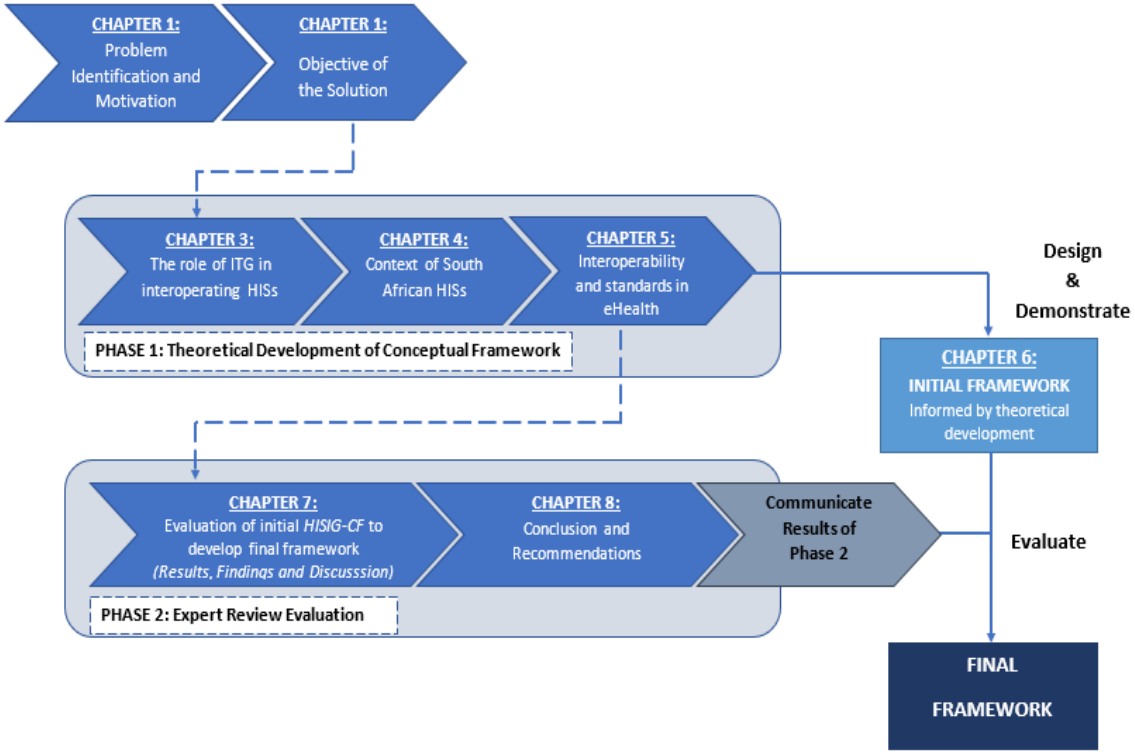


Figure 8-2: DSRM overview and application

The theoretical lens through which this research is viewed is that of the Institutional Theory. This research advances this theory by contextualising coercive, mimetic and normative isomorphism in the health environment by using these guidelines to develop the artefact for this research. In addition to theory, the development of this research is further guided by literature and the artefact designed is evaluated by experts.

7.3.2 Practical Contribution

Although well-defined policies are in place to guide health interventions, implementation is still lagging in South Africa. The novelty of this research was illustrated by drawing from IT governance, health information systems, and interoperability literature to develop the HISIG-CF. Experts evaluated the conceptual framework in the health environment and academia to assess and validate the foundation on which design occurred. The designed HISIG-CF is suitable for the health environment (health systems) to guide management on using ITG to drive HIS interoperability.

8.4. Limitations of the Research

The limitations identified in this research include:

- The sample used to evaluate the conceptual framework was limited due to the access the organisations considered. The results could have differed had a larger sample been used.
- The first two phases of the research were mainly theoretical. More insights could have been considered had a case study approach been used to further assist in contextualising the research.
- The constructs considered were defined based on the literature exposed to the researcher. The researcher does acknowledge that more constructs may be included as more literature is explored.

8.5. Learning Areas and Personal Reflection

This research was motivated by the need to address and contribute to HIS interoperability using ITG to improve current health systems. The impact of this research can potentially be used towards strengthening the foundation on which the NHI program is delivered. The development of this research would not have been possible without the clear process presented by the DSRM. This approach was crucial in ensuring that I critically think about how to incorporate theory and what was learnt from the various experts into the design of the HISIG-CF.

The development of this research has not been without its challenges. More so with the restrictions imposed nationally due to the COVID-19 pandemic. This restricted my access to a number of health care facilities and the extent to which my research could gain greater insights. However, being able to interact and learn from the experts I had the privilege to engage with broadened my perspectives of the health environment and allowed me to form fruitful relations.

This will also a lesson to remain resilient and not let the hurdles encountered derail my progress.

Through this research, I have learnt the value of immersing myself in literature and reflecting on each study and the impact of the methodology in research. This has allowed me to spend time thinking on the foundation of what it is I am developing to create the final product.

I have also found significant value in interacting with two supervisors who provided a wealth of knowledge from industry and academia. This diverse skillset contributed to my research and my overall research progress.

8.6. Recommendations for Future Studies

The division of power between different levels of government creates complications when attempting to implement policy on the ground. To facilitate improved collaboration across levels, more than a top-down approach is required. Additionally, front-line workers must be included in the process of recommending new projects to ensure their buy-in during the early stages of implementation.

Another recommendation is that, in addition to private-public sector collaborations, structures involving public participation. This enables increased transparency and accountability, as well as a better understanding of critical health needs.

The focus should not solely be on defining implementation focusing on technical aspects, but provisions need to be made to drive change. This could include integrating social considerations into technical solutions. Consequently, HIS interoperability interventions will reduce the perception of strictly technical solutions as being out of reach or too complex. In conjunction with health literacy, this has an opportunity to lead to more effective solutions that people can optimise.

8.7. Summary

This research aimed to design a conceptual ITG that can be used to guide the development of interoperable HIS. This was done following the DSRM process and applied across the various chapters. The research then proceeded to develop three central themes, which are as follows: ITG, HISs, and Interoperability. The themes were used to guide the theoretical foundation of the conceptual framework in Phase 1 of the research.

It was also important to ascertain the constructs of the conceptual framework and evaluate its foundation. As such, expert reviews were conducted to determine whether the conceptual framework addresses a real need in the health environment and identify potential areas for improvement. The insights obtained from the research were used to advance and develop the final HISIG-CF, which integrated the three research themes to aid future HIS interoperability interventions. Through this chapter, the researcher reflected on how each of the research questions was addressed, the value and significance of the research, personal learning areas, the limitations presented, and the recommendations for future studies.

References

Adebesin, F. and Kotzé, P., 2017. A process for developing an e-health standards selection method artefact using design science research, *Journal of Design Research*, 15(4), pp. 258–287.

Adebesin, F., Kotzé, P., Van Greunen, D. and Foster, R., 2013. Barriers & challenges to the adoption of E-Health standards in Africa.

Alam, U., Nabyonga-Orem, J., Mohammed, A., Malac, D.R., Nkengasong, J.N. and Moeti, M.R., 2021. Redesigning health systems for global heath security. *The Lancet Global Health*, *9*(4), pp.e393-e394.

Ali, S. and Green, P., 2012. Effective information technology (IT) governance mechanisms: An IT outsourcing perspective, *Information Systems Frontiers*, 14(2), pp. 179–193.

AlKalbani, A., Deng, H., Kam, B. and Zhang, X., 2016. Investigating the impact of institutional pressures on information security compliance in organizations. *Proceedings of the 27th Australasian Conference on Information Systems, ACIS 2016*, pp. 1–12.

Allam, S., Flowerday, S. V. and Flowerday, E., 2014. Smartphone information security awareness: A victim of operational pressures, *Computers and Security*, 42, pp. 56–65.

Al Qassimi, N. and Rusu, L., 2015. IT governance in a public organization in a developing country: A case study of a governmental organization. *Procedia Computer Science*, *64*, pp.450-456.

Alunyu, A.E. and Nabukenya, J., 2018. A Conceptual Model for Adaptation of eHealth Standards by Low and Middle-Income Countries. *Journal of Health Informatics in Africa*, *5*(2).

Amin, M. M., Sutrisman, A., Stiawan, D., Alzahrani, E. M. Y., Budiarto, R., 2020. Interoperability framework for integrated e-health services, *Bulletin of Electrical Engineering and Informatics*, 9(1), pp. 354–361.

Arksey, H. and O'Malley, L., 2005. Scoping studies: Towards a methodological framework, *International Journal of Social Research Methodology: Theory and Practice*, 8(1), pp. 19–32.

Baskerville, R., Baiyere, A., Gregor, S., Hevner, A., Rossi, M. 2018. Design science research

contributions: Finding a balance between artifact and theory, *Journal of the Association for Information Systems*, 19(5), pp. 358–376.

Bell, E., Bryman, A. and Harley, B., 2018. *Business Research Methods.* 5th Edition. Oxford: Oxford University Press.

Benedict, M. and Schlieter, H., 2015. Governance Guidelines for Digital Healthcare Ecosystems, *Studies in Health Technology and Informatics*, 212, pp. 233–240.

Benson, T. and Grieve, G., 2016. *Principles of Health Interoperability*. Springer.

Bergmo, T. S., 2015. How to measure costs and benefits of ehealth interventions: An overview of methods and frameworks, *Journal of Medical Internet Research*, 17(11).

Bharti, K., Agrawal, R. and Sharma, V., 2015. Literature Review and Proposed Conceptual Framework, *International Journal of Market Research*, 57(4), pp. 571–604.

Boak, G., Dickens, V., Newson, A. and Brown, L., 2015. Distributed leadership, team working and service improvement in healthcare. *Leadership in Health Services*.

Booth, A., Sutton, A. and Papaioannou, D., 2016. Systematic approaches to a successful literature review.

Bradshaw, C., Atkinson, S. and Doody, O., 2017. Employing a qualitative description approach in health care research. *Global qualitative nursing research*, *4*.

Brauns, M., 2016. *Public healthcare in a post-apartheid South Africa: a critical analysis in governance practices* (Doctoral dissertation).

Caluwe, L., De Haes, S., Wilkin, C. and Huygh, T., 2021, January. How Boards of Directors Can Contribute to Governing IT. In *Proceedings of the 54th Hawaii International Conference on System Sciences* (p. 6047).

Campbell, J., McDonald, C. and Sethibe, T., 2010. Public and Private Sector IT Governance: Identifying Contextual Differences, *Australasian Journal of Information Systems*, 16(2), pp. 5–18.

Clark, V.L.P., 2019. Meaningful integration within mixed methods studies: Identifying why, what, when, and how. *Contemporary Educational Psychology*, *57*, pp.106-111.

Clarke, J.M., Warren, L.R., Arora, S., Barahona, M. and Darzi, A.W., 2018. Guiding interoperable electronic health records through patient-sharing networks. *NPJ digital medicine*, *1*(1), pp.1-6.

Creswell, J.W. and Poth, C.N., 2016. *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.

da Luz Júnior, S.H., Silva, F.Í.C., Albuquerque, G.S.G., de Medeiros, F.P.A. and Lira, H.B., 2020. Enterprise Architecture in Healthcare Systems: A systematic literature review. *arXiv preprint arXiv:2007.06767*.

Dawson, G.S., Denford, J.S., Williams, C.K., Preston, D. and Desouza, K.C., 2016. An examination of effective IT governance in the public sector using the legal view of agency theory. *Journal of Management Information Systems*, *33*(4), pp.1180-1208.

De Haes, S. and Van Grembergen, W., 2008. Practices in IT governance and business/IT alignment. *Information Systems Control Journal*, *2*(2008), pp.1-5.

De Haes, S. and Van iGrembergen, W., 2015. Enterprise governance of IT. In *Enterprise Governance of Information Technology* (pp. 11-43). Springer, Cham.

De Haes, S., and Van Grembergen, W., 2015. Enterprise governance of information technology: achieving strategic alignment and value, featuring COBIT 5. 2nd Edition. Springer Publishing Company, Incorporated.

Desai, S., 2015. Health information exchange, interoperability, and network effects, *University of Pennsylvania Scholarly Commons*, p. 102.

DiMaggio, P.J. and Powell, W.W., 1983. The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American sociological review*, pp.147-160.

Drechsler, A. and Hevner, A., 2016. A four-cycle model of IS design science research: Capturing the dynamic nature of IS artefact design. *Cork Open Research Archive (CORA)*, p. 1-9.

Ekinci, Y., 2015. *Designing research questionnaires for business and management students*. Sage.

English, R., Masilela, T., Barron, P. and Schonfeldt, A., 2011. Health information systems in South Africa. *South African health review*, *2011*(1), pp.81-89.

Etikan, I., 2016. Comparison of Convenience Sampling and Purposive Sampling, *American Journal of Theoretical and Applied Statistics*, 5(1), p. 1.

European Commission, 2017. European Interoperability Framework - Implementation Strategy, p. 9.

Fogwill, T., Barron, P. and Benjamin, P., 2016. MomConnect : an exemplar implementation of the Health Normative Standards Framework in South Africa, *South African Health Review*, 2016(1), pp. 125–135.

Fusheini, A. and Eyles, J., 2016. Achieving universal health coverage in South Africa through a district health system approach: conflicting ideologies of health care provision, *BMC Health Services Research*, 16(1), pp. 1–11.

Gilson, L. and Daire, J., 2011. Leadership and governance within the South African health system. *South African health review*, *2011*(1), pp.69-80.

Goldkuhl, G., 2012. Pragmatism vs interpretivism in qualitative information systems research, *European Journal of Information Systems*, 21(2), pp. 135–146.

Gregor, S. and Hevner, A. R., 2013. Positioning and Presenting Design Science Research for Maximum Impact, *MIS Quarterly: Management Information Systems*, 37(2), pp. 337–355.

Graue, C., 2015. Qualitative data analysis. *International Journal of Sales, Retailing & Marketing*, *4*(9), pp.5-14.

Hammond, W.E., 2017. Standards for Global health information systems. In *Global Health Informatics*. Academic Press. pp. 94 –108.

Han, L., Liu, J., Evans, R., Song, Y. and Ma, J., 2020. Factors influencing the adoption of health information standards in health care organizations: a systematic review based on best fit framework synthesis. *JMIR medical informatics*, *8*(5), p.e17334.

Health Level Seven International (HL7), 2017. HL7 Version 3 Product Suite, Michigan. Available at: https://www.hl7.org/implement/standards/product_brief.cfm? product_ id=186 [Accessed 26 January 2021].

Herselman, M. and Botha, A., 2016. Strategies, Approaches and Experiences : Towards building a South African Digital Health Innovation Ecosystem, CSIR Meraka.

Hevner, A.R., 2007. A Three Cycle View of Design Science Research, *Scandinavian Journal of Information Systems*. 19 (2).

Hevner, A.R., March, S.T., Park, J. and Ram, S., 2004. Design science in information systems research. *MIS quarterly*, pp.75-105.

Healthcare Information and Management Systems Society, 2017. *HIMSS dictionary of health information technology terms, acronyms, and organizations*. CRC Press.

HL7 FHIR, 2019. HL7 FHIR Available at: http://www.hl7.org/fhir/index.html [Accessed 4 February 2021].

Holbrook, A., Bourke, S., Fairbairn, H. and Lovat, T., 2007. Examiner comment on the literature review in Ph. D. theses. *Studies in Higher Education*, *32*(3), pp.337-356.

ISO, 2008. ISO 13606-2:2008 - Electronic Health Record Communication - Part 2: Archetype Interchange Specification.

Iroju, O., Soriyan, A., Gambo, I., Olaleke, J., 2013. Interoperability in Healthcare: Benefits, Challenges and Resolutions, *International Journal of Innovation and Applied Studies*, 3(1), pp. 262–270.

Iyawa, G.E., Herselman, M. and Botha, A., 2019. Digital Health Innovation Ecosystems: Identifying key participants, benefits, challenges, and guidelines for the Namibian context. *International Journal of Reliable and Quality E-Healthcare (IJRQEH)*, *8*(2), pp.1-14.

Joshi, A., Bollen, L., Hassink, H., De Haes, S. and Van Grembergen, W., 2018. Explaining IT governance disclosure through the constructs of IT governance maturity and IT strategic role. *Information & Management*, *55*(3), pp.368-380.

ISACA, 2018. *Designing an Information and Technology Governance Solution*. COBIT 2019.

Katuu, S., 2016. Transforming South Africa's health sector: The eHealth Strategy, the implementation of electronic document and records management systems (EDRMS) and the utility of maturity models, *Journal of Science and Technology Policy Management*, 7(3), pp. 330–345.

Klein, H. K. and Myers, M. D., 1999. A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS quarterly*, 67-93.

Kobusinge, G., 2020. Putting interoperability on health-information-systems implementation agenda.

Kobusinge, G., 2021. Health Information Systems Interoperability: Towards a Managing as Designing Approach.

Kotter, J.P., 1995. Leading change. *Harvard business review*, *2*(1), pp.1-10.

Kotter, J.P. and Cohen, D.S., 2015. *Successful Organizational Change: The Kotter-Cohen Collection (2 Books)*. Harvard Business Review Press.

Kroeze, J. H. and Van Zyl, I., 2015. The theme of hermeneutics in is - The need for a structured literature review, *Twenty-first Americas Conference on Information Systems, AMCIS 2015*, (January 2015).

Kruk, M.E., Gage, A.D., Arsenault, C., Jordan, K., Leslie, H.H., Roder-DeWan, S., Adeyi, O., Barker, P., Daelmans, B., Doubova, S.V. and English, M., 2018. High-quality health systems in the Sustainable Development Goals era: time for a revolution. *The Lancet global health*, *6*(11), pp.e1196-e1252.

Kruse, C.S., Kim, F., Deshazo, J.P. and Fulton, L., 2014. Factors Associated With Adoption of Health Information Technology: A Conceptual Model Based on a Systematic Review, *JMIR Medical Informatics*, 2(1), p. 9.

Lal, A., Erondu, N.A., Heymann, D.L., Gitahi, G. and Yates, R., 2021. Fragmented health systems in COVID-19: rectifying the misalignment between global health security and universal health coverage. *The Lancet*, *397*(10268), pp.61-67.

Levac, D., Colquhoun, H. and O'Brien, K., 2010. Scoping studies: advancing the methodology, *Implementation Science*, 5(69), pp. 1–9.

Levstek, A., Hovelja, T. and Pucihar, A., 2018. IT Governance Mechanisms and Contingency Factors: Towards an Adaptive IT Governance Model, *Organizacija*, 51(4), pp. 286–310.

Martin, G., Beech, N., MacIntosh, R. and Bushfield, S., 2015. Potential challenges facing distributed leadership in health care: evidence from the UK National Health

Service. *Sociology of health & illness*, *37*(1), pp.14-29.

Matsoso, M.P. and Fryatt, R., 2013. National Health Insurance: the first 18 months. *South African Medical Journal*, *103*(3), pp.156-158.

Mehl, G. L. *et al.*, 2018. Digital health vision : could MomConnect provide a pragmatic starting point for achieving universal health coverage in South Africa and elsewhere ?, pp. 1–5.

Misuraca, G. and Viscusi, G., 2015. Shaping public sector innovation theory: an interpretative framework for ICT-enabled governance innovation, *Electronic Commerce Research*. Springer US, 15(3), pp. 303–322.

Myers, M., 2016. Hermeneutics in organization studies. *The Routledge companion to philosophy in organization studies*.

Myllyoja, J., Toivanen, H., Herselman, M., Botha, A. and Fogwill, T., 2016. Conceptualising of a South African Digital Health Innovation Ecosystem.

Nakano, D. and Muniz, J., 2018. Writing the literature review for empirical papers, *Production*, 28.

NDoH and CSIR, 2014. South African National Health Normative Standards Framework for Interoperability in eHealth: Complete Version, (March), pp. 1–57.

Nicol, E., Hanmer, L.A., Mukumbang, F.C., Basera, W., Zitho, A. and Bradshaw, D., 2021. Is the routine health information system ready to support the planned national health insurance scheme in South Africa?. *Health policy and planning*, *36*(5), pp.639-650.

Nielsen, J., 2000. Why you only need to test with 5 users. Nielsen Norman Group. *Available at: https://www. nngroup. com/articles/why-you-only-need-to-test-with-5-users* [Accessed 20 October 2021]

Ojo, A. I., 2018. mHealth Interventions in South Africa: A Review, *SAGE Open*, 8(1).

Othman, M. F. I., 2016. Barriers To The Adoption of Formal IT Governance Practice : A Malaysian Case, p. 392.

Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S., 2007. A design science research methodology for information systems research. *Journal of Management Information Systems*,24(3), 45-77.

Peters, D.H., 2014. The application of systems thinking in health: why use systems thinking?. *Health research policy and systems*, *12*(1), pp.1-6.

Peters, M.D., Godfrey, C.M., Khalil, H., McInerney, P., Parker, D. and Soares, C.B., 2015. Guidance for conducting systematic scoping reviews. *International journal of evidence-based healthcare*, *13*(3), pp.141-146.

Raynard, M., Johnson, G. and Greenwood, R., 2015. Institutional theory and strategic management. *Advanced strategic management: A multi-perspective approach*, pp.9-34.

Saripalle, R., Runyan, C. and Russell, M., 2019. Using HL7 FHIR to achieve interoperability in patient health record. *Journal of biomedical informatics*, *94*, p.103188.

Saunders, M., Lewis, P. and Thornhill, A., 2016. *Research methods for business students.* 7th Edition. Harlow: Pearson.

Scott, W.R., 2005. Institutional theory: Contributing to a theoretical research program. *Great minds in management: The process of theory development*, *37*(2), pp.460-484.

Seebregts, C., Barron, P., Tanna, G., Benjamin, P. and Fogwill, T., 2016. MomConnect: an exemplar implementation of the health normative standards framework in South Africa. *South African Health Review*, *2016*(1), pp.125-135.

Selig, G.J., 2018, August. It Governance—An Integrated Framework and Roadmap: How to Plan, Deploy and Sustain for Competitive Advantage. In *2018 Portland International Conference on Management of Engineering and Technology (PICMET)* (pp. 1-15). IEEE.

Schmidt, B.M., Colvin, C.J., Hohlfeld, A. and Leon, N., 2020. Definitions, components and processes of data harmonisation in healthcare: a scoping review. *BMC Medical Informatics and Decision Making*, *20*(1), pp.1-19.

Shusterman, R., 2016. *Practicing philosophy: Pragmatism and the philosophical life*. Routledge.

Smits, D. and Van Hillegersberg, J., 2015, January. IT governance maturity: Developing a maturity model using the delphi method. In *2015 48th Hawaii International Conference on System Sciences* (pp. 4534-4543). IEEE.

South African National Department of Health, 2015. National Health Insurance for South Africa: Towards Universal Health Coverage (White Paper). Available at: https://www.gov.za/sites/default/files/gcis_document/201512/39506gon1230.pdf [Accessed 10 March 2020].

South African National Department of Health, 2019. National Digital Health Strategy for South Africa 2019-2024.

South African National Department of Health, 2020. Strategic Plan 2020/21 - 2024/25. Available at: https://www.health.gov.za/wp-content/uploads/2020/11/depthealthstrategicplanfinal2020-21to2024-25-1.pdf [Accessed 12 May 2021].

Symon, G. and Cassell, C., 2012. *Qualitative organizational research: core methods and current challenges*. Sage.

Tonelli, A.O., de Souza Bermejo, P.H., Dos Santos, P.A., Zuppo, L. and Zambalde, A.L., 2017. It governance in the public sector: a conceptual model. *Information Systems Frontiers*, *19*(3), pp.593-610.

United Nations, 2021. The 17 Goals. Available at: https://sdgs.un.org/goals [Accessed 20 June 2021].

Vaishnavi, V. and Kuechler, W, 2013. Design Science Research in Information Systems. Available at: http://www.desrist.org/design-research-in-information-systems/ [Accessed on 30 November 2020].

Van der Merwe, A., Gerber, A. and Smuts, H., 2020. Guidelines for conducting design science research in information systems, *Communications in Computer and Information Science*, 1136 CCIS, pp. 163–178.

Van Grembergen, W., De Haes, S. and Guldentops, E., 2004. Structures, processes and relational mechanisms for IT governance. In *Strategies for information technology governance* (pp. 1-36). Igi Global.

van Zyl, I., 2015. Disciplinary kingdoms: Navigating the politics of research philosophy in the information systems, *Electronic Journal of Information Systems in Developing Countries*, 70(1), pp. 1–17.

Venable, J., Pries-Heje, J. and Baskerville, R., 2016. FEDS: a framework for evaluation in

design science research. *European journal of information systems*, *25*(1), pp.77-89.

WHO, 2010. Monitoring the Building Blocks of Health Systems : a Handbook of Indicators and their measurement instruments, p. 110.

Wimmer, M.A., Boneva, R. and Di Giacomo, D., 2018, May. Interoperability governance: a definition and insights from case studies in Europe. In *Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age*, pp. 1-1.

Winkler, T.J., 2013. IT governance mechanisms and administration/IT alignment in the public sector: A conceptual model and case validation. In *Wirtschaftsinformatik* (p. 53).

Wu, S.P.J., Straub, D.W. and Liang, T.P., 2015. How information technology governance mechanisms and strategic alignment influence organizational performance. *MIS quarterly*, *39*(2), pp.497-518.

Appendices

Appendix A: Ethical Clearance Letters

RHODES UNIVERSITY
Where leaders learn

Rhodes University Human Ethics Committee
PO Box 94, Makhanda, 6140, South Africa
t: +27 (0) 46 603 7727
f: +27 (0) 46 603 8822
e: s.manqele@ru.ac.za
NHREC Registration number: RC-241114-045

https://www.ru.ac.za/researchgateway/ethics/

25/06/2021

Lebogang MATSHABA

Email: g15m8039@campus.ru.ac.za

Review Reference: 2021-4876-6096

Dear Mr. Monelo Nxozi

Title: A conceptual IT governance framework to guide the development of interoperable health information systems

Principal Investigator: Mr Monelo Nxozi

Collaborators: Ms. Lebogang Matshaba,

This letter confirms that the above research proposal has been reviewed and **APPROVED** by the Rhodes University Human Ethics Committee (RU-HEC). Your Approval number is: 2021-4876-6096

Approval has been granted for 1 year. An annual progress report will be required in order to renew approval for an additional period. You will receive an email notifying when the annual report is due.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on the completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloging number allocated.

Sincerely,

Prof Arthur Webb

Chair: Rhodes University Human Ethics Committee, RU-HEC

cc: Mr. Siyanda Manqele - Ethics Coordinator

health
Department of
Health
North West Province
REPUBLIC OF SOUTH AFRICA

Cnr Sekame & First Street
New Office Park
Mafikeng, 2745
Private Bag X2068
MMABATHO, 2735

Enq: Ms. Tshiamo Mokate
Tel: 018 391 4501
7(Mokate@nwpg.gov.za
www.nwhealth.gov.za

2030 NDP

RESEARCH, MONITORING AND EVALUATION DIRECTORATE

Name of researchers: **Ms. L. Matshaba**

Rhodes University
Information Systems Department

Physical Address
(Work/ Institution)
Drosty Road
Grahamstown
6139

HEAD OF DEPARTMENT
2021 -05- 30
NORTH WEST DEPARTMENT OF HEALTH
PRIVATE BAG X 2068, MMABATHO, 2735

Subject **Research Approval Letter – A conceptual IT governance framework to guide the development of interoperable Health Information Systems.**

This letter serves to inform the Researcher that permission to undertake the above mentioned study has been granted by the North West Department of Health. The Researcher must arrange in advance a meeting with the District Chief Director and District Director to introduce their research team/members on the proposed research to be undertaken. Further to the above the researcher must produce this letter to the District and chosen facilities as proof that the research was approved by the NWDoH.

This letter of permission should be signed and a copy returned to the Department. By signing, the Researcher agrees, binds him/herself and undertakes to furnish the Department with an electronic copy of the **final research report to be presented to the Departmental Management Committee** (DMC). Alternatively, the Researcher can also provide the Department with electronic summary highlighting recommendations that will assist the Department in its planning to improve some of its services where possible. Through this the Researcher will not only contribute to the academic body of knowledge but also contributes towards the bettering of health care services and thus the overall health of citizens in the North West Province.

Below are the contact details of Office of the Chief Director and District Director for all districts.

Bojanala District

Office of the Chief Director	Office of the District Director
Mr. Pule Monale Goitsemang Khumalo **(PA)**	Ms. Maggy Mere Goitsemang Alitah Senbeta **(PA)**
PMonale@nwpg.gov.za/ KhumaloG@nwpg.gov.za	MMere@nwpg.gov.za/eboniye938@gmail.com GSenbeta@nwpg.gov.za
014 592 8906/ 159	014 592 8906/ 159

Dr. Kenneth Kaunda District

Office of the Chief Director	Office of the District Director
Mr. Ishmael Molo Stokie Skhosana (PA)	Ms. Keitumetse Miambo Calvin Mmisele (PA)
IMolo@nwpg.gov.za SRoffice@nwpg.gov.za	KMiambo@nwpg.gov.za CMmisele@nwpg.gov.za
018 462 5744	018 462 5744

Dr. Ruth Segomotsi Mompati District

Office of the Chief Director	Office of the District Director
Mr. Ruben Matsepe Ms. Kesaobaka Monchwe (PA)	Mr. Onkarabile Pheko (PA)
rmatsepe@nwpg.gov.za KMonchwe@nwpg.gov.za	GOPheko@nwpg.gov.za
053 928 0506/7	053 928 0502

Ngaka Modiri Molema District

Office of the Chief Director	Office of the District Director
Ms. Mosela Kaudi Ms. Boitumelo Sethaiso (PA)	Ms. Nomvula Legobye Kealeboga Lobega (PA)
MKaudi@nwpg.gov.za BSethaiso@nwpg.gov.za	NLegobye@nwpg.gov.za LobegaK@nwpg.gov.za
018 384 0240	018 384 0240

Kindest regards.

Dr. FRM Reichel **Director: RM&E**	30/6/2021 **Date**
Researcher	05 July 2021 **Date**

Appendix B: Expert Review Questionnaire

Research Information

Research purpose: This research aims to enhance the knowledge of IT governance in the healthcare environment. It is a response to the National Department of Health's call to strengthen the leadership and governance needed to guide the development of the interoperability of health information across various health systems. The outcome of this research will be presented through a conceptual framework, referred to as the *Health Information Systems Interoperability and Governance Conceptual Framework (*HISIG-CF*),* that will serve to inform health systems interoperability intervention in the South African healthcare environment.

Participant's contribution: Currently, the researcher has completed a review of literature which has subsequently resulted in the development of the HISIG-CF. As an expert reviewer, your contribution will assist in evaluating the constructs of the conceptual framework and position its usefulness in the broader South African healthcare context. The results of this questionnaire will contribute to the recommendations of the study.

The questionnaire is administered across the following three sections:

- **Section A:** Demographical and background information
- **Section B:** HISIG-CF Evaluation
- **Section C:** HISIG-CF Diagram Evaluation

SECTION A: DEMOGRAPHICAL & BACKGROUND INFORMATION

1. **Please indicate your gender:**

   ☐Male

   ☐Female

2. **What is your age range?**

   ☐18 – 25

   ☐26 – 35

   ☐36 – 45

   ☐46 – 60

   ☐Over 60

3. **Which sector does your organisation operate?**

   ☐Public

   ☐Private

   ☐Mixed (50% Public & 50% Private)

   ☐NGO

4. **Please indicate which domain your experience lies:**

   ☐Healthcare environment

   ☐IT Governance

   ☐Academia

   ☐Other

   If "Other" please provide a description

5. **Please indicate how many years' experience you have in your domain?**

   ☐Less than a year

   ☐1 – 3 years

   ☐4 – 6 years

   ☐7 – 10 years

   ☐More than 10 years

6. **Please describe your occupation:**

SECTION B: HISIG-CF Evaluation

HISIG-CF Constructs Overview

As informed by literature, the table below provides an overview of the constructs of the HISIG-CF. Each construct relates to sub-research questions, addressing a specific theme of the research. The table additionally provides background information for each construct to ground its linkage and relevance to the HISIG-CF.

Please read through the summary below then answer the questions that follow.

Sub-Research Questions (Themes)	Construct	Background of construct	Linkage and relevance in HISIG-CF
What IT governance mechanisms can be used to support interoperable health systems? **Theme 1: IT governance**	**IT Governance Mechanisms**	The implementation of IT Governance (ITG) mechanisms facilitated through a mixture of appropriate organisational (Levstek, Hovelja and Pucihar, 2018): ▪ Structures – define the accountability layer of implementation with the intent of establishing "who is responsible" for an ITG program. ▪ Processes – are an arrangement of formalities involved in making decisions and provides guidance on how to delivery of IT activities. ▪ Relational mechanisms – can be viewed as key cohesive tools that can be used to ensure that structures and processes function well. These relate to the softer aspects of ITG e.g., training programmes, senior management engagement, rewards and incentives etc.	The premise of this construct is founded on the acknowledgement of government's call to improve governance in health care. In order to improve the delivery of healthcare services through the health systems currently in place, the researcher posits that improvement of health systems can be attained through a combination of ITG mechanisms. This can be done by first examining the present organisational capacity (on a structural, process and relational attributes basis) to assess the as is state. In accordance with the organisational IT strategy, improved ITG mechanisms can then be defined.
	Level of governance	Traditionally, the levels of governance in the public domain are carried out from a top-down approach, which involves: ▪ The national government setting out the strategic objectives ▪ The provincial office providing guidance on frameworks and policies to deploy as set out by the national office ▪ Local government divided across various districts.	This construct underscores the notion that governance in the health care environment is primarily the responsible of individuals at the apex office of the health sector. Through this construct, the researcher argues for the advancement of "distributed leadership" (Martin *et al.*, 2015). Distributed leadership requires coordination and collaborative effort from the different levels of governance. This enables effective contributions across the various governance levels.

	Sectoral differences	The health sector predominantly operates on a two-tier system, namely, the private and public sector. The vast majority of South Africans rely on services provided by public health care facilities, which continue to be burdened by the influx of patient needs (Katuu, 2016). The private sector is viewed to provide the most efficient health services, however, access is limited and often subject to affordability (Stanton, 2016). Health facilities in both sectors are defined by their various systematic differences and thus operate according to their various regulations.	At the core of each sector, is the objective to deliver quality health care. With this goal in mind, a multi sector engagement between the two sectors can potentially improve how facilities function in both sectors. This will enable both sectors to collaborate and draw valuable lessons from each sector. This will additionally serve as a good foundation towards the envisioned National Health Insurance (NHI) of creating accessible and affordable quality health care for all.
	Implementation Life Cycle (Continuous improvement lifecycle)	The implementation of ITG in healthcare, requires placement in the broader organisational environment that will ensure that the approaches employed are above par. Developed by ISACA, through COBIT 19, the Continual Improvement Life Cycle provides guidance to ensure that the IT strategy of an organisation can be positioned in the broader organistional context. The model proposes the following layers (ISACA, 2018): ▪ **Program management** – involves defining the requirements of an ITG program and how it is to be carried out, e.g., defining the problem and opportunities, defining a road map, planning the program etc. ▪ **Change enablement** – defines the process involved in assisting organisations and employees transition from their current state towards the desired improve goals. ▪ **Continual improvement** – defining program requirements and processes for enabling change requires constant activities that encourage further improvement. This can be done through e.g., assessing the current state of the program implemented, monitoring its use, communicating improvements etc.	Improving health systems across health facilities cannot be done haphazardly. Using models such as the Continual Improvement Life Cycle, will enable health care management to follow an iterative approach to reaching the desired end goal. Furthermore, this model/process acknowledges the complexities involved when engaging various stakeholders. Therefore, the change enablement dimension provides guidelines that can be considered to effect interoperable health systems. The last layer notes the importance of continuous improvement. Essentially, once the program management and change enablement aspects have been defined, an opportunity to scrutinise the changes effected.
	eHealth maturity levels	Health systems in South Africa, range across four maturity levels, which include (NDoH and CSIR, 2014): ▪ **Level 1 – Local paper-based health systems** At this level, medical records are manually recorded and stored with no use of any eHealth features. Additionally, information in this level is stored in a single local facility.	The success of interoperability (or any similar improvements) to health systems, require a great understanding of the maturity level at which the various health facilities operate. Through this construct, the researcher proposes understanding the current state of the health systems and place. As individual health facilities expand and the capacity

		▪ **Level 2 – Local paper-based health systems with limited IT support** HISs in this category is predominantly paper based however, provision is made for limited IT use to capture patient identifiers and demographical information. ▪ **Level 3 – Centralised electronic system with paper-based and electronic features** Health systems that operate in level 3 are a combination of both paper-based and electronic functions. The HISs uses a local infrastructure, found in various healthcare facilities, and a shared infrastructure which is accessible across different facilities. ▪ **Level 4 - Fully electronic-based electronic health records (EHR) system.** This level of eHealth maturity represents the desired, end goal for a fully electronic-based EHR system that enables health information exchange to occur. At this level of eHealth maturity, patient's health records are stored at the localised healthcare facility's EMR. The relevant aspects of a patient's health record are then stored onto a shared EHRs system, accessible across different networks.	of their services improve, a move to the next level can be made. This will allow health facilities to realistically assess their health systems. Then consider the requirements necessary to advance to the next levels.
RQ2: How should health information systems align with interoperability practices? **Theme 2: Health Information Systems** **Theme 3: Interoperability**	**eHealth building blocks**	The six building blocks provides dimensions crucial for strengthening health systems. Additionally, the building blocks can also be used as a measure of progress made to improve health systems currently in place and these include (WHO, 2010; Iyawa, Herselman and Botha, 2019): 1. Health service delivery 2. Health workforce 3. Health information system 4. Access to essential medicines 5. Health financing 6. Leadership and governance Leadership and governance cuts across the dimensions of the other building blocks (WHO, 2010). It plays a critical role in ensuring accountability in the different dimensions. In the South African context, the National Department of Health (NDoH) has outlined leadership, governance and multi-sector	The researcher posits that the strength of health systems relies on the governance in place. Through this construct, the researcher asserts governance can be strengthened across the different building blocks from an ITG perspective, following the guidelines of the ITG mechanisms (refer to the first construct).

		engagement as one of the key components in creating an enabling environment for eHealth. Although governance has been acknowledged to be of great significance, its value within the health environment is yet to be realised (Benedict and Schlieter, 2015). It is through this lens that the researcher argues for the importance of leadership and governance in strengthening health systems currently in place.	
	Interoperability layers	In context to the health industry, interoperability defines how healthcare information can be interchanged with the intention of enabling knowledge sharing networks between healthcare providers (Desai, 2015). The purpose is to improve the accessibility of patient health records and information required to guide decisions towards providing quality health services (European Commission, 2017). Amin *et al.* (2020) notes four different layers enable the facilitation of interoperability, which includes: 1. **Organisational interoperability** Focused on ensuring that business goals, processes, and collaboration can be integrated beyond a single organisation's scope. 2. **Technical interoperability** Related to the technical matters that enable information exchange, including protocols, interfaces, and related features 3. **Semantic interoperability** Concerned with ensuring that a common set of descriptions and interpretations are consistently maintained across communication channels. In eHealth, semantic interoperability often relates to creating consistent coding standards. 4. **Syntactical interoperability** Focuses on facilitating the exchange of information using predefined messaging and data formats.	The success of interoperability is reliant on the creation of an enabling environment that will allow information exchange. To pursue interoperability, healthcare organisations may examine the capabilities of their current hardware resources (addressing the technical and organisational layers) as well as software resources (semantic and syntactical use). This will provide a comprehensive vision of the foundation on which interoperability may be investigated (either on a hardware basis or software basis). Furthermore, it will assist in determining which areas to place emphasis on for further development. The researcher further proposes exploring interoperability using a multi-faceted approach to facilitate the process of implementation. Through a multi-layered approach, each basic layer of interoperability will be considered, improving the impact of knowledge sharing networks.

SRQ3: What is the role of interoperability standards on health systems? **Theme 3: Interoperability**	**Standards of interoperability**	Standards define specifications that have been mutually agreed upon to create or maintain consistently (Han *et al.*, 2019). Furthermore, standards are necessary to ensure that regulations set at both national and international level are translated into the operations in the healthcare environment (Katuu, 2016). Central to the facilitation of interoperability in the healthcare environment, is a need to understand what standards exist and be best utilised to develop suitable. Importantly, standards serve to promote effective health information exchange, create co-existing environments and ensure that the systems are interoperable (Alunyu and Nabukenya, 2018).	The creation of the National Health Normative Standards Framework for Interoperability in eHealth in South Africa (HNSF), provides a foundation that sets precedence for interoperability using a standards-based approach (NDoH and CSIR, 2014). The framework presents a practical view of implementing interoperability and plays a pivotal role in the South African health landscape. Reviews of international eHealth standards are provided and considered in context to South Africa and further use cases are developed to define the applicability of the specifications outlined. On the other hand, a standards specifications defined as Fast Healthcare Interoperability Resources (FHIR), is gaining prominence in healthcare (Fogwill, Barron and Benjamin, 2016). FHIR has been developed to provide standards for exchanging healthcare information electronically. Though it has not been considered much in the South African healthcare environment, the standard offers an opportunity that may greatly contribute to industry and health research in future (HL7 FHIR, 2019). FHIR specifications are driven by the need to provide a more understandable and simplified approach to the standardisation in healthcare (HL7 FHIR, 2019). Drawing from present logical and theoretical models, best practices are defined in alignment with standards in existence (HL7 FHIR, 2019).

HISIG-CF Constructs Evaluation

Based on your domain knowledge, please assess the below constructs as accurately as possible. Please provide your response (by crossing the relevant box) for each question below. Please provide a response using a scale of one (1) to five (5) which indicates:

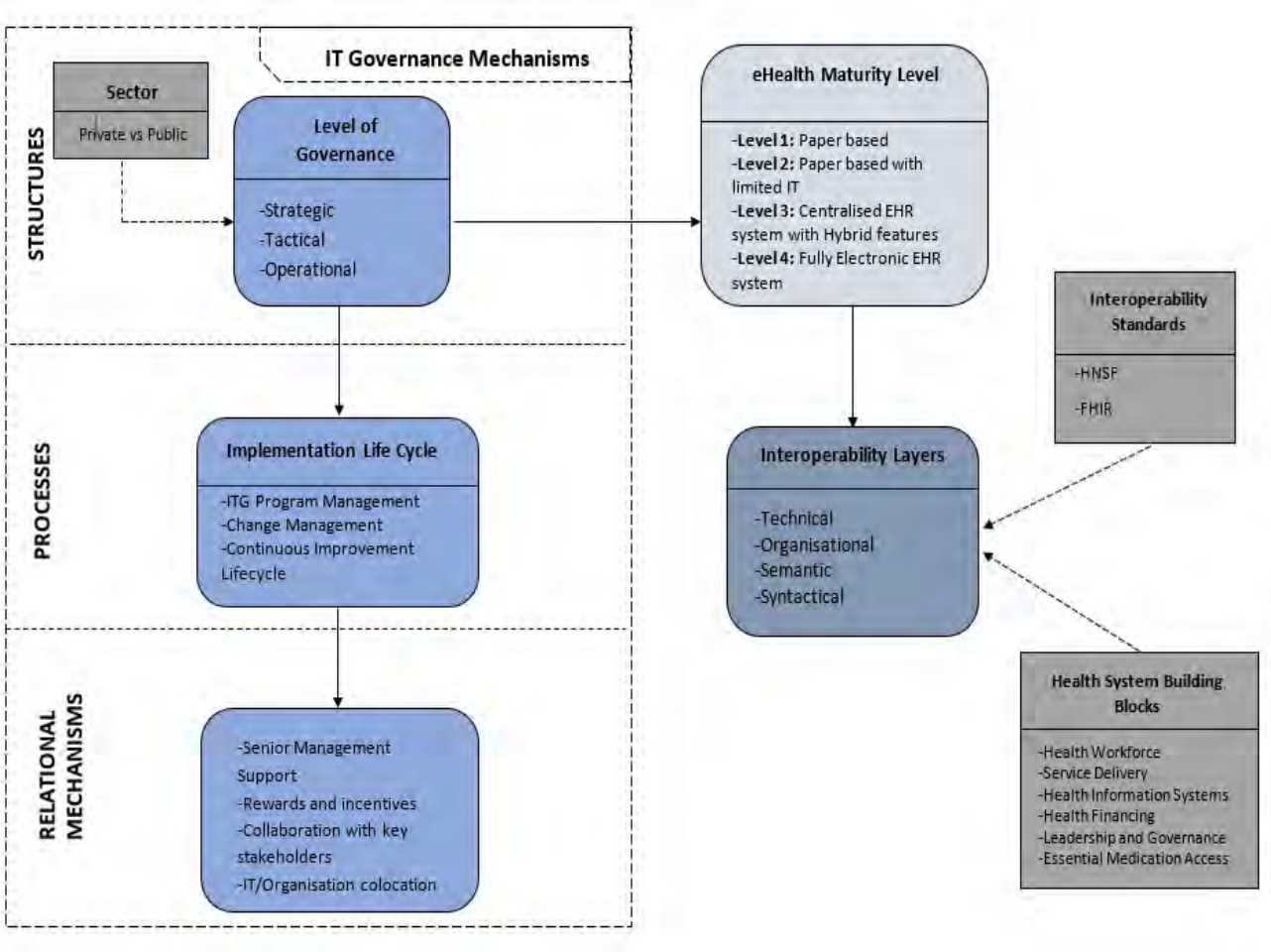
1*-Strong Disagree;* ***2*** *– Disagree;* ***3*** *– Neutral;* ***4*** *– Agree;* ***5****-Strongly Agree*

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
	1	**2**	**3**	**4**	**5**
Do the HISIG-CF constructs align with the sub-research questions of the research?	☐	☐	☐	☐	☐
Do the HISIG-CF constructs align with the research themes?	☐	☐	☐	☐	☐
How strongly would you consider the following construct related to **IT Governance** relevant in the development of interoperable health information systems?					
IT governance mechanisms	☐	☐	☐	☐	☐
Level of governance	☐	☐	☐	☐	☐
Sectoral differences: Private vs public	☐	☐	☐	☐	☐
Implementation lifecycle	☐	☐	☐	☐	☐
How strongly would you consider the following construct related to **Health Information Systems** relevant in the development of interoperable health information systems?					
eHealth maturity levels	☐	☐	☐	☐	☐
eHealth building blocks	☐	☐	☐	☐	☐
How strongly would you consider the following construct related to **Interoperability** relevant in the development of interoperable health information systems?					
Interoperability layers	☐	☐	☐	☐	☐
Standards of interoperability	☐	☐	☐	☐	☐
Which of the following HISIG-CF constructs would you consider **significant** for the development of interoperable health information systems?					
IT governance mechanisms	☐	☐	☐	☐	☐
Level of governance	☐	☐	☐	☐	☐
Sectoral differences: Private vs public	☐	☐	☐	☐	☐
Implementation lifecycle	☐	☐	☐	☐	☐
eHealth maturity levels	☐	☐	☐	☐	☐

eHealth building blocks	☐	☐	☐	☐	☐
Interoperability layers	☐	☐	☐	☐	☐
Standards of interoperability	☐	☐	☐	☐	☐

SECTION C: HISIG-CF DIAGRAM EVALUATION

As informed by literature, several constructs were identified as being relevant to assist in using IT governance to guide the development of interoperable health information systems. Insights from literature led to design of HISIG-CF diagram presented below. Based on your domain knowledge, please answer the following questions.



1. **Validity: In its current state, do you think the conceptual framework would contribute to the healthcare environment? If not, which aspects would not enable its contribution?**

2. **Utility: Does the framework address a real need in the healthcare environment?**

3. **Utility: Do you think the application of the HISIG-CF will deliver useful results in the healthcare environment?**

4. **Quality: Has the framework been rigorously developed?**

5. **Efficiency: In its current state, is the HISIG-CF simplistic enough to understand and apply? If not, what can be improved?**

6. **Are there any constructs of the conceptual framework, which require improvement? If so, which constructs?**

7. **Additional comments:**

Appendix C: Scoping Reviews Sample for Analysis

Core Literature Review Papers					
Paper Number	**Author**	**Publication Year**	**Title**	**Key Findings**	**Research Theme**
1	De Haes and Van Grembergen	2015	Enterprise governance of IT	Examines how enterprise governance can be deployed through a mixture of structures, processes and relational mechanisms	IT Governance
2	Wu, S. P., Straub, Detemar, W. and Liang, T.-P.	2015	How Information Technology Governance Mechanims and Strategic Alignment Influence Organizational Perfromance: Insights from a Matched Survey of Business and IT Managers	The impact and linkage between IT governance mechanisms and strategic alignment. Further shows how these infleunce organisational performance	IT Governance
3	Manda and Backhouse	2016	An analysis of the barriers to e-government integration, interoperability and information sharing in developing countries: a systematic review of literature	The barriers to e-government integration and interoperability in developing countries	Interoperability
4	Levstek, Hovelja and Pucihar	2018	IT Governance Mechanism and Contingency Factors: Towards an Adaptive IT Governance Model	Introduces ITG mechanisms crucial for the implementation of ITG. Additionally identifies contingency factors that infleunce ITG use	IT Governance
5	Nicol *et al.*	2021	Is routine health information system ready to support the planned national health insurance scheme in South Africa?	Analyses the level of preparedness of the NHI in South African hospitals in the public sector	Health Information Systems
6	Selig	2016	IT Governance - An Integrated Framework and Roadmap: How to Plan, Deploy and Sustain for Improved Effectiveness	Proposes an ITG framework and roadmap which identifies current and emerging best practices to achieve effective alignment and management of IT	IT Governance
7	Caluwe *et al.*	2021	How Boards of Directors Can Contribute to Governing IT	Explores the role played by board members in governing and creating IT value	IT Governance
8	Dawson *et al.*	2016	An Examination of Effective IT Governance in the Public Sector Using the Legal View of Agency Theory	Focuses on how shifting from a control-orientated view of governance in the private sector to a more mediating view in the public sector could potentially could create portable practices.	IT Governance
9	Caluwe and De Haes	2019	Board level IT Governance: A Scoping Review to Set the Research Agenda	The impact of board level involvement on IT Governance	IT Governance
10	Misuraca and Viscusi	2020	Shaping public sector innovation theory: an interpretative	Proposes a new theory of public sector innovation in specific	IT Governance

10	Misuraca and Viscusi	2020	Shaping public sector innovation theory: an interpretative framework for ICT-enabled governance innovation	Proposes a new theory of public sector innovation in specific network structures of governance, policy making goals and constituencies and stakeholders.	IT Governance
11	Tonelli et al.	2017	IT governance in the public sector: a conceptual framework	Presents an explanatory model of the impact of ITG mechanisms on IT and organisational performance	IT Governance
12	Iyawa, Herselman and Botha	2019	Digital Health Innovation Ecosystems: Identifying Key Participants, Benefits, Challenges, and Guidelines for the Namibian Context	Identifies key participants, benefits and challenges of a digital health innovation ecosystem in Namibia	Health Information Systems
13	Brauns	2016	Public healthcare in a post-apartheid South Africa: A critical analysis in governance practices	Determines the progress that has been made in reforming and chellenges experienced by healthcare systems under the leadership of the democratic government	IT Governance
14	Katuu	2016	Transforming South Africa's health sector	Outlines how the legacy of fragmentation has impacted South Africa's HIS. Explores related terminologies for standardisation as well as maturity models to consider for the future of eHealth	Health Information Systems
15	Herselman and Botha	2016	Strategies, Approaches and Experiences: Towards building a South African Digital Health Innovation Ecosystem	Draws from international experience to contribute to the planning and building of a national health infrastructure for digital solutions	Health Information Systems
16	Kruk et al.	2018	High-quality health systems in the Sustainable Development Goals era: time for a revolution	Study proposes that health systems should be judged across a set a values including - being for the people, should be equitable, resilient and efficient	Health Information Systems
17	Benedict and Schlieter	2015	Governance guidelines for digital healthcare ecosystems	Provides guidelines that can be used for implementing eHealth platforms	IT Governance
18	Bergmo	2015	How to Measure Costs and Benefits of eHealth Interventions: An Overview of Methods and Frameworks		Health Information Systems
19	Al Qassimi and Rusu	2015	IT Governance in a Public Organization in a Developing Country: A Case Study of a Governmental Organization	The application of ITG in public sector governmental organisations with focus on developing countries	IT Governance
20	Wimmer, Boneva and Giacomo	2018	Interoperability Governance: A Definition and Insights from Case Studies in Europe	Defines interoperability governance across the different layers of interoperability. Additionally presents an interoperability governance model that can be used to guide implementation	Interoperability

21	Desai	2015	Health Information Exchange, Interoperability and Network Effects	Presents a theoretical framework that shows how competitive effects can lead to the under-adoption of health information exchange and its effects on social welfare	Health Information Systems
22	Amin *et al.*	2020	Interoperability framework for intergrated e-health services	Builds a framework to materialize data interoperability and information exchange amongst e-health systems	Interoperability
23	Han *et al.*	2020	Factors influencing the adoption of health information standards in health care organizations: A systematic Review based on best fit framework synthesis	Provides policy and decision makers with a framework synthesizing factors that hinder or facilitate the adoption of health information standards	Interoperability
24	Fogwill, Barron and Benjamin	2016	MomConnect: an exemplar implementation of the Health Normative Standards Framework in South Africa	Focuses on the design and devemopment of the technical infrastructure for supporting MomConnect	Health Information Systems
25	Saripalle, Runyan and Russell	2019	Using HL7 FHIR to achieve interoperability in patient health record	Explores and critically analyzes HL7 FHIR to design and prototype an interoperable mobile personal health record	Interoperability
26	Fusheini and Eyles	2016	Achieving universal health coverage in South Africa through a district health system approach: conflicting ideologies of health care provision	Reviews data from NHI pilot districts that reveals DHS are pivotal for health reform in addition to minimal UHC	Health Information Systems
27	Boak *et al.*	2015	Distributed leadership, team working and service improvement in healthcare	Studies factors that have influenced the successful introduction of distributed learning and team work	IT Governance
28	Eden *et al.*	2016	Barriers and facilitators to exchanging health information: A systematic review	A review of literature that focuses on assessing factors that could serve as facilitators or barriers for the exchange of health information	Health Information Systems Interoperability
29	Wright, O'Mahony and Cilliers	2017	Electronic health information systems for public health care in South Africa: a review of current operational systems	Reviews electronic HISs in South Africa and recommends that HISs shoud be expanded to support direct patient care to improve health outcomes	Health Information Systems
30	Alunyu *et al.*	2020	Factors that Influence Potential Success of eHealth Standards Adoption in a Low and Middle-Income Country: a review	Reviews literature to investigate the potential success of eHealth standards adoption	Interoperability
31	Kobusinge	2020	Contextual factors influencing the design and management of health information systems interoperability	Studies the factors that impact how HIS interoperability is designed	Health Information Systems Interoperability
32	Martin *et al.*	2015	Potential challenges facing distributed leadership in health care	Introduces the concept of distribted leadership in the goverance of health care	IT Governance