A NAMIBIAN DIGITAL HEALTH INNOVATION ECOSYSTEM FRAMEWORK

By

GLORIA EJEHIOHEN IYAWA

(Student number: 50862979)

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SUPERVISOR: Prof. M.E. Herselman

JOINT SUPERVISOR: Prof. A. Botha

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This thesis is dedicated to my Lord and Saviour Jesus Christ for giving me the grace to complete this study.

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ABSTRACT

Digital Health relates to "health information systems which enable the merging of social-care and healthcare systems. This would impact on the organisation, service delivery as well as the technological infrastructure" (Herselman & Botha, 2016, p.10). However, with relatively sparse research publications emanating from within the Namibian Health domain, and the concept of Namibian Digital Health as an emergent phenomenon, a *Namibian Digital Health Innovation Ecosystem Framework* would provide a start to conceptualising, developing and implementing such an ecosystem for Namibia and thus unlocking the potential of Digital Health in this country.

The purpose of this study is to develop a *Namibian Digital Health Innovation Ecosystem Framework* based on literature reviews and the feedback from knowledgeable professionals (KPs) in Namibia, as well as global experts. The methodology which was applied in this study to address the purpose, and to answer the research questions, was *Design Science Research Methodology* and the Design Science Research Methodology (DSRM) process of Peffers, Tuunanen, Rothenberger and Chatterjee (2008), was adopted. *Pragmatism* is the overall philosophy guiding the study, as proposed by Ackoff's theory regarding the hierarchy of human understanding (1989) and Shneiderman's visual information seeking mantra (1996). During Phases 2 and 3 of the study *interpretivism* and *positivism* were applied as philosophies, guided by hermeneutics and triangulation, towards understanding the feedback of Knowledgeable Professionals (KPs) in Namibia, as well as the global experts. The study was divided into three phases. The first phase entailed a literature study which identified the components of *Digital Health, Innovation* and *Digital Ecosystems* as well as related research of *Digital health, Innovation* and *Digital Ecosystems* in developed and developing countries. This process led to the compilation of the initial *Namibian Digital Health Innovation Ecosystem Framework* using a conceptual approach. In the second phase of the study, the initial *Namibian Digital Health Innovation Ecosystem* was evaluated by KPs in Namibia using the Delphi method and interviews. Phase 2 adopted both quantitative and qualitative approaches. The findings from Phase 2 resulted in the development of the intermediate *Namibian Digital Health Innovation Ecosystem Framework*. In Phase 3 of the study, the intermediate framework was validated by global experts. Feedback was collected from global experts through questionnaires which were analysed through qualitative content analysis. The findings, from Phase 3 led to the development of the final *Namibian Digital Health Innovation Ecosystems Framework*. The guidelines, which can be used by the Namibian government to implement the suggested digital health innovation ecosystem framework, were also provided.

Keywords: Design Science Research, Digital Health, Innovation, Digital Ecosystems, Digital Health Innovation Ecosystems, E-Health, M-health, Telemedicine, Health

Information Systems and Namibia.

DECLARATION

I declare that, **A NAMIBIAN DIGITAL HEALTH INNOVATION ECOSYSTEM FRAMEWORK**, is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

SIGNATURE DATE

(Ms. GE Iyawa)
Student number: 50862979

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LIST OF ACRONYMS AND ABBREVIATIONS

ASD	Autism Spectrum Disorder
CI	Change Impact
CSET	College of Science, Engineering and Technology
DHIS	District Health Information System
DSR	Design Science Research
DSRM	Design Science Research Methodology
ECG	Electrocardiography
EDA	Electrodermal Activity (EDA)
EDCTP	European and Developing Countries Clinic Trials Partnership
e-health	Electronic Health
EHR	Electronic Health Record
EMR	Electronic Medical Record
EPMS	Electronic Patient Management System
e-prescription	Electronic Prescription
HDI	Human Development Index
HIS	Health Information Systems
ICT	Information and Communication Technology
IHCIMS	Integrated Healthcare Information Management Systems
IMF	International Monetary Fund
IS	Information Systems
IT	Information Technology
KPs	Knowledgeable Professionals
m-health	Mobile Health
MoHSS	Ministry of Health and Social Services
MS	Microsoft
NCRST	Namibia Commission for Research, Science and Technology
NHIS	National Health Information System
OECD	Organisation for Economic Co-operation and Development
OSS	Open Source Software
SADC	South African Development Community
SD	Standard Deviation
SIB	Survey of Innovation and Business
SPSS	Statistical Package for Social Sciences
PMIS	Pharmacy Management Information System
UN	United Nations
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UK	United Kingdom
UNISA	University of South Africa
USAID	United States Agency for International Development
UX	User eXperience
WHO	World Health Organisation

PUBLICATIONS

1. **Iyawa, G.E.**, Herselman, M. and Botha, A. (2017). Application of wireless sensor networks and wearable technologies for educational purposes: A scoping review, *Proceedings of Second International Conference on Advanced Wireless Information, Data and Communication Technologies*, Paris, France, ACM.
2. **Iyawa, G.E.**, Herselman, M. and Botha, A. (2017). Potential stakeholders and perceived benefits of a digital health innovation ecosystem for the Namibian context. *Proceedings of International Conference on Health and Social Care Information Systems and Technologies,* Barcelona, Spain, Elsevier.
3. **Iyawa, G.E.**, Herselman, M. and Botha, A. (2017). Identifying components of digital health innovation ecosystems for the Namibian context. Findings from a Delphi study. *Electronic Journal of Information Systems in Developing Countries*, 82.
4. **Iyawa, G.E.**, Herselman, M. and Botha, A. (2017). A scoping review of digital health innovation ecosystems in developed and developing countries. *Proceedings of IST Africa,* Windhoek, Namibia, IEEE.
5. **Iyawa, G.E.**, Herselman, M. and Botha, A. (2016). Digital health innovation ecosystems: From systematic literature review to conceptual Framework. *Procedia Computer Science,* 100, 244-252.
6. **Iyawa, G.E**. Botha, A. and Herselman, M. (2016). Identifying and defining elements of a *Digital Health* innovation ecosystem. In: Herselman, M. and Botha, A. Ed. *Strategies, Approaches* and *Experiences: Towards building a South African Digital Health Innovation Ecosystem*, Pretoria, CSIR.
7. **Iyawa, G.E.**, Herselman, M. and Coleman, A. (2016). Customer interaction in software development: A comparison of software development methodologies deployed in Namibian software firms. *Electronic Journal of Information Systems in Developing Countries,* 77(1), 1-13.
8. **Iyawa, G.E.** (2016). A framework for improving knowledge management practices in Namibian software firms. *Journal of Information and Knowledge Management,* 10(1), 1-13.

CHAPTER 1. SCOPE OF THE STUDY

1.1. INTRODUCTION

This study explores the components that constitute a *Namibian Digital Health Innovation Ecosystem Framework*. Heeks (2006, p. 2) defines a framework as a construct that "explicitly derives itself from a body of theoretical work." Hassan (2014), differentiating between conceptual, research and theoretical frameworks, refers to a framework as a "product of theorising" and quotes Miles and Huberman (1994) when he states that it is the researcher's map of the territory being studied. Their understanding of a framework consequently consists of the map of main concepts, constructs and their related positions. For this research, a framework is understood as a means of presenting identified, validated components and their relationship within the Namibian Health domain. As such, although the study is based within the Namibian Health domain, it extends to include the notions of constructs and their relations within *Digital Health, Innovation* and *Digital Ecosystems*. The premise of the work is that a *Namibian Digital Health Innovation Ecosystem Framework* can potentially inform stakeholders, within the Namibian Health domain, as to the potential and opportunities that exist when innovation and ecosystem thinking is incorporated.

1.2. BACKGROUND

Namibia is a country located in Southern Africa. As of 2013, Namibia was estimated to have a population of approximately 2.3 million people (World Bank, 2013). Namibia can be described as a "semi-arid" country with an area of about 825 000 square meters (Government of Namibia, 2002, p. 6). Namibia is one of the member states of the United Nations (UN) and the South African Development Community (SADC) (Mbuende, 2014).

The Namibian healthcare system has both private and public healthcare; the public healthcare is government owned and managed (World Health Organisation [WHO], 2010). Eighty five percent of the population is dependent on the government for healthcare delivery services, while the remaining 15% make use of services provided by the private healthcare sector (WHO, 2010). The large number of people dependent on public healthcare has resulted in the system being overburdened with chronic medical staff shortages (Van Rooy et al., 2012). This burden carried by the public healthcare system is further exasperated by the increasing number of health challenges including HIV/AIDS (Schellekens et al., 2009) and maternal and child mortality (Nakale, 2012).

Hamunyela and Iyamu (2013) state that despite the existence of health information systems (HIS) in the Namibian health sector, the Namibian Ministry of Health and Social Services (MoHSS) still mainly rely on paper-based records. In addition, most of the 61 health information systems used in Namibian government hospitals are not interoperable (United States Agency for International Development [USAID], 2012).

Figure 1-1: Location of Namibia within the African Continent (Adopted from Geology, 2017).

One of the goals of the Namibian Vision 2030 is to ensure that Information and Communication Technology (ICT) is disseminated into different sectors of the economy (Government of Namibia, 2004). This has been realised to a larger degree in the public sector (The Namibian, 2006) and to a lesser degree in the public healthcare sector (USAID, 2012). However, there is consensus that the implementation of electronic health (e-health) systems alone is not sufficient in meeting the healthcare needs of a developing country like Namibia. Robinson et al. (2015) state that *Digital Health* holds much potential for not only healthcare practitioners, but patients as well. This potential extends to the developing context (Tambo et al., 2016; Sarumi & Idowu (2016); Gardstedt et al., 2013; Herselman et al., 2016).

As the body of academic, policy and business literature increasingly supports arguments for *Digital Health,* as put forward by the Organisation for Economic Co-operation and Development (OECD, 2013) and the World Bank (Chetley, 2006; Qiang et al., 2011), the potential that *Digital Health* holds for the Namibian Healthcare domain is becoming increasingly apparent.

1.3. RATIONALE AND *PURPOSE*

Digital Health broadens the concept of healthcare provision to incorporate “personalised, participatory healthcare models, health monitoring, well-being practices and preventive care” (Herselman & Botha, 2016, p.10). Digital Health relates to “health information systems that enable the merging of social-care and healthcare systems” (Herselman & Botha, 2016, p.10). This would significantly impact on the organisation, service delivery and technological infrastructure. Digital Health, in addition, suggests health-related service delivery beyond professional healthcare organisations and implies personalised ICT devices, software and services, which creates the opportunity of an innovation platform for health-related services. In brief, Digital Health "implies ubiquitous change throughout the existing healthcare system, as well as the expansion and re-definition of the traditional boundaries between patients, consumers, citizens, healthcare professionals, innovators, organisations, sectoral policies" (Herselman et al., 2016, p. 4).

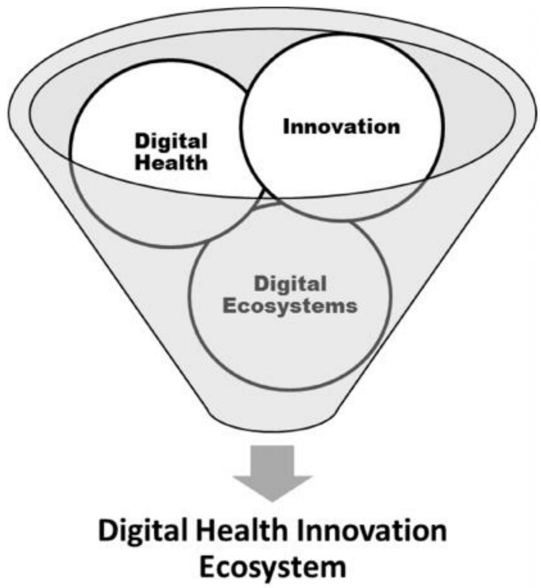


Figure 1-2: Concepts that constitute a Digital Health Innovation Ecosystem.

The development of a *Namibian Digital Health Innovation Ecosystem Framework* would therefore incorporate the **concepts** of *Digital Health, Innovation* and *Digital Ecosystems*. The reason for selecting these specific concepts is found in the narrative on Open Innovation 2.0 (Salmelin, 2015) wherein Digital Ecosystem thinking evolves around the concepts of domain knowledge, innovation and Digital Ecosystems. This is particularly relevant as the conceptualisation of Digital Health is an emerging concept, especially in Namibia. With relatively sparse research publications emanating from within the Namibian Health domain, and the concept of Namibian Digital Health still an emergent phenomenon, a *Namibian Digital Health Innovation Ecosystem Framework* would provide a start to conceptualising, developing and implementing such an ecosystem for Namibia and thus unlocking the potential of Digital Health in this country.

The purpose of this study is thus to develop a *Digital Health Innovation Ecosystem Framework* for the Namibian context.

1.4. RESEARCH QUESTION

To address this purpose, the main research question that will guide this study is:

What are the components that constitute a framework for a Digital Health Innovation Ecosystem in Namibia?

The main research question seeks to identify the core components which have to be considered when developing a *Namibian Digital Health Innovation Ecosystem Framework*. To answer the main research question, the following sub-research questions need to be investigated:

- **Sub-question 1:** What are the components of *Digital Health, Innovation* and *Digital Ecosystems*?
- **Sub-question 2:** What does the existing literature communicate about *Digital Health, Innovation* and *Digital Ecosystems* in developed and developing countries?
- **Sub-question 3:** What are the components of *Digital Health, Innovation* and *Digital Ecosystems* specifically relevant to the Namibian context, as identified by knowledgeable professionals (KPs) in Namibia and globally?
- **Sub-question 4**: What strategies need to be put into place for *Digital Health* to be established in Namibia?

1.4.1. Objectives of the study

The objectives of the study, based on the main research question and the sub-questions as presented in section 1.4, are:

- Review the components that constitute Digital Health, Innovation and Digital Ecosystems.
- Review the evidence from literature of how *Digital Health, Innovation* and *Digital Ecosystems* operate and exist in developed and developing countries.
- Provide an initial framework (artefact) for a *Digital Health Innovation Ecosystem*.
- Evaluate the initial framework (artefact) for a *Digital Health Innovation Ecosystem* in Namibia by KPs in Namibia.
- Identify the perceived benefits of a *Digital Health Innovation Ecosystem* for Namibia based on the findings garnered from KPs in Namibia.
- Identify potential stakeholders of a *Digital Health Innovation Ecosystem* for Namibia based on the findings from KPs in Namibia.
- Identify strategies to be put in place for *Digital Health* to be established in Namibia based on the findings from KPs in Namibia.

- Provide the intermediate framework (artefact) for a *Digital Health Innovation Ecosystem* in Namibia.
- Validate the intermediate framework (artefact) for a *Digital Health Innovation Ecosystem* through expert reviews globally.
- Identify the perceived benefits of a *Digital Health Innovation Ecosystem* for Namibia based on the findings from experts globally.
- Identify potential stakeholders of a *Digital Health Innovation Ecosystem* for Namibia based on the findings from experts globally.
- Identify strategies to be put in place for *Digital Health* to be established in Namibia based on the findings from expert globally.
- Develop the final framework (artefact) for a *Digital Health Innovation Ecosystem* in Namibia based on the findings from expert reviews globally.
- Propose guidelines with approaches for implementing a *Digital Health Innovation Ecosystem* in developing countries.

1.5. RESEARCH METHODOLOGY

The research methodology section explains the processes according to which the research was conducted. This research follows a *Design Science* research approach (see Chapter 2) to answer the research questions and research objectives, as posed in section 1.4 and section 1.4.1, respectively. Design Science Research (DSR) is an appropriate method for the problem at hand. Its relevance becomes clear in that this methodology is rooted in its ability to develop solutions (artefacts) *to solve human problems* (Hevner & Chatterjee, 2010), as well as in the rigour of the process that is followed (Peffers, Tuunanen, Rothenberger & Chatterjee, 2008). DSR also has the potential to create impact in its field of application by appropriately positioning and structuring its contribution relative to the relevant knowledge base (Gregor & Hevner, 2013). The most appropriate Design Science Research Methodology Process (DSRM) selected to address the purpose of this study is that proposed by Peffers et al. (2008) which describes the process to be followed - from problem definition and structuring, through the development and validation of an artefact, and the final dissemination of results. This process, as adapted from Peffers et al. (2007), informs the research plan and outline of this thesis.

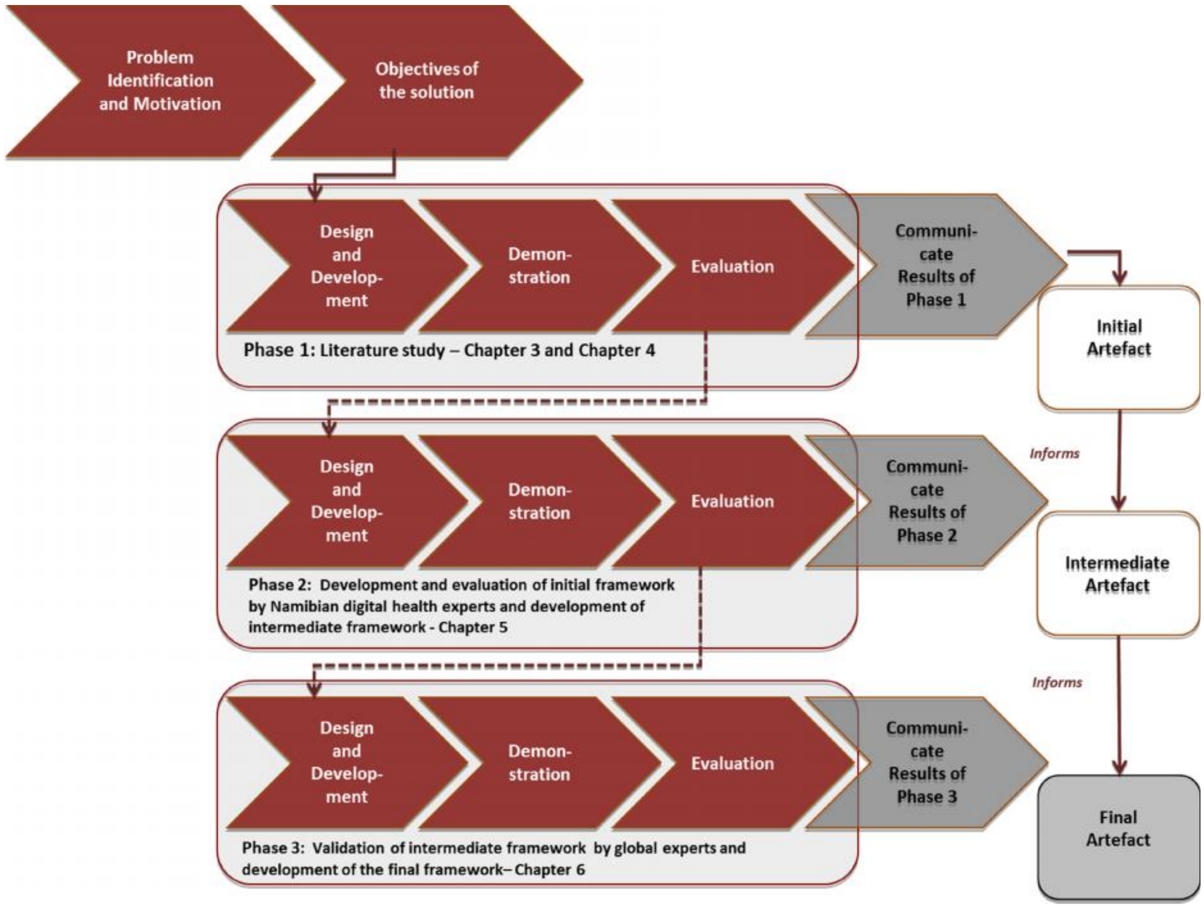


Figure 1-3: Design Science Research Process (Adapted from Peffers et. al., 2008).

This DSRM process will be further explained in Chapter 2. The research methodology is grounded in the philosophy of pragmatism. Pragmatism assumes that knowledge is provisional, socially created and situated in history (Kelder, Marshall & Perrey, 2005). Hence, theory is only deemed to be true after it has been proved to be useful – and then only in the context and the period within which it has been established to be useful (Kelder et al., 2005; Levy & Hirschheim, 2012). However, the current study also applied interpretivism to understand the feedback obtained from the qualitative data collection instruments (Phases 2 and 3; Figure 1-3).

To a design science researcher, reality is socio-technologically enabled and knowledge is gained through the process of artefact creation (Vaishnavi & Kuechler, 2015). Hevner and Chatterjee (2010) indicate that an artefact is a man-made object created to solve a specific problem, as opposed to naturally occurring objects. The artefacts created in DSR could involve one of the following elements (Hevner & Chatterjee, 2010; Hevner, March, Park & Ram, 2004; Vaishnavi & Kuechler, 2013):

- *Constructs:* A construct is the term used to describe a problem or solution. Constructs establish the specialised language and shared knowledge of a discipline that arises during the conceptualisation of a problem and they are refined throughout the DSR cycle.
- *Models:* A model is a set of propositions, or statements, that describe the relationships between constructs. It could also refer to an abstraction and representation of a problem, or solution that may include frameworks and guidelines. The focus of models in DSR is their usefulness or utility.
- *Methods:* A method is a set of steps that guide the performance of tasks. Methods also represent the plan of action aimed at achieving a goal. In DSR, a method aimed at solving a previously known problem in a more effective way is deemed valuable.
- *Instantiation:* This is the actualisation of a construct, model or method. Instantiations demonstrate the feasibility and effectiveness of the constructs, models or methods in an environment. The final *Digital Health Innovation Ecosystem* for Namibia framework is an example of this.
- *Better theories:* DSR can contribute to the formulation of better theories, or the development of new ones. The development or evaluation of an artefact may result in a better understanding of the relationship between its elements and this could potentially lead to the development of a new design theory for that artefact.

Based on these definitions, the artefact known as the *Namibian Digital Health Innovation Ecosystem Framework*, which was conceptualised in a developing context, is an instantiation. The notion of a developing context is outlined in Chapter 4.

According to Gregor and Hevner (2013), the construction of a design science research artefact should be informed by descriptive *kernel theories*. For this study, Ackoff's hierarchy of human understanding (1989) and Shneiderman's visual information seeking mantra (1996) were applied as *kernel theories* which were incorporated into the design of the final artefact.

The following section briefly outlines the phases which are discussed in more detail in Chapter 2.

1.5.1. Phase 1

The first phase of the study entailed a literature study, presented in Chapters 3 and 4, towards identifying the components of the concepts: *Digital Health, Innovation* and *Digital Ecosystems* in developed and developing countries. The components of *Digital Health* innovation ecosystems were compiled from Chapters 3 and 4 to present the initial *Namibian Digital Health Innovation Ecosystems Framework*.

1.5.2. Phase 2

The components, identified in Chapters 3 and 4, were evaluated by twenty-two KPs in Namibia, as presented in Chapter 5. The method of evaluation, employed by KPs in Namibia, involved ranking the different components of *Digital Health, Innovation* and *Digital Ecosystems* through the application of the quantitative Delphi method. The results are presented through using descriptive statistics and interviews, also conducted with KPs in Namibia. These adopted a qualitative approach towards investigating: the perceived value of *Digital Health, Innovation and Digital Ecosystems* for the Namibian context, the potential stakeholders of *Digital Health Innovation Ecosystems* within the Namibian context and strategies needed for the establishment of *Digital Health* within the Namibian context.

1.5.3. Phase 3

Chapter 6 presents expert reviews used to gather data from global experts. The questionnaires, administered to the global experts, contained open-ended questions which sought to investigate: the perceived value of *Digital Health, Innovation, and Digital Ecosystems* for the Namibian context, the potential stakeholders of *Digital Health Innovation Ecosystems* within the Namibian context and strategies needed for *Digital Health* to be established within the Namibian context. The questionnaire issued to global experts adopted a qualitative approach.

1.6. ETHICAL CONSIDERATION

The research was approved by the University of South Africa's (UNISA) College of Science, Engineering and Technology (CSET) Research Ethics Committee (see Appendix I).

No vulnerable participant was involved in the research. All participants were older than 18 years of age. Participants who participated in the interviews signed the informed consent form (see Appendix H), while participants who answered the questionnaire were asked to give their consent by responding to the email request.

1.7. RELEVANCE AND ***CONTRIBUTION***

This study is relevant as it can provide a *Digital Health Innovation Ecosystem Framework*, based on the requirements and needs of the Namibian context. Components of the framework, known as *Digital Health, Innovation* and *Digital Ecosystems,* contribute both theoretically and practically through their exploration, evaluation and validation within the Namibian context.

The final framework will provide decision makers in the Namibian healthcare sector with useful information regarding which important components to consider when implementing a *Digital Health Innovation Ecosystem*. The findings of the study also provide valuable insights into strategies needed for *Digital Health* to be established within the Namibian context. The guidelines, with approaches for implementing a *Digital Health Innovation Ecosystem* as provided in the study, can be adopted by other countries with a similar context.

1.8. LIMITATIONS AND *FUTURE RESEARCH*

This study is limited to identifying the components of *Digital Health Innovation Ecosystems* relevant to only the Namibian context. Although guidelines with approaches for implementing a *Digital Health Innovation Ecosystem* in developing countries and for the Namibian context specifically were proposed, the guidelines for implementing the individual components of the final *Digital Health Innovation Ecosystem* in Namibia was not provided. This is futher explained in Chapter 7, section 7.8.

Possible future research could include how best to implement the *Digital Health Innovation Ecosystem* framework within the Namibian context and the provision of guidelines on how individual components of the *Digital Health Innovation Ecosystem Framework* could be implemented.

1.9. CHAPTER MAP FOR THE THESIS

The content of each chapter is briefly described below:

- ***Chapter 1*** introduces the study. This chapter highlights the research problem, research questions and research objectives.
- ***Chapter 2*** explains the research methodology adopted for this study. This chapter firstly explains different research approaches and then explains which specific approaches were applied in the study.
- **Chapter 3** addresses the first sub-research question of this study: What are the components of *Digital Health*, *Innovation* and *Digital Ecosystems*? The chapter also addresses the first objective of the study: to review the components that constitute *Digital Health, Innovation* and *Digital Ecosystems*. Chapter 3 also presents a systematic literature review on *Digital Health, Innovation* and *Digital Ecosystems*, and provides a concept map for *Digital Health* innovation ecosystems.
- **Chapter 4** addresses the second sub-research question of this study: What does the existing literature communicate about *Digital Health, Innovation* and *Digital*

Ecosystems in developed and developing countries? This chapter further addresses the second objective of the study: to review the evidence from literature of how *Digital Health, Innovation* and *Digital Ecosystems* operate and exist in developed and developing countries. This chapter presents a scoping review of *Digital Health, Innovation* and *Digital Ecosystems* in developed and developing countries, guidelines with approaches for implementing a *Digital Health* innovation ecosystem in developing countries and the initial framework.

- ***Chapter 5*** provides the findings of the evaluation of the components of *Digital Health, Innovation* and *Digital Ecosystems* by KPs in Namibia to identify relevant components of *Digital Health, Innovation* and *Digital Ecosystems* relevant to the Namibian context. The chapter also identifies the perceived value of *Digital Health Innovation Ecosystems* to the Namibian context, potential stakeholders of the *Digital Health Innovation Ecosystem* for the Namibian context, and strategies needed for *Digital Health* to be established within the Namibian context, as presented by KPs in Namibia. In conclusion, the intermediate *Digital Health Innovation Ecosystem Framework* is provided.
- ***Chapter 6*** presents and validates the intermediate framework as well as the findings of the validation of the components of *Digital Health, Innovation* and *Digital Ecosystems* relevant to the Namibian context by global experts. The chapter also identifies the perceived value of *Digital Health Innovation Ecosystems* to the Namibian context, potential stakeholders of the *Digital Health Innovation Ecosystem* for the Namibian context, and strategies needed for *Digital Health* to be established within the Namibian context, as presented by global experts. The final *Digital Health Innovation Ecosystems* framework and the guidelines for implementing it in the Namibian context is also provided.
- ***Chapter 7*** concludes the study. The findings of the study are discussed. Future work is presented.

1.10. SUMMARY

This chapter provides a blueprint of the research which is presented in the rest of this study towards the development of a *Namibian Digital Health Innovation Ecosystem Framework* by:

- Firstly, deconstructing the notion of *Digital Health Innovation Ecosystems* as consisting of the concepts: *Digital Health, Innovation* and *Digital Ecosystems*. These concepts explain the essence of what should be considered as components to constitute a framework for *Digital Health Innovation Ecosystem*.
- Secondly, within these concepts (*Digital Health, Innovation* and *Digital Ecosystems)* the components had to be identified which explain the concepts and how these concepts operate in general.

- Thirdly, the use of these components, as associated with the concepts (*Digital Health, Innovation* and *Digital Ecosystems*) was investigated within the context of developed and developing countries. This allowed the researcher to formulate a concept map which displays the components, and the relationship of the components and the concepts, to be considered. This is described as Phase 1 of the study (see Figure 3.8) and it led to the conceptualisation of an initial framework (as an artefact) for this study.
- The constituting components of the concepts were then evaluated, rated and contextualised by KPs from Namibia. These informed the progression of the *Initial Framework* into the *Intermediate Framework* (see Chapter 5), as part of Phase 2 of the study.
- The *Intermediate Framework* was validated by global experts who reviewed and provided input toward the *Final Framework* (artefact), namely the *Namibian Digital Health Innovation Ecosystem Framework* (see Chapter 6). This process formed part of Phase 3 of this study.

  Guidelines were developed, based on literature (Chapter 4). These guidelines are strategies which can be applied by the Namibian government when implementing the framework.

The *Namibian Digital Health Innovation Ecosystem Framework* can potentially inform stakeholders within the Namibian Health domain as to the potential, and opportunities, created when innovation and ecosystem thinking are incorporated.

Chapter 2 discusses the research methodology applied to develop this framework.

CHAPTER 2. RESEARCH METHODOLOGY

2.1. INTRODUCTION

Chapter 1 provided the background and outline to the research and explained the research problem in terms of research questions and objectives. The purpose of this chapter is to describe the methodology which was applied to facilitate the research.

The DSR methodology follows a pragmatic philosophy. Ackoff's hierarchy of human understanding (1989) and Shneiderman's visual information seeking mantra (1996) were applied and served as the central theories according to which the artefact, a *Namibian Digital Health Innovation Ecosystem Framework*, was designed. The philosophy of Interpretivism was only applied in Phases 2 and 3 of the study to interpret the qualitative data which was collected during validation, and evaluation, of the artefact by Namibian KPs and global experts. The DSRM process of Peffers et al. (2007) was used to explain how this study unfolded in different phases (1 to 3) and the manner in which the phases were applied to develop the framework. An overview of Chapter 2 is presented in the next section.

2.2. OVERVIEW OF CHAPTER 2

The first section of this chapter maps the research questions to the research objectives and further explains, in specific chapters, where the objectives were met. Subsequent sections outline the essence of the Design Science process, as applied to this study.

2.3. MAPPING THE RESEARCH QUESTIONS TO THE RESEARCH OBJECTIVES

The main purpose of this study is to identify those components which constitute a framework for a *Digital Health Innovation Ecosystem* for the Namibian context. The research questions and objectives facilitated the gathering of relevant information to answer sub-research questions and to thus meet the objectives of the study, as outlined in Chapter 1 (sections 1.4 and 1.4.1 respectively). The research questions and objectives are outlined in Table 2.1.

Table 2-1: Mapping the research questions, the objectives and the chapters.

Main research question	**Sub-Research questions**		**Research objectives**	**Chapter**
What are the components that constitute a framework for a *Digital Health Innovation Ecosystem* in Namibia?	What are the components of *Digital Health*, *Innovation* and *Digital Ecosystems*?	→	Review the components of *Digital Health*, *Innovation* and *Digital Ecosystems*.	Chapter 3
	What does the existing literature communicate about *Digital Health*, *Innovation* and *Digital Ecosystems* in developed and developing countries?	→	Review the evidence from literature of how Digital Health, Innovation and Digital Ecosystems operate and exist in developed and developing countries.	Chapter 4
	What are the components of *Digital Health* innovation ecosystems specifically relevant to the Namibian context, as identified by KPs in Namibia and globally?	→	Provide an initial framework (artefact) for a *Digital Health* innovation ecosystem. Evaluate the initial framework (artefact) for a *Digital Health Innovation Ecosystem* in Namibia by KPs in Namibia. Provide an intermediate framework (artefact) for *Digital Health* innovation ecosystems in Namibia. Evaluate the final framework by experts globally.	Chapter 5 Chapter 5 Chapter 6 Chapter 6
	What strategies need to be put in place for *Digital Health* to be established in Namibia?	→	Identify strategies to be put in place for *Digital Health* to be established in Namibia, based on the findings from KPs in Namibia. Identify strategies to be put in place for *Digital Health* to be established in Namibia, based on expert reviews globally. Propose guidelines with approaches for implementing a *Digital Health Innovation Ecosystem* in developing countries.	Chapter 5 Chapter 6 Chapter 4

2.4. RESEARCH METHODOLOGY

The research design and methodology adopted for this study is Design Science Research (DSR), which focuses on the creation of new knowledge as the purpose of design science is "to change existing situations into preferred ones" (Simon, 1996). Design Research is research *into* or *about* design, whereas DSR mainly involves research which uses *design* as a research method, or technique (Vaishnavi & Kuechler, 2015). DSR is a research procedure which facilitates the creation of innovative constructions intended to solve problems faced in the real world and so contribute to the theory of the discipline in which it is applied (Lukka, 2003).

Design science addresses *wicked problems* in information systems (IS) (Rittel & Webber, 1984) and is fundamentally a problem-solving paradigm. Wicked problems, as explained by Hevner & Chatterjee (2010, p. 11), relate to "ill-defined environmental contexts as well as the creativity and teamwork needed to produce effective solutions." DSR also addresses *messy* problems. These are characterised by "a large degree of uncertainty as to how the problem should be approached and how to establish and evaluate the set of alternative solutions" (Pries-Heje & Baskerville, 2008, p. 731). This description is applicable to the development of the *Namibian Digital Health Innovation Ecosystem Framework*, since there are many possible ways to develop such an ecosystem. It should thus be evaluated and validated in its own, and global, contexts for specific purposes.

The researcher acknowledges the existence of other research methodologies such as grounded theory, action research, case study research and ethnography, but posits that design science is the best choice of methodology for this study as it provides practical solutions in a complex context.

2.4.1. Research paradigms and *theoretical grounding of the study*

Per Saunders et al. (2015), a researcher's personal values influence his/her chosen research paradigm as well as the philosophy which is applied in a study. Wahyuni (2012) regards research paradigms as fundamental beliefs and assumptions that affect the way in which a researcher conducts research, including the choice of a research methodology. Creswell (2014) uses the term *worldview* to indicate that a research paradigm describes how the researcher regards the world from a general philosophical view. This worldview influences the way in which the research is conducted.

Hussain, Elyas & Nasseef (2013) and Wahyuni (2012) state that existing research paradigms can be distinguished by considering the *ontology* and *epistemology* of each. Krauss (2005) state that the *epistemology, ontology* and *methodology* of a study are interrelated in that *ontology* involves the philosophy of reality, *epistemology* is engaged with how one gets to know that reality and *methodology* defines the practices necessary to acquire that knowledge. Creswell (2014) and Orlikowski & Baroudi (1991) identify the following types of research paradigms:

2.4.1.1. Positivism

Rubin & Rubin (2011) explain that when positivism is employed as a research philosophy, data is objectively gathered and thus considered free from the researcher's personal opinion. Positivists are therefore likely to employ quantitative methods in their research. Oates (2008) describes the characteristics of positivist research as follows:

- **The world exists independently from humans**: There is a physical and social world that exists externally to the mind of man which needs to be studied, captured and measured.
- **Measurement and modelling**: The researcher discovers this world by making observations and measurements and produces models showing how it works.
- **Objectivity**: The researcher is neutral and objective and an impartial observer. Facts about the world can thus be discovered independently of the researcher's personal values and beliefs.
- **Hypotheses testing**: Research is based on the empirical testing of theories and hypotheses which lead to them either being confirmed or refuted.
- **Quantitative data analysis**: There is often a strong preference for mathematical modelling and proofs of statistical analysis. The use of mathematics provides a logical, objective means of analysing observations and results.
- **Universal laws**: Researchers look for generalisations, universal laws, patterns or irrefutable facts that can be shown to be true, regardless of the researcher and/or the occasion.

2.4.1.2. Critical research

Orlikowski & Baroudi (1991) assert that critical philosophy enables the researcher to criticise the findings of a study based on already established facts. Donnelly & Trochim (2007) posit that these established facts are derived from that which already exists in history. Per Rubin & Rubin (2011), critical research is common in studies which advocate for the under-privileged as well as individuals who have suffered some form of social injustice.

2.4.1.3. Interpretivism

According to Bryman & Bell (2015, p. 28), interpretivism "is concerned with the empathic understanding of human action rather than the forces that act on it." According to the interpretivist point of view, researchers attempt to understand how participants perceive a situation (Deetz, 1996). Saunders et al. (2015) suggest that interpretivism is suitable for research studies set within a strong social context. Although Myers & Avison (2002) believe that qualitative studies can be applied in any research philosophy (positivist, critical and interpretivist), Goldkuhl (2012) and Thanh & Thanh (2015) found that studies which follow the interpretivist approach are qualitative in nature. Collis & Hussey (2009) agree that the interpretivist approach is qualitative in nature because it tries to examine the *how* and *why* of a situation. Differences between the positivist and interpretivist approaches are highlighted in Table 2.2.

Table 2-2: Features of positivism and Interpretivism (Collis & Hussey, 2009).

Positivism	**Interpretivism**
Uses large samples.	Uses small samples.
Has an artificial location.	Has a natural location.
Is concerned with hypotheses testing.	Is concerned with generating theories.
Produces precise, objective, quantitative data.	Produces rich, subjective, qualitative data.
Produces results with high reliability but low validity.	Produces results with high validity but low reliability.
Enables results to be generalised, from the sample to population.	Enables findings to be generalised, from one setting to another similar setting.
Uses methodologies such as surveys, experimental studies and cross-sectional studies.	Uses methodologies such as case studies, grounded theory and action research.

In addition to positivism, critical research and interpretivism, other DSR studies have adopted pragmatism (Patsopoulos, 2011).

2.4.1.4. Pragmatism

When it cannot be clearly determined if a study should adopt an interpretivist or positivist point of view, then pragmatism is a suitable choice (Saunders et al., 2015). March and Smith (1995) and Hevner et al. (2004) identify pragmatism as a paradigm relevant to DSR. Pragmatism emphasises the need to investigate "knowledge" through "practical activity" (Cornish & Gillespie, 2009, p. 7). Thus, Kelder et al. (2005) and Levy & Hirschheim (2012) opine that knowledge only becomes usable once it has been applied within the context, and within the time suggested.

The *epistemology* and *ontology* of each of these major paradigms, as provided by Wahyuni (2012), are listed below:

Table 2-3: The Epistemology and Ontology of the different paradigms.

Paradigm	**Epistemology**	**Ontology**
Positivism	Only observable phenomena can provide credible data, facts. Focuses on causality and law-like generalisations, reducing phenomena to simplest elements.	External, objective and independent of social actors.
Interpretivism	Subjective meanings and social phenomena. Focuses on the details of situations, the reality behind these details, subjective meanings and motivating actions.	Socially constructed, subjective, may change, multiple.

Paradigm	Epistemology	Ontology
Critical research	Only observable phenomena can provide credible data, facts. Focuses on explaining within a context, or contexts.	Objective. Exists independently of human thoughts and beliefs or knowledge of their existence, but is interpreted through social conditioning (critical realist).
Pragmatism	Either, or both, observable phenomena and subjective meanings can provide acceptable knowledge, dependent upon the research question. Focuses on practically applied research, integrating different perspectives to help interpret the data.	External, multiple, view chosen to best achieve an answer to the research question.

The use of different paradigms and philosophies in a single study is not a new process but has previously been mentioned in literature (Orlikowski & Baroudi, 1991; Mingers, 2001). The purpose of combining paradigms and philosophies is to produce a better research work in the process (Mingers, 2003). Thus, the theoretical grounding of this study is that the overall research paradigm adopted in this study is pragmatism. Pragmatism was selected mainly because its applications helped in the development of the *Namibian Digital Health Innovation Ecosystem Framework* using design science process of Peffers et al. (2008). Pragmatism is suitable for studies that adopt a design science research design and strategy (March & Smith, 1995) and has also been described as a practical approach (Cornish & Gillespie, 2009). This fits the aim of this study which is to produce a framework (artefact) which can be applied within a particular context.

Interpretivism was applied in the second and third phases of the study which dealt with the evaluation and validation of the framework. Qualitative data, collected from KPs and global experts, was analysed using triangulation and the hermeneutic circle. Positivism was applied with the use of the Delphi method, as well as Statistical Package for Social Sciences (SPSS) software version 21, to measure central tendency (mean) and dispersion level (standard deviation, SD).

The second phase of the study involved the development and evaluation of the initial framework in which KPs in Namibia had to rank the different components of *Digital Health, Innovation* and *Digital Ecosystems*. Interviews were also conducted with said KPs. The ranking of the components of *Digital Health, Innovation* and *Digital Ecosystems* involved quantitative analysis and thus a positivist approach was applied (Rubin & Rubin, 2011). The interviewing of KPs, as discussed in Chapter 5 (section 5.23), adopted interpretivism.

The third phase of the study involved the ranking of the components of *Digital Health, Innovation* and *Digital Ecosystems.* This ranking was done by global experts and analysed in a qualitative manner as a closed-ended questionnaire was applied. The analysis of the rankings adopted interpretivism.

The purpose of the interviews in the second phase of the study, as well as the open-ended questions contained in the questionnaires administered to global experts, was to understand the perceptions of the participants towards *Digital Health* and *Digital Health Innovation Ecosystems*. Interpretivism was used as a strategy to facilitate an understanding of the findings of the interviews and responses to open-ended questions, by Namibian KPs and global experts, as contained in Phases 2 and 3.

An overview of paradigms, research methodologies and data collection methods adapted and combined from Mackenzie & Knipe (2006:5-6); Mertens (2005:9) and Creswell (2003:13), are listed below:

Table 2-4: An overview of paradigms, research methodologies and data collection methods.

World view or paradigm				
Positivist/ Post-positivist	**Constructivist/ Interpretivist**	**Transformative**	**Participatory**	**Pragmatist**
Experimental Quasi-experimental Correlation Reductionism Theory verification Causal Comparative Determination Normative	Naturalistic Phenomenological Hermenutic Interpretivist Ethnographic Multiple participant meanings Social/historical construction Theory generation Symbolic interaction	Critical theory Neo-Marxist Feminist Critical race theory Freirean Participatory Emancipatory Advocacy Grand narrative Empowerment issue orientated Change orientated Interventionist Queer theory Race specific Political	Political Empowerment issue oriented Collaborative Change oriented (the participatory paradigm can also be categorised under the transformative paradigm)	Consequences of actions Problem-centered Pluralistic Real-world practice Mixed models
Prime methods of particular worldview or paradigm				
Mostly quantitative Not only	Mostly qualitative Not only	Qualitative Quantitative Mixed methods	Qualitative Quantitative Mixed methods	Either qualitative or quantitative matching purpose
Data collection methods (Examples)				
Experiments Quasi-experiment Tests Scales	Interviews Observations Document reviews Visual data analysis	Diverse range of tools- particular focus on diverse participants	Diverse range of tools – particular focus on diverse participants	May include tools from positivist/interpretivist; e.g. interviews, observation, testing and experiments

The next section discusses the impact of DSR as a methodology.

2.4.2. Impact of Design Science Research

Design science is a strategy that "creates and evaluates IT artefacts intended to solve identified organisational problems" (Hevner et al., 2004, p. 77). The artefacts are modified until the final rendition of the artefact meets the solution criteria to the problem (Peffers et al., 2008). The four types of artefacts identified in literature are: constructs, models, methods and instantiations (March & Smith, 1995). However, the artefact in this study is labelled as f*ramework* and can be regarded as an instantiation (as explained in Chapter 1, section 1.5). The framework consists of components that make up a *Digital Health Innovation Ecosystem* for the Namibian context, perceived benefits, potential stakeholders of the *Digital Health Innovation Ecosystem* and strategies to be put into place for *Digital Health* to be established in Namibia. Design science has been applied in different fields including architecture (Krauss & Lichtenstein, 1999), software engineering, computer science (Morrison & George, 1995) and Information Systems (Huppatz, 2015). Hevner (2007, p. 91) postulates that that which makes design science unique is "relevance cycle and rigor cycle" which enhances the process of creating innovative solutions. Hevner (2007) further highlights three cycles relevant to design science namely: the rigour cycle (informs the research based on alignment of the already known facts), relevance cycle (the applicability of the artefact within its desired context) and design cycle (the process of developing and improving the artefact). Recently, a fourth cycle was added by Drechsler and Hevner (2016) namely the change and impact cycle (relates to the overall impact of the artefact on a larger context) as illustrated in Figure 2-1.

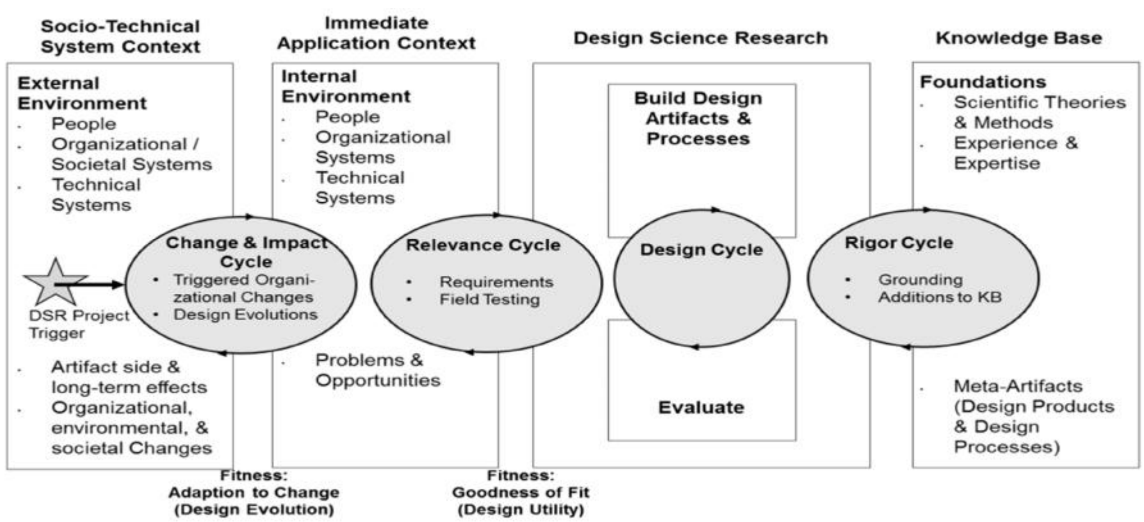


Figure 2-1: The four cycle view of Design Science Research (Drechsler & Hevner, 2016).

In the next paragraphs, each of the cycles is described and the way in which they informed the development of the *Digital Health Innovation Ecosystem Framework* is subsequently discussed.

2.4.2.1. Relevance Cycle

The relevance cycle initiates DSR with an application context that not only outlines the requirements for the research (e.g. the opportunity/problem to be addressed) as inputs, but also defines acceptance criteria for the ultimate evaluation of the research results (Hevner, 2007).

The *Namibian Digital Health Innovation Ecosystem Framework* can inform other developing countries in respect of similar initiatives, where appropriate. Identified requirements were peer reviewed by experts (or published in peer-reviewed publications) for validation and to ensure that the artefact design had a solid foundation. The individual component requirements provided the input for the design cycle and were used to collect data and evaluate the artefact.

2.4.2.2. Rigour Cycle

The rigour cycle provides the ecosystem with existing knowledge to thus ensure innovation. It is contingent on the researchers to thoroughly research and reference the knowledge base and so guarantee that the produced designs are research contributions, and not routine designs based on the application of well-known processes (Hevner, 2007). Additions to the knowledge base, resulting from the DSR, will include any extensions made during the research, the new artefact (ecosystem) and all experiences gained from performing the research and field testing the artefact in the application environment (Hevner et al., 2004; Hevner, 2007). This is where the validation and evaluation of the initial framework was informed by knowledge professionals from Namibia.

2.4.2.3. Design Cycle

The internal design cycle of research activities iterates more rapidly than the relevance and rigour cycles between the development of technological rules, the construction of an artefact, its evaluation and subsequent feedback towards further refining the design (Carlsson, 2006; Hevner, 2007). Simon (1996) describes the nature of this cycle as generating design alternatives and evaluating said alternatives against requirements, until a satisfactory design is achieved. In this study, the design cycle involves the development and evaluation of the ecosystem in Namibia and by global experts.

Based on recent literature that highlights the dynamic and increasingly complex nature of IS research which necessitates an agile approach to the design process, Drechsler and Hevner (2016) added a fourth cycle to the initial three-cycle view of the DSR process.

2.4.2.4. Change and Impact Cycle

The addition of a fourth cycle, referred to as the Change and Impact (CI) cycle, by Drechsler & Hevner (2016) was necessary when researchers considered the secondary or longer-term impact of the artefact in and on societal environments. During the change and impact cycle, Drechsler & Hevner (2016) propose that one distinguishes between an artefact's immediate application context (where users find themselves within their environment) and the encompassing socio-technical system (within which the immediate application context is a subsystem). This cycle therefore indicates the long-term effects, as well as the unintended side-effects that a traditional artefact utility evaluation may not be designed to capture. The fourth cycle is directly relevant to the work in hand as this is where the influence of people and systems in a specific context indicates what needs to be done to adapt, or improve, the artefact to have greater impact. This cycle also showed its impact on the users involved during this intervention. This became evident during the evaluation of the KPs within the Namibian context (Chapter 5).

2.4.2.5. Design science process

Peffers et al. (2008) proposed the design science process in which design science activities are to be conducted. The process consists of six stages: problem identification and motivation, objectives for a solution, design and development, demonstration, evaluation and communication. The process is illustrated in the following figure.

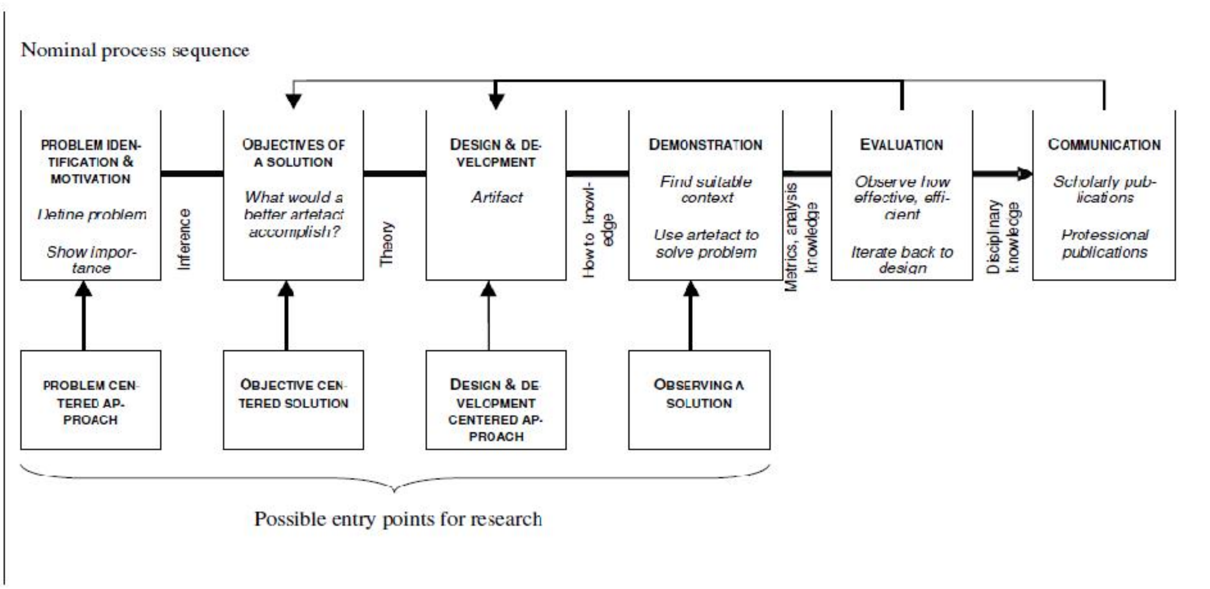


Figure 2-2: The design science research process of Peffers et al. (2007).

The design science process illustrated above was adapted for this study and was applied as follows:

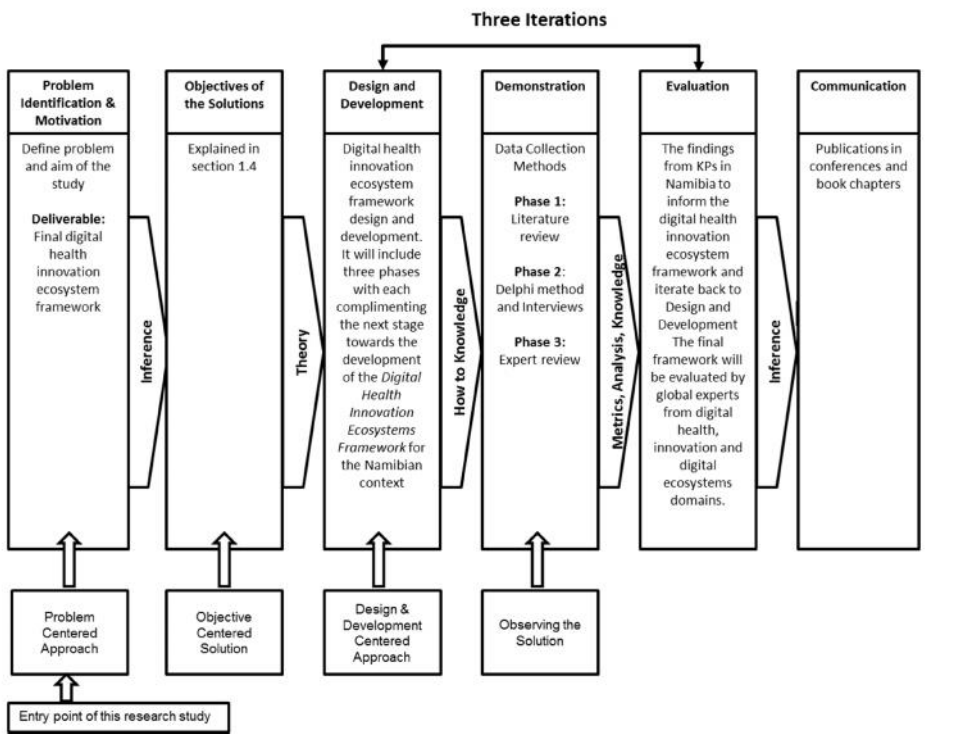


Figure 2-3: Applying the Peffers et al. (2008) process.

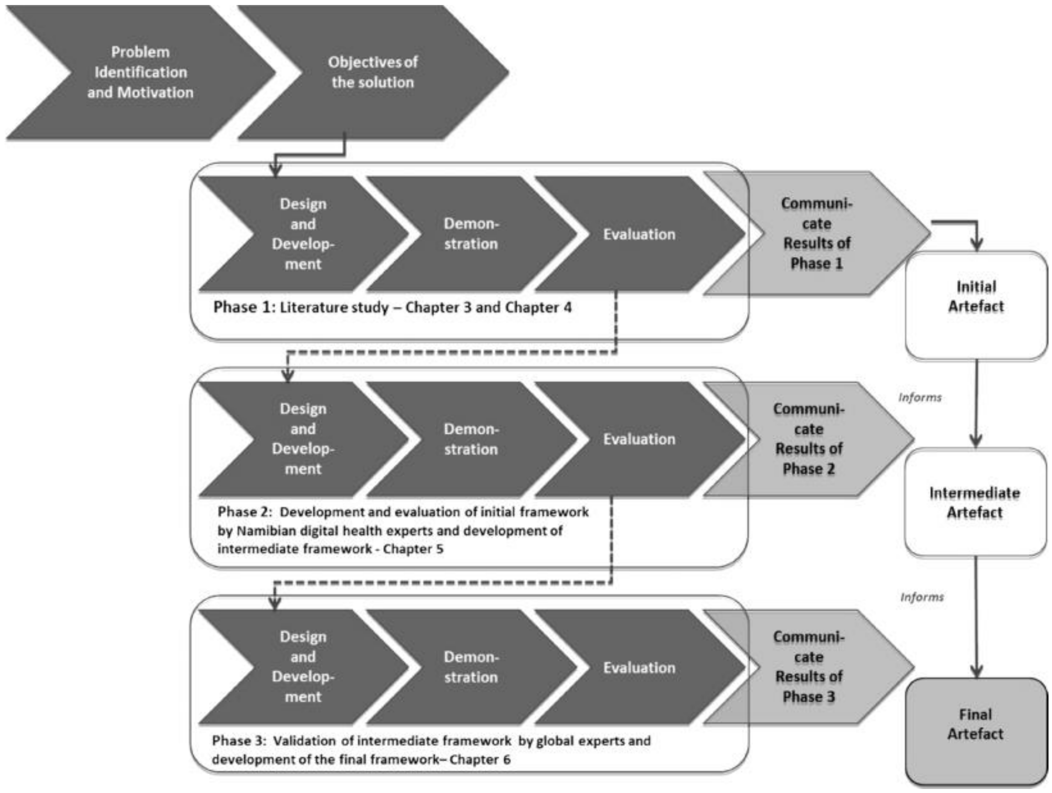


Figure 2-4: Detailed process in each phase.

As illustrated in Figure 2.4, Phase 1 focused on the literature study which led to the development of the initial framework. Phase 2 focused on the development and evaluation of the initial framework by *Digital Health, Innovation* and *Digital Ecosystems* KPs within the Namibian context and the development of the intermediate framework. Phase 3 focused on the development and validation of the intermediate framework by global experts and the development of the final framework.

The guidelines for carrying out design science research are explained in the next section.

2.4.2.6. Guidelines for carrying out Design Science Research

Hevner et al. (2004) provide guidelines for carrying out Design Science Research. Table 2-4 lists each guideline, its description and how it was applied in the study.

Table 2-4: Guidelines for carrying out design science research (Hevner, 2004).

Guideline	Description	Application to this Study
Guideline 1: Design as an Artefact	Design-science research must result in the creation of a practical artefact in the form of constructs, models, methods or instantiations.	The study identified the components that constitute Digital Health Innovation Ecosystems for the Namibian context. The artefact is designed as an instantiation and involves different phases (1-3).
Guideline 2:	Design science research aims	The problem identified in this study refers to the lack

Guideline	Description	Application to this Study
Problem Relevance	at building up technology-based solutions to inherent and relevant business problems.	of information sharing among healthcare practitioners, healthcare institutions and patients in the Namibian context because of organisational policies and competitions among healthcare practitioners and health institutions in Namibia. The framework will provide a possible solution towards addressing this problem and ensuring that the public healthcare sector in Namibia recognises the importance of understanding the relevance and applicability of *Digital Health*, *Innovation* and *Digital Ecosystems* in their context to affect change.
Guideline 3: Design Evaluation	The design artefact must be thoroughly evaluated through well-executed methods to yield utility, quality and usefulness.	The framework was refined during the different phases, starting from the extensive literature reviews, evaluation of *Digital Health*, *Innovation* and *Digital Ecosystems* by KPs within the Namibian context through the Delphi study and the validation of the components of *Digital Health*, *Innovation* and *Digital Ecosystems* by global experts through expert reviews. The final framework incorporated all the changes suggested in each phase.
Guideline 4: Research Contributions	Design science research needs to offer new and acceptable contributions in the fields of design artefact, design foundations and/or design methodologies	The framework is expected to provide useful insights for the implementation of a Digital Health Innovation Ecosystem within the Namibian context.
Guideline 5: Research Rigor	Design science research employs rigorous methods in the construction and evaluation of the design artefact to ensure coherence and consistency.	To maintain rigour, different approaches were applied in the study. Firstly, literature was used to identify components of *Digital Health*, *Innovation* and *Digital Ecosystems* which have been validated previously. Secondly, to make the components relevant to the Namibian context, primary data was gathered from the Namibian context through questionnaires and interviews. Thirdly, questionnaires were also used to gather data from global experts to validate the framework.
Guideline 6: Design as a Search Process	The creation of an effective artefact requires consideration of the problem environment and mechanisms that can find an effective solution.	Some of the research questions were answered using literature reviews to identify relevant components of *Digital Health*, *Innovation* and *Digital Ecosystems*.
Guideline 7: Communication of Research	Design-science research must be communicated effectively, both to technology-oriented as well as management-oriented audiences.	The findings of the study have been published in the form of conference papers and book chapters.

2.4.3. Qualitative and *quantitative data collection techniques*

Qualitative research is used to explore and understand a social, or human, problem from the individual's perspective. The research process includes: the combining of processes and questions, inductive analysis, building from facts to more general themes and interpreting of data (Creswell, 2014).

In this study both qualitative (document analysis, semi-structured interviews, expert reviews, literature reviews) and quantitative (Delphi methods and descriptive statistics) data collection techniques were applied. Different authors have identified the different data collection techniques that can be applied in research (Iyamu, 2015; Kawulich, 2005; Gill et al., 2008; Driscoll, 2011; Saunders et al., 2015). The applicable data collection techniques are explained below:

2.4.3.1. Interviews

Driscoll (2011) and Iyamu (2015) emphasise that interviews allow the researcher to interact with the participants. Gill et al. (2008) posit that there are three types of interviews namely: structured, unstructured and semi-structured interviews. Lindlof & Taylor (2002) indicate that in structured interviews the questions are set prior to the interview and these exact questions must then be answered by the participants. However, Saunders et al. (2009, p. 21) refer to unstructured interviews as “informal” methods in which the interview is guided by the conversation between the researcher and the participant. In semi-structured interviews, questions originally set by the researcher may be modified based on the flow of conversation between the researcher and the participant (Iyamu, 2015).

Semi-structured interviews were conducted with KPs, within the Namibian context, to understand the perceived benefits of *Digital Health Innovation Ecosystems* within the Namibian context, potential *Digital Health Innovation Ecosystem Stakeholders* for the Namibian context and the strategies that need to be put in place for *Digital Health* to be established within the Namibian context. Each interview lasted approximately 25 minutes and was recorded and subsequently transcribed. The number of KPs who participated in the interviews is presented in Chapter 5 (section 5.6).

2.4.3.2. Document analysis

This refers to the process of analysing existing documents which can then provide useful insight into subject matter. Bowen (2009) posits that document analysis is popular in studies which adopt the qualitative research method. Documents analysis can also be used to validate previous studies (Iyamu, 2015). In this study documents from the Namibian government were analysed to determine whether the concepts *Digital Health, Innovation* and *Digital Ecosystems* were addressed at all.

2.4.3.3. Expert reviews

Expert reviews are essential in corroborating the outcomes of research studies (Klein & Richey, 2007). Therefore, to determine whether a proposed solution is relevant to the problem being addressed, it is important that expert opinions be solicited. Expert reviews were employed in Phase 3 of the study. To corroborate the outcome of the findings derived from KPs in Namibia, a panel of global experts were requested to validate the findings. The findings from the expert reviews, presented in Chapter 6, helped to finalise the framework for this study. The number of expert reviewers who participated in the study is presented in Chapter 6 (section 6.3.1)

2.4.3.4. Questionnaires

Per Siniscalco & Auriat (2005), questionnaires may be open-ended, closed or contingent. The difference between a closed and open-ended questionnaire is that closed questionnaires result in restrained answers by participants while open-ended questionnaires provide for flexibility as participants are allowed to express their views (Siniscalco & Auriat, 2005). In Phases 2 and 3 of the study, questionnaires (which included both open- and closed-ended questions) were used to solicit feedback regarding the ranking of the components *Digital Health, Innovation* and *Digital Ecosystems,* as relevant to the Namibian context, by KPs in Namibia and global experts. In Phase 3 of the study, questionnaires were used to solicit feedback on the ranking of the components of *Digital Health, Innovation* and *Digital Ecosystems* relevant to the Namibian contexts by experts globally.

2.4.3.5. Literature reviews

Literature reviews are conducted to evaluate the views of other researchers regarding a research area (Leedy & Ormrod, 2012). Cronin, Ryan & Couglan (2008) also explain that the purpose of a literature review is not only to ensure that extensive enquiry has been carried out on a research area, but also to provide a good reason to validate further research in a particular research area. A literature review is needed to gain useful insight regarding the area being studied, and to establish whether further research is warranted. In addition, Strauss & Corbin (1998) emphasise that ideas which have not been explored in previous studies are identified when a literature review is properly conducted. During the first phase of the study, literature reviews were used to gather relevant information on the components of *Digital Health, Innovation* and *Digital Ecosystems* (Chapter 3) and how *Digital Health, Innovation* and *Digital Ecosystems* were applied in developed and developing countries (Chapter 4). The purpose of the literature review was to answer the research questions which were posed in Chapter 1 (section 1.4). Two different types of literature reviews where conducted in the study. In Chapter 3, a systematic literature review was adopted and in Chapter 4 a scoping review was applied. Chapter 2 identifies the components of *Digital*

Health, Innovation and *Digital Ecosystems*. Chapter 4 identifies evidence of *Digital Health, Innovation* and *Digital Ecosystems* in developing countries. The findings garnered from Chapters 3 and 4 helped in the creation and building of the initial framework, as presented in Chapter 5.

2.4.3.6. Delphi method

One approach which is regularly used to gather consensus on the rankings of experts, is the Delphi method (Evans et al., 2016; Morgan et al., 2016; Jiang et al., 2016). The Delphi method was also applied in this study. The Delphi method allows for a process of collecting information from knowledgeable participants, usually referred to as *experts*, through a repetitive process until the judgements of all participants correlate (Hsu & Sandford, 2007; Morgan et al., 2016). The Delphi method uses a process called *rounds* to solicit feedback from participants (Hsu & Sandford, 2007). A different number of rounds is applied to each individual study. Studies may include two rounds (Evans et al., 2016), three rounds (Morgan et al., 2016; Jiang et al., 2016). Hsu & Sandford (2007) suggest that the number of Delphi rounds can even be as many as four. Literature seems to suggest that the number of rounds applied in the Delphi method should be no less than two. At the end of each round, the results are statistically analysed and the anonymous responses of each participant are shared with all participants with a chance to modify the feedback (Hsu & Sandford, 2007). This process is repeated until participants' feedback reaches a consensus. The key point to note in Delphi studies is that the participants remain anonymous, thus possible dominance of an opinion aired by a particular influential participant is limited (Hsu & Sandford, 2007). The instrument most commonly used in Delphi studies is questionnaires (Rådestad et al., 2013; Morgan et al., 2016; Evans et al., 2016). Questionnaires were also used in this study to solicit feedback from KPs in Namibia. These findings are considered very important to the study as they inform the ratings of the global experts. The adoption of a method which allows for iteration and feedback from KPs in Namibia was thus necessary in order to reach consensus amongst the participants (Morgan et al., 2016). An in-depth discussion of the application of Delphi method, and the number of participants who participated in the Delphi rounds, is provided in Chapter 5 (section 5.6.1).

The next section explains the data analysis techniques.

2.4.4. Data analysis techniques

After conducting a research study, data should be analysed to fully comprehend what the findings indicate. Prasad (2002), Patterson & Williams (2002), Saunders et al. (2015) and Schutt (2009) identify different forms of data analysis which include descriptive statistics, hermeneutics, content analysis and grounded theory. Some of these data analysis techniques are described below:

2.4.4.1. Hermeneutic analysis

Prasad (2002) indicates that hermeneutics can be used for data analysis when conducting interpretive research. Hermeneutics is mainly used in interpretive research as they help one to “understand the meaning of data or text analogues” (Coleman, 2010:138). Boell & Cecez-Kecmanovic (2010) illustrate the hermeneutic cycle of reviewing literature as follows:

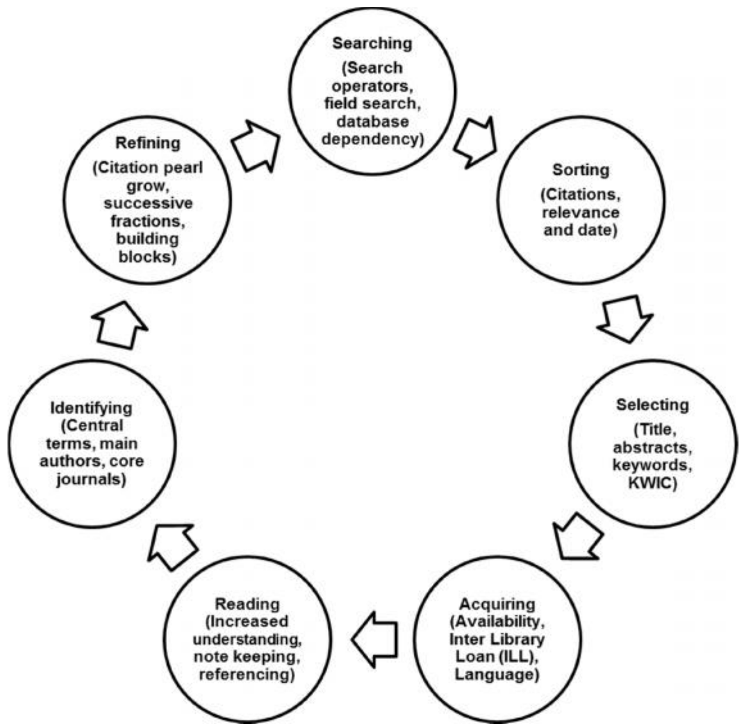


Figure 2-5: The hermeneutic circle, as adapted from Boell & Cecez-Kecmanovic (2010).

As indicated in Figure 2-5, the hermeneutic circle of analysing literature goes through seven stages. These stages involve: finding relevant information, checking the relevance of the information found, selecting the relevant information applicable to the study, gaining access to the information needed, using the information for the relevant purpose, selecting the exact information to be used and adapting the information to fit the purpose of the study. Applying hermeneutics as a data analysis technique is relevant in this study as the text derived from the interviews and literature review needs to be understood. The processes, as illustrated in the hermeneutic circle, were adapted align with this study and are presented in Chapters 3 and 4, respectively. The hermeneutic process was also applied to the interviews (Chapter 5) and open-ended questions (Chapter 6).

Other aspects of hermeneutics, including fusion horizon and dialogue (Aylesworth, 1991), were also be applied in the study. Fusion horizon is based on the understanding that the researcher has previous knowledge of the research topic (Koch, 1996). Fusion horizon is applied in this study as the findings from the literature review facilitated the creation of the initial *Digital Health Innovation Ecosystems framework* (Chapter 5). The initial *Digital Health Innovation Ecosystem Framework* was thus based on the researcher's understanding of the literature. The initial *Digital Health Innovation Ecosystem Framework,* as presented in Chapter 5, was evaluated using the Delphi method and consequently validated through expert reviews (Chapter 6).

Per Aylesworth (1991), the researcher has a dialogue with the findings generated from the study until the research objectives are met. Dialogue was applied in this study, specifically in Chapter 7 wherein the researcher investigated whether the research objectives of the study had been met.

Table 2.5 explains how the fundamental principle for conducting and evaluating interpretive studies (Klein & Myers, 1999) were applied in this chapter.

Table 2-5: Applying the fundamental principle of conducting and evaluating interpretive studies (adopted from Klein & Meyers, 1999).

Fundamental principle for conducting and evaluating interpretive studies	**How and where were they applied in this study?**
The fundamental principle of the hermeneutic circle. This suggests that all human understanding is achieved through an iteration between: considering the interdependent meaning of parts and considering the whole which they form. This principle of human understanding is fundamental to all the other principles.	Data was collected during the literature review, as discussed in Chapters 3 and 4, and was analysed in parts, and in whole. Data collected during interviews (Chapter 5) and questionnaires from expert reviews (Chapter 6) were analysed in parts, and in whole.
The principle of contextualisation. This requires critical reflection of the social and historical background of the research setting to shed light on how the current situation under investigation emerged.	Description of the contextual setting was provided in Chapter 5, section 5.4. The background of the KPs and experts were also described in Chapter 5, section 5.6.1 and Chapter 6, section 6.3.1.
The principle of interaction between the researcher and the subjects. This requires critical reflection on how the research materials (or "data") were socially constructed through interaction between the researcher/s and participant/s.	Interaction between the researcher and the KPs in Namibia was initiated through interviews.
The Principle of Abstraction and Generalisation. This requires relating the idiographic details revealed by the data interpretation through the application of the first and second principles in this table to theoretical, general concepts that describe the nature of human understanding and social action.	The findings from the interviews and questionnaires administered to global experts were analysed specifically in the context of the *Digital Health Innovation Ecosystem Framework* for the Namibian context.
The Principle of Dialogical Reasoning. This requires sensitivity to possible contradictions between theoretical preconceptions, guiding the research design, and actual findings ("the story which the data tell"), with subsequent cycles of	The evaluation and validation of framework were done considering the literature discussed in Chapters 3 and 4.

Fundamental principle for conducting and evaluating interpretive studies	**How and where were they applied in this study?**
revision.	
The Principle of Multiple Interpretations. This requires sensitivity to possible differences in interpretations among the participants, as are typically expressed in multiple narratives or stories of the same sequence of events under study. Similar to multiple witness accounts, even if all tell it as they saw it.	KPs in Namibia, as well as global experts, were selected to evaluate and validate the framework. .
The Principle of Suspicion. This requires sensitivity to possible "biases" and systematic "distortions" in the narratives collected from the participants.	Data collection for each participant was done individually. The study also employed different data collection techniques including questionnaires, interviews and literature review.

2.4.4.2. Descriptive statistics

Per Saunders et al. (2009, p. 444), descriptive statistics "describe (and compare) variables numerically." This suggests that descriptive statistics deal with quantitative data. Descriptive statistics can be done using tables and graphs (McHugh & Villarrvel, 2003), central tendency (mean), or dispersion level (standard deviation, SD) (Rådestad et al., 2013). This study adopted descriptive statistics for analysing data collected through questionnaires during each Delphi round. Descriptive statistics were selected to quantify the data to determine whether for each component consensus had been reached by the participants. The percentage, as well as the mean and SD, was provided.

2.4.4.3. Thematic analysis

Judger (2016) posits that thematic analysis is associated with interviews in terms of analysing the findings. Braun & Clarke (2006) postulate that one of the benefits of using thematic analysis is that it can provide meaning to data in a way which is understandable. Braun & Clarke (2006) suggest thematic analysis helps the researcher to better grasp the relevant literature. The concepts of *Digital Health*, *Innovation* and *Digital Ecosystems* as themes in an analysis can provide a relevant contribution to the development of the *Digital Health Innovation Ecosystem Framework*. Thematic analysis was applied in the analysis of interviews with KPs in Namibia to identify themes in relation to the findings provided by the participants. Thematic analysis was applied in the analysis of the open-ended questions from the questionnaire administered to global experts. Hyper Research 3.7.3 software was used to code the data.

2.4.4.4. Content analysis

Leedy & Ormrod (2001, p. 155) define content analysis as "a detailed and systematic examination of the contents of a particular body of materials for the purpose of identifying patterns, themes, or biases." This definition suggests that the main purpose of content analysis is to investigate the similarities, or differences, in the data being analysed. Content analysis can be applied in both qualitative and quantitative studies (White & Marsh, 2006). Bengtsson (2016) describes content analysis as a technique for understanding the content of the data being analysed. Content analysis was applied in the literature review phase (Chapters 3 and 4), in which the content of the literature search was analysed until themes were generated.

2.4.4.5. Coding and analysis

Once the data has been collected it must be processed and analysed (Creswell, 2014). The processing of data involves editing, coding, classifying and tabulating the collected data so that it is ready for analysis (Leedy & Ormrod, 2012). Conversely, analysis involves breaking data into manageable themes, trends, patterns and relationships (Leedy & Ormrod, 2009).

Quantitative data is used to produce tables and averages, while qualitative data is reduced by grouping textual material into categories (Stake, 2005). The analysis procedures used by the researcher are determined by the type of data collected (quantitative or qualitative). The main themes from the concepts (*Digital Health, Innovation* and *Digital Ecosystems*) were identified from the collected data. The coding categories used were mainly drawn from the theoretical lens obtained from the literature review. The emergent categories were then organised into tables and nodes to facilitate comparison between the participants, which enabled a holistic case analysis (Creswell, 2014).

Reading or data immersion: This was done to understand the content and familiarise the researcher with the data. Further, emergent themes were identified and tentative explanations developed. During this process the quality of data obtained was also assessed.

Responses from the semi-structured interviews and questionnaires were coded, and categorised, to highlight the characteristics of selected resources and guide the researcher towards presenting the final artefact (*Namibian Digital Health Innovation Ecosystem Framework*). Coding enabled the researcher to retrieve and group data (Oates 2006; Creswell, 2014). Coding can occur as *inductive coding* where no pre-set codes are determined and the data is used to reveal probable codes or *priori coding* where codes are developed before the data is collected (Myers & Avison, 2002). This was done in the case of the interviews and during literature acquisition on the pre-defined concepts of *Digital Health*, *Innovation* and *Digital Ecosystem* as well. This process was necessary for the development of the *Digital Health Innovation Ecosystem* for this study.

The analysis process is conducted to provide an understanding of various constitutive elements of data by inspecting the relationships between constructs, concepts, or variables, and by then determining the elements of data that can be isolated, or by establishing themes in the data. We may, therefore, conclude that data analysis helps in summarising the collected data and organising it in such a way that it can answer the research question(s). In this study data obtained from the research instruments was transcribed and coded.

Data transcription: The first data transcribed was that captured from the questionnaires. The Delphi method assisted with the expert reviews and interview transcripts were made from the digital recordings of the interviews.

For **qualitative data** analysis, various approaches have been proposed in the literature. For analysing case studies, Yin (2009) suggests the following methods:

- Pattern matching: This method of case study analysis compares an empirical pattern (observed) to a predicted pattern (hypothesis).
- Explanation building: This method focuses on building a detailed explanation about the case under investigation. The aim is to describe *how* or *why* something has happened.
- Time series analysis: This method is concerned with the match between the trend observed in the data and the trends previously stated in the literature regarding the phenomena under investigation.
- Logic models: This involves matching the events observed in the data to the events predicted prior to the study, based on theory.

Quantitative data refers to data that is numeric, the values of which can be measured numerically as quantities (Saunders et al., 2015). Oates (2008) identifies four types of quantitative data which the researcher needs to be aware of when conducting quantitative data analysis. Leedy & Ormrod (2012) identify four scales of measurement for quantitative data, arguing that any form of analysis for quantitative data will fall onto one of these scales:

- Nominal scale of measurement: This type of scale describes categories such as gender.
- Ordinal scale of measurement: This type of scale asks respondents to rank the items. This scale measures in terms of values such as *more* or *less*, l*arger* or *smaller,* without specifying the exact value.
- Interval scale of measurement: In interval data, the researcher can indicate the difference between any two data values on an interval scale. This scale measures in terms of equal intervals, or degrees.
- Ratio scale of measurement: This is the same as the interval scale of measurement, the only difference being that there is a fixed and absolute zero value.

For this study, Namibian KPs had to rank the components of the concepts and the ordinal scale of measurement was applied. The interval scale, and ratio scale, of measurement was also applied in Chapter 5 (where SPSS software package was used).

SPSS enables one to "accommodate designs with empty cells, to more readily interpret the results using profile plots of estimated means, and to customise the linear model so that it directly addresses the research questions one asks" (SPSS Library, 2011, p. 25).

2.4.4.6. Data analysis tools used in this study

Three main software application tools facilitated data analysis in this study: Microsoft (MS) Access 2007, SPSS version 21 and MS Excel 2010. MS Access is a database management tool that forms part of the Microsoft Office Professional package. MS Excel is a mathematical spreadsheet application that is also one of the software applications included in the Microsoft Office package. Finally, SPSS is a Statistical Software Package for Social Sciences. The data, collected through the administration of the survey questionnaire, was captured on a form which was designed and developed in MS Access 2007. MS Access was also used for data cleaning and the initial querying of the data set. Thus, simple exploratory analysis was done in MS Access. Inferential statistical procedures were conducted using SPSS version 21. Any further calculations needed and the graphical representation of data was carried out using MS Excel 2007.

Qualitative data, as obtained from two interviews, was captured with a digital audio tape recorder. The other semi-structured interviews were recorded by means of the researcher's notes.

2.4.5. Population and *sampling*

Gledhill et al. (2008) indicate that purposive sampling is a sampling technique that is widely used in a qualitative research context. Purposive sampling allows the researcher to "select units (e.g. individuals, groups of individuals, institutions) based on specific purposes associated with answering a research study's question" Teddlie & Yu (2007, p. 77). The KPs in Namibia, and global experts, were purposefully selected to include participants who have extensive experience in the related field of *Digital Health, Innovation* and *Digital Ecosystems*. Discussions on the selected KPs in Namibia and global experts are provided in Chapter 5 (section 5.6.1) and Chapter 6 (section 6.3.1), respectively.

The next section explains how triangulation was realised in this study.

2.5. TRIANGULATION USED IN THIS STUDY

According to Denzin (1970, p. 291), triangulation is the “combination of methodologies in the study of the same phenomenon.” Jick (1979, p. 610) believes that triangulation “has vital strengths and encourages productive research.” From the explanations provided by Denzin (1970) and Jick (1979) regarding triangulation, it is suggested that different forms of data collection techniques be used in research studies to thus provide more credibility to the findings.

Denzin (1970) further points out the following forms of triangulation, as explained below:

- Data triangulation, which entails gathering data through several sampling strategies, so that slices of data, at different times and social situations, as well as on a variety of people, are gathered.
- Investigator triangulation, which refers to the use of more than one researcher in the field to gather and interpret data.
- Theoretical triangulation, which refers to the use of more than one theoretical position in interpreting data.
- Methodological triangulation, which refers to the use of more than one method for gathering data.

Kimchi et al. (1991, p. 385) subsequently identifies other forms of triangulation which are explained below:

- **Analysis triangulation** refers to the application of different forms of data “analysis techniques” for evaluating the result of a study.

This study employs different forms of triangulation which are explained below:

- **Methodological triangulation**: The use of literature reviews in Chapters 2 and 3 as well as the use of questionnaires, the Delphi method, interviews and expert reviews constitute different forms of data collection used in this study.
- **Data triangulation:** The use of primary sources (expert review, the Delphi method, interview, questionnaires) and a secondary source (literature review) in the data collection process, as explained in section 5.4, constitutes different forms of data triangulation used in this study.
- **Analysis triangulation:** The use of different forms of data analysis techniques such as hermeneutics, descriptive statistics and thematic analysis constitute different forms of analysis triangulation in the study.

Triangulation was employed to verify findings from independent measures (see Chapter 5, 5.4). To ensure that the test had face validity, the questionnaires were compiled with the assistance of the supervisor and co-supervisors of this project. This ensured that the questions were relevant to the purpose of the study and free from ambiguity in their wording. The aim is to illicit responses that properly relate to the participant's understanding of the concepts (*Digital Health, Innovation* and *Digital Ecosystems*). Triangulation is explained by Oates (2006) as a fundamental technique to validate data through cross verification from multiple sources. Another advantage of triangulation is the amount of data collected that can then be analysed and which can indicate possible patterns (Creswell, 2014).

2.6. ETHICAL CONSIDERATIONS

This study complies with UNISA (2007) research ethics policy which include the following themes:

- **Formal permission:** Formal permission was granted by UNISA before the study was conducted (see Appendix I).
- **Confidentiality:** The confidentiality of participants was protected in the data collection process as the identities of the experts who took part in the study were not revealed.
- **Informed Consent:** The participants who took part in the study were asked to sign an informed consent form and were also told that they could withdraw at any time during the data collection process. Participants who were contacted via email were asked to respond to the email and thus indicate their willingness to take part in the study. This was done to ensure that the experts willingly participated in the study.

2.7. SUMMARY

This chapter mapped the research questions to the research objectives. This chapter also explained the research design used to answer the research questions. Pragmatism was selected as the overall research paradigm for this study while interpretivism and positivism were adopted for data collection and analysis only in Phases 2 and 3 of the research. This chapter also reflected on the use of design science as the main methodology which was supplemented by specific qualitative and quantitative data collection techniques in different phases of the study. The chapter further revealed that hermeneutics, descriptive statistics and thematic analysis were used to analyse the findings. The different triangulation techniques, as well as the ethical considerations, were highlighted. The next chapter will outline the literature study where systematic literature reviews were applied to analyse the concepts: *Digital Health, Innovation* and *Digital Ecosystems*.

CHAPTER 3. COMPONENTS OF DIGITAL HEALTH INNOVATION ECOSYSTEMS BASED ON CONCEPTUAL ANALYSIS

3.1. INTRODUCTION

Chapter 2 described the research processes according to which this study was conducted. This chapter provides a systematic literature review of *Digital Health Innovation Ecosystems*. This chapter aims to:

- Identify what has already been established in existing literature regarding *Digital Health Innovation Ecosystems.*
- Answer the first sub-research question: What are the components of *Digital Health*, *Innovation* and *Digital Ecosystems*?

Figure 3-1 highlights the relevant phases covered in Chapter 3. This chapter contributes towards the development of the *initial framework (artefact)* as the findings from Chapters 3 and 4 will form the foundation of this *initial framework*.

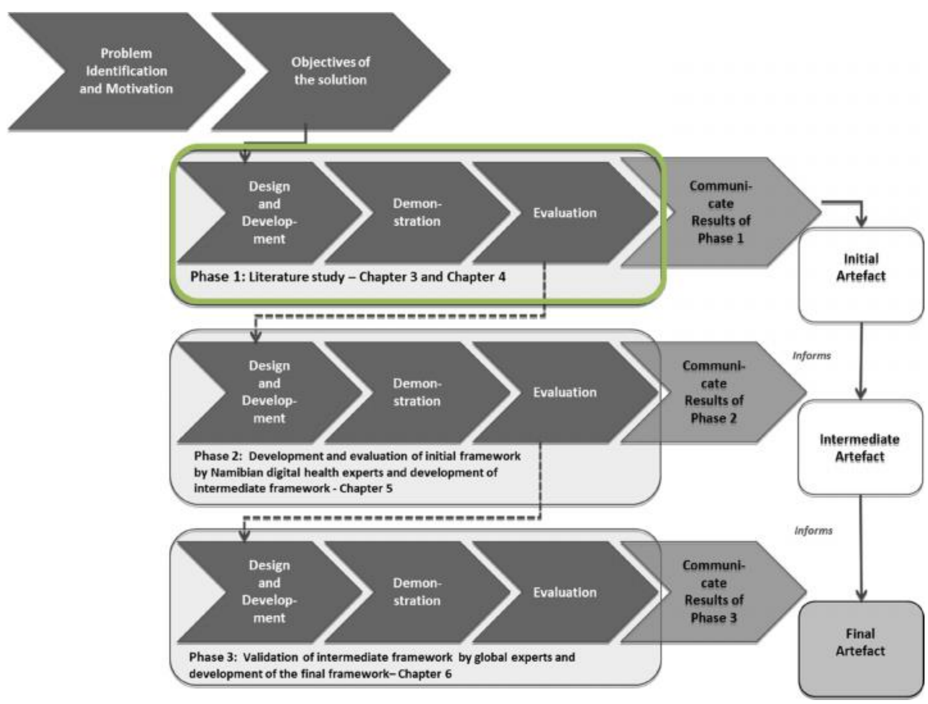


Figure 3-1: Phase 1 of the study consisting of Chapters 3 and 4.

The next section provides an overview of Chapter 3.

3.2. OVERVIEW OF CHAPTER 3

This chapter is divided into four parts:

- Part 1 (section 3.3) discusses how a systematic literature review was conducted for the study.
- Part 2 (section 3.4) presents a discussion on *Digital Health*.
- Part 3 (section 3.5) presents a discussion on *Innovation*.
- Part 4 (section 3.6) presents a discussion on *Digital Ecosystems*. A concept map for a *Digital Health Innovation Ecosystems* is presented in section 3.7 towards the creation of the Initial Artifact, as referred to in Figure 3-1.

3.3. SYSTEMATIC LITERATURE REVIEW

Fink (2010, p. 3) describes a literature review as “a systematic, explicit, and reproducible method for identifying, evaluating, and synthesising the existing body of completed and recorded work produced by researchers, scholars, and practitioners.” Fink’s definition (2010, p. 3) implies that a literature review should adopt a “systematic*”* approach. Furthermore, Okoli (2015) recommends that studies which aim to contribute, rather than summarise existing literature, should adopt a systematic literature review approach.

Petticrew & Roberts (2006) describe systematic literature reviews as “literature reviews that adhere closely to a set of scientific methods that explicitly aim to limit systematic error (bias), mainly by attempting to identify, appraise and synthesise all relevant studies (of whatever design) in order to answer a particular question (or set of questions).”

3.3.1. Steps for conducting a systematic literature review

Okoli & Schabram (2010, p. 7) present the following steps according to which a systematic literature review should be done:

- **Purpose of the literature review**: The first step in any review requires the reviewer to clearly identify the purpose and intended goals of the review. This is necessary for the review to be explicit to its readers.
- **Protocol and training**: In any review that employs more than one reviewer, it is critical that said reviewers be in agreement regarding the detailed procedure to be followed. The creation of a written, detailed protocol document, and training for all reviewers will ensure consistency in the execution of the review.

- **Searching for the literature**: The reviewer needs to explicitly describe the details of the literature search. In addition, he/she needs to explain and justify how the comprehensiveness of the search was assured.
- **Practical screen**: Also known as screening for inclusion, this step requires that the reviewer explicitly explains which studies were considered for review and which were eliminated without further examination (a necessary part of any literature review). For excluded studies, the reviewer must list the practical reasons for their non-consideration and justify how the resulting review can still be comprehensive, given the practical exclusion criteria.
- **Quality appraisal**: Also known as screening for exclusion, the reviewer needs to explicitly detail the judging criteria according to which articles are deemed insufficient quality to be included in the review synthesis. All included articles need be scored for quality, depending on the research methodologies employed by the articles.
- **Data extraction**: After all the studies that should be included in the review have been identified, the reviewer needs to systematically extract the applicable information from each study.
- **Synthesis of studies**: Also known as analysis, this step involves combining the facts extracted from the studies through the use of appropriate techniques, be they quantitative, qualitative, or both.
- **Writing the review**: In addition to the standard principles to be followed in writing research articles, the process of a systematic literature review needs to be reported in sufficient detail so that the results of the review can be independently reproduced.

The next section describes the application of a *systematic literature review* in identifying the components of the following concepts:

- Digital Health,
- Innovation and
- Digital Ecosystems.

3.3.2. Literature sources

An initial search was conducted using Harzing's Publish or Perish software. Harzing's Publish or Perish software retrieves highly cited articles within the context of the topic being studied (Harzing, 2011). While Harzing's Publish or Perish software retrieves important and relevant papers within the field, there is a tendency for important publications on the subject, which have just recently been published and which are not highly cited, to be excluded from the search. Furthermore, Harzing's Publish or Perish software can only retrieve 1 000 papers in the search (Harzing, 2011). Therefore, to present a comprehensive overview of the concepts *Digital Health, Innovation* and *Digital Ecosystems* towards conceptualising components of a *Digital Health Innovation Ecosystem,* and to address the short comings of Harzing's Publish or Perish software, academic databases such as ACM, IEEE Xplore, Scopus and Science Direct, were used. Google scholar was also used to ensure that relevant literature not listed was indeed included in the database search.

3.3.3. Searching the literature

Relevant and well cited publications pertaining to *Digital Health*, *Innovation* and *Digital Ecosystems*, were identified using the Harzing's Publish or Perish software. In the *All of the words* section, the following terms were searched consecutively:

- Components of *Digital Health*
- Components of *Innovation* and
- Components of Digital Ecosystems.

For *the Year of Publication,* 2000 to 2016 was entered for each search.

Similarly, the academic databases ACM, IEEE Xplore and Scopus were searched employing the search keywords *Digital Health, Innovation* and *Digital Ecosystems* from the period 2000 to 2016.

3.3.4. Study inclusion and *exclusion criteria*

The inclusion and exclusion criteria for *Digital Health* were:

- Only publications written in English were included.
- Studies referring to the components of *Digital Health* were included.
- Studies outside the *Digital Health* domain were excluded.
- Studies referring to *Digital Health* ecosystems were included.
- Studies referring to technologies which assist in patient health engagement were included.
- Studies not describing how technologies can be used to support patients or healthcare practitioners were excluded.
- Studies referring to any platform that could be used for patient self-management were included.
- Studies referring to how technologies could be used to facilitate patient doctor interaction were included.
- Patent documents were excluded.

- Studies in which the authors indicated the technologies as components or elements relating to *Digital Health* were included.

The inclusion and exclusion criteria for *Innovation* were:

- Studies referring to what should be included or necessary for innovation were included.
- Studies within the healthcare domain and publications in English were also included.
- Only publications written in English were included.
- Studies referring to the components of innovation were included.
- Studies outside the innovation domain were excluded.
- Studies in which the descriptions, or the purpose, of these components matched the definition of innovation for this study.
- Studies outside the innovation domain, websites which did not have any valid publication date and websites in which information could not be verified were excluded.

The inclusion and exclusion criteria for *Digital Ecosystems* were:

- Only publications written in English were included.
- Studies referring to the components of digital ecosystems were included.
- Studies outside the digital ecosystems domain were excluded.
- Studies referring to what constitutes a digital ecosystem were included.
- Studies referring to digital health ecosystems were included.
- Studies in which the authors indicated the technologies as components or elements relating to digital ecosystems were included.

The following were screened for appropriate search terms: Books, book chapters, journal articles, conference papers, non-academic publications and practitioner case reports.

3.3.5. Data analysis and *selection*

A total of 2 981 publications were retrieved from the Harzing's Publish or Perish software, 1 200 publications were retrieved from academic databases, and 651 publications were retrieved from the Google search engine. A total of 1 862 duplicate publications were removed from the search. The first step in analysing the literature retrieved from the search was to screen the titles and abstracts for relevance to the topic. After titles and abstracts had been screened, 1 738 publications were removed. A total of 1 232 full-text publications were screened and 1 025 publications were removed based on the exclusion criteria. A total of

230 full-text publications met the inclusion criteria for this study. Figure 3-2 illustrates the processes according to which the search was conducted.

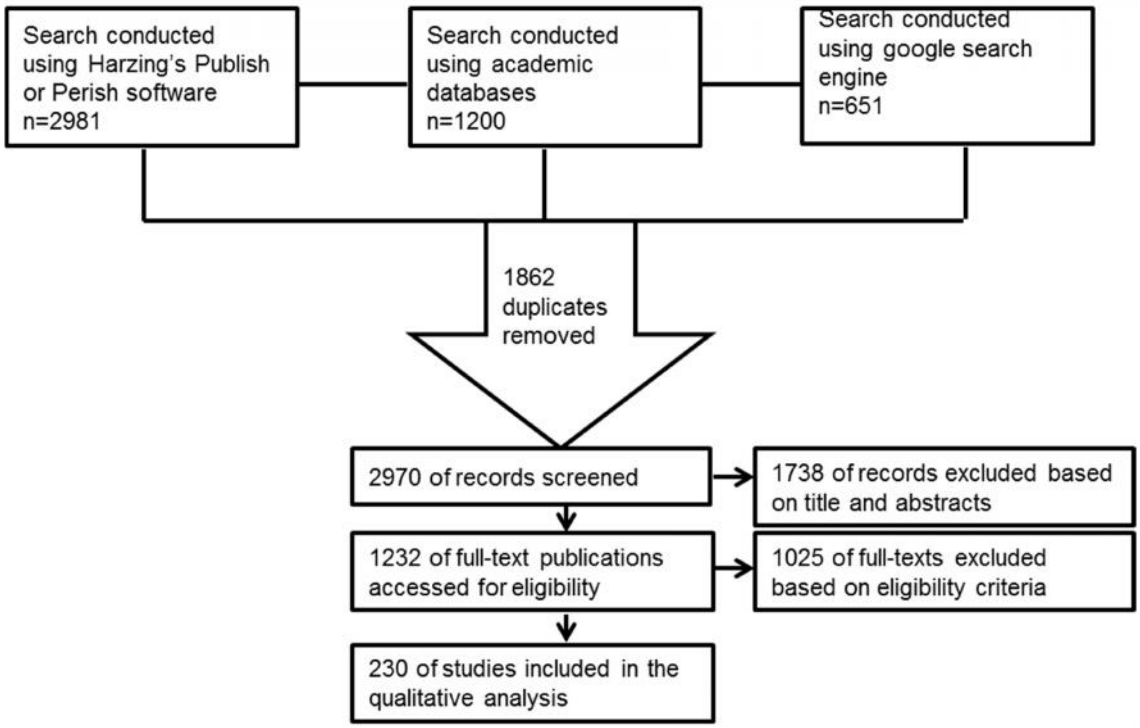


Figure 3-2: Flow chart of search phases for components of Digital Health, innovation and digital ecosystem.

3.4. DIGITAL HEALTH

This next section provides an overview on the findings from the literature study related to *Digital Health*.

3.4.1. Defining Digital Health

Different authors agree that Digital Health involves the use of different healthcare technologies in administering healthcare services to enhance patients' health (Mellodge & Vendetti, 2011; Kotskova, 2015; Robinson et al., 2015). For example, Mellodge and Vendetti (2011, p. 33) refer to *Digital Health* as the "use of digital instruments in monitoring the health or well-being of an individual in need of medical assistance" and Kotskova (2015, p. 1) defines *Digital Health* as the "use of information and communications technologies to improve human health, healthcare services, and wellness for individuals and across populations."

Although Robinson et al. (2015, p. 105), in contrast to existing definitions of *Digital Health*, insist that *Digital Health* “lacks theoretical definition,” Robinson et al. (2015, p. 105) suggest that *Digital Health* is the “use of digital media to transform the way healthcare provision is conceived and delivered” and further posit that *Digital Health* enables patients to “track, manage and improve their own and their family’s health.”

Furthermore, it is suggested that an appropriate definition of *Digital Health* should include those stakeholders involved in healthcare provision and delivery processes. In addition to the definitions of *Digital Health* provided by Kotskova (2015) and Robinson et al. (2015), and for this study, *Digital Health* is defined as: *An improvement in the way healthcare provision is conceived* and *delivered by healthcare providers through the use of information* and *communication technologies to enable patients to track, manage* and *improve their own* and *their family’s health*.

This definition not only encapsulates the tools involved in the delivery of healthcare services but includes patients, as well as healthcare providers involved in the healthcare provision and delivery process. Having explained the definitions of *Digital Health* in selected literature and having provided a definition of *Digital Health* that will be used for this study, it is also important to identify the components which constitute *Digital Health* identified in selected literature. The next section provides an overview of *Digital Health* components identified in selected literature.

3.4.2. Components of the concept Digital Health relevant to this study

The following were identified in selected literature as components that constitute the concept of *Digital Health*. Publications identified in this study were analysed according to themes.

- Electronic health (e-health): Different authors identified e-Health as a component of Digital Health (Robinson et al., 2015; Lupton, 2014b; Isakovic et al., 2015). There have been instances in which the terms *Digital Health* and *e-health* have been used interchangeably (Thomas & Bond, 2014). Thomas and Bond (2014) postulate that “Digital Health and eHealth (electronic health) are some of the broadest terms used to describe health-related technology.”

  E-health systems adopt the use of Internet and web technologies in the provision of healthcare delivery services (Oh et al., 2005). Health institutions are migrating from paper-based health records to electronic health records (EHRs) (Esposito et al. 2014). Ruxwana et al. (2010) posit that the drive for the implementation of e-health systems was as a result of the need to improve healthcare services. The introduction of ICTs in healthcare has indeed improved healthcare delivery services (Majeed et al., 2009).

Because of the benefits provided by e-health systems, such as EHRs and Health Information Systems (HISs), health institutions have tried to encourage its integration into the health system (Esposito et al., 2014). Different countries continue to invest in e-health systems (Scott & Mars, 2013).

Based on the definition of Digital Health for this study in section 3.4.1., e-health is thus considered as a component of Digital Health as it can be used to improve healthcare delivery services provided to patients.

- **Mobile health (m-health)**: Robinson et al. (2015), Lupton (2014b), Monitor Deloitte (2015), Isakovic et al. (2015) and Ahsan et al. (2013) have also indicated m-health as a component of *Digital Health*. Kazi and Jafri (2015) define m-health as the use of mobile devices to administer healthcare services. While e-health adopts the use of Internet and web technologies to provide healthcare delivery services through electronic communications (Harrison & Lee, 2006), m-health does this through mobile technologies (Vital Wave Consulting, 2009). The accessibility of mobile technologies opens the use of m-health to a larger population as most people have access to a mobile phone but not necessarily to a computer (Vital Wave Consulting, 2009).

Additionally, Ouma et al. (2011) emphasise that there is a connection between e-Health and m-Health. As shown in Figure 3-3, they emphasise that while healthcare services are provided through e-health in specialised hospitals, otherwise known as level three or tertiary hospitals, healthcare services can be provided through m-health services within the primary healthcare setting.

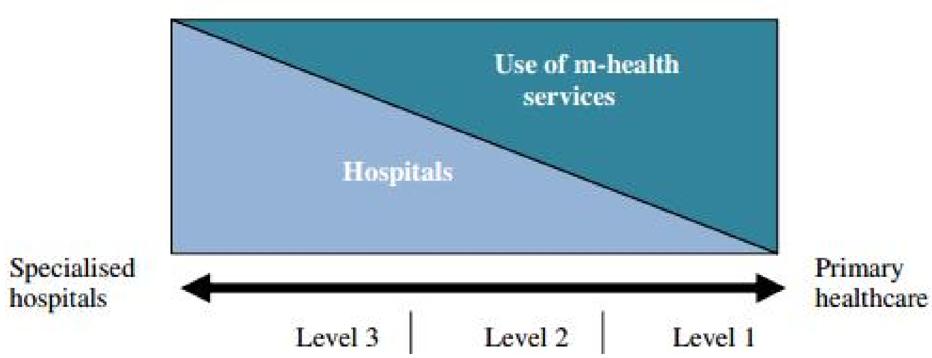


Figure 3-3: The link between m-health and e-health (Ouma et al., 2011).

M-health applications include mobile applications that specialise in providing healthcare services (Lupton, 2014c). Furthermore, mobile applications (mobile apps) are designed to address different cases of healthcare management. For example, expectant mothers/pregnancy (Johnson, 2014), stress management

(Morris et al., 2010) and asthma management (Kikidis et al., 2015; Anantharam, 2015). In addition, Free et al. (2013) indicate that despite implementations of m-health applications, more efforts should be made to test these applications in both developing and developed countries. Consequently, Arcilla et al. (2015, p. 113) developed and tested a “web and mobile information system” which aids in the monitoring of kidney transplant patients. Imran et al. (2016) also developed and tested directing messages to a specific context. Mobile apps have been used to keep track of ailments (Miele et al., 2015).

Thus, for this study, m-health can be classified as part of digital health as it adopts technology which helps to support healthcare delivery and hence, improve patient health.

- **Telemedicine/telehealth:** Isakovic et al. (2015) suggest that telemedicine is a component of *Digital Health*. The definition of *Digital Health* (section 3.1.6) in this study accepts that patients are involved in the healthcare delivery process. Telemedicine/telehealth, as described in a study by Lupton (2013a), Lupton (2014b) and Monitor Deloitte (2015) suggest that telemedicine/telehealth is a component of *Digital Health*. Kahn et al. (2016, p. 2) describe telemedicine as “remote care of patients, aided by Internet-based or telephone telecommunications technology.” This description implies that patient care can be facilitated by remote calls, or devices with Internet connections. With telemedicine, physicians can examine patients who are not physically present at the hospital. Kahn et al. (2016) explain that telemedicine aids in patient-doctor interaction using different information and communication technologies (ICTs). Apart from telemedicine being used by physicians to remotely connect with patients, it also results in the reduction of the cost of providing, and receiving, healthcare services. Kahn et al. (2016) postulate that telemedicine implementations have reduced the cost of healthcare in the United States. Other terms to describe telemedicine include “telehealth” (Lupton, 2013a; Lupton, 2013b) and “tele-expert” (Kahn et al., 2016). Furthermore, telemedicine has proven to have positive effects in stroke treatment (Demaerschalk et al., 2012). Tachakra et al. (2003) further explain that telemedicine can be provided using mobile technologies as well.

Telemedicine, therefore, forms an important part of *Digital Health* as it fits the definition of *Digital Health,* as stated in section 3.4.1. The use of ICT to provide healthcare services to patients at a distance, as in the case of telemedicine, allows patients to become involved in the management of their health.

- **Health 2.0/ medicine 2.0:** Robinson et al. (2015) posit that Health 2.0 is part of *Digital Health* and Lupton (2013a) affirms that Health 2.0 and Medicine 2.0 are components of *Digital Health*. Web 2.0 is described as the generation of the web that allows users to interact with web content (Bottles, 2009). Health 2.0, derived from Web 2.0 (Bottles, 2009, p. 22), is described by Hansen (2008) as an "improved communication and collaboration between people via social networking." Van De Belt et al. (2010) explain that some studies differentiate between Health 2.0 and Medicine 2.0, whilst other studies state that Health 2.0 and Web 2.0 refer to the same thing. In a review conducted by Hughes et al. (2008) it was ascertained that Health 2.0 and Medicine 2.0 were used interchangeably. Eysenbach (2008, p. 3) explicitly defines Medicine 2.0 as:

> *Web-based services for healthcare consumers, caregivers, patients, health professionals,* and *biomedical researchers, that use Web 2.0 technologies* and*/or semantic web* and *virtual-reality tools, to enable* and *facilitate specifically social networking, participation, apomediation, collaboration,* and *openness within* and *between these user groups.*

Popoiu et al. (2012) posit that Medicine 2.0 enables interaction between different healthcare stakeholders. Eysenbach (2008) admits that researchers do not distinguish between Health 2.0 and Medicine 2.0. Thus, Health 2.0/Medicine 2.0 is the integration of Web 2.0 in the utilisation of healthcare and medicine (Van De Belt et al., 2010). Eysenbach (2008, p. 2) asserts that Health 2.0/Medicine 2.0 includes "social networking, participation, Apo mediation, collaboration and openness." Sadeghi et al. (2011) describe different platforms which may be used to facilitate Health 2.0 including blogs, enterprise wikis, RSS, social networks, mashups, podcasts, microblogging and folksonomy (tagging).

In relation to the definition of *Digital Health* adopted in this study, enabling patients to manage their own health, Popoiu et al. (2012) explain that Health 2.0 is a tool which aids the process of patients managing their own health, therefore Health 2.0/Medicine 2.0 forms a component of *Digital Health*.

Furthermore, Topol (2013) illustrates *Digital Health* as having the following components, as described in Figure 3-4.

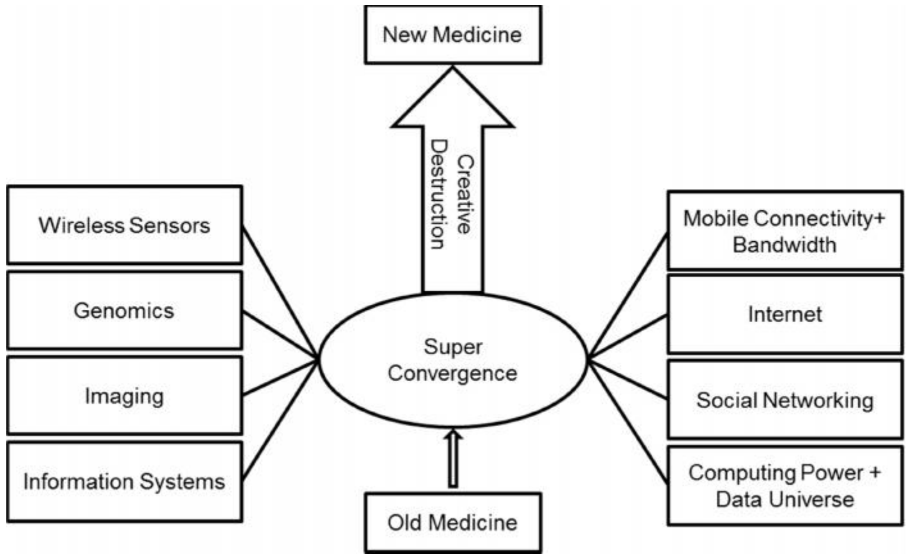


Figure 3-4: Components of *Digital Health* (Topol, 2013).

- **Wireless health/wireless sensors:** Robinson et al. (2015) points to wireless health as a component of Digital Health whilst Topol (2013) points to wireless sensors as part of Digital Health. Wireless sensors refer to different wireless monitoring devices, situated in a wireless network, used for monitoring patients' health by a physician (Alemdar & Esroy, 2010). The use of wireless sensors date back to the 1980s when they were first used. These sensors can collect a wide range of information and then send it to another location (Sarkar & Misra, 2016, p. 21). A review by Yilmaz et al. (2010, p. 4) details the various ways in which wireless sensors may be used to "monitor" patient's "vital signs." Simm et al. (2016) explore how wearable technologies can be developed in association with users to promote healthcare.

  Wireless health/wireless sensors thus form part of technologies which facilitate patient management devices using wearable devices. Hence, for this study, they are classified as a component of *Digital Health*.

- **Internet:** Topol (2013) identified the Internet as a component of *Digital Health.* Per Thomas & Bond (2014), the Internet is related to *Digital Health* as it can be used to disseminate health related information. There is a marked increase in the use of Internet technologies to seek health related information (Cline & Haynes, 2001). In healthcare, specifically, the Internet has facilitated information sharing to patients as well as acting as a communication conduit between patients and doctors (Powell et al., 2003). As part of *Digital Health*, interaction between patients and doctors is thus facilitated by the internet. Eysenbach (2000) postulates that one way of ensuring patients' involvement with their health, is through the Internet. Eysenbach (2000) explains that the Internet can be used as a source of health information to patients, but he adds that this should be done in a "controlled" manner. Houston & Allison (2002) agree with Eysenbach (2000) and recommend that healthcare practitioners should ensure that patients do, in fact, receive the correct information when they seek health related data on the Internet.

The use of the Internet has been studied in different user groups, including women (Pandey et al., 2003) and students (Escoffrey et al., 2005). A study by Hixson et al. (2015) reveals that epileptic patients, who do not have access to digital tools, are interested in using Internet technologies as a means of healthcare support. Two of the factors which influence the positive perception of a health website are the appearance of the site as well as articles from academic sources posted on the site (Sillence et al., 2004).

Based on the definition of *Digital Health* for this study in section 3.4.1., the *Internet* can be classified as a component of *Digital Health*.

- **Genomics/personalised medicine:** Topol (2013) points to genomics as a component of *Digital Health*. Genomics support personalised medicine, as it emphasises the uniqueness of each individual patient's reaction to diseases (Academy of Medical Sciences, 2015; Bauer et al., 2014). It is thus beneficial to include a patient's genomic information when administering healthcare services to him/her. However, current research informing the mapping of genomics information to existing e-health systems is limited (Kannry & Williams, 2013).

  Genomics is therefore considered as a component of Digital Health as it can help improve the way in which treatment is provided to specific patients. This may provide a better alternative approach to managing patient health.

- **Mobile connectivity and bandwidth**: Topol (2013) points to mobile connectivity and bandwidth as a component of Digital Health. As explained in section 3.4.2.2., m-health is a component of Digital Health. Furthermore, as explained in section 3.4.2.3., Digital Health encapsulates telemedicine where patients receive healthcare delivery services from a distance. These processes need connectivity to function and thus mobile connectivity and bandwidth are required if Digital Health is to be deployed.
- **Social networking/social media/health medical platforms:** Topol (2013) *identifies* social networking as a component of Digital Health and Lupton (2014b) *refers* to social media as a component of Digital Health. Swan (2009, p. 495) describes social networking in healthcare as "a website where consumers may

be able to find health resources at a number of different levels." The purpose of social networking in healthcare is to enable patients to participate in the management of their own health. This can be done by accessing social interactions, such as websites, where patients can retrieve health information. Patients usually turn to online sources when seeking medical help (Rubinelli et al., 2013) or when verifying medical information provided by medical experts (Lin et al., 2016). Online platforms, such as online forums (Rubinelli et al., 2013) and social networking websites (McCarroll et al., 2013), are useful in that they foster interaction between patients and experts. Both health professionals and patients share health-related information via social networks (Ventola, 2014). Social networking sites, like Twitter, have been used for monitoring trends regarding diseases (Zou et al., 2016; Quincey et al., 2016) and for sharing health information online (Wang et al., 2016). Social networking platforms where both health professionals and patients can share information include the following (Ventola, 2014):

- Blogs
- Microblogs
- Wikis
- Media-sharing sites
- Virtual reality and gaming environments
- Professional networking

Incorporating social networking features into a mobile device for healthcare purposes proved to have positive effects in the treatment of diabetes (Chomutare et al., 2013). Health and medical platforms, such as websites, which provide health information and foster health interactions, form a critical component of *Digital Health* as it helps to improve patient health management. The elderly can also use social media to source health related information (Palsdottir, 2016). Based on the description of social networking in healthcare, the aim is to improve interaction among the healthcare stakeholder community and hence provide patients with the tools for health management. In the light of this, social networking/social media/health medical platforms is classified as a component of *Digital Health* in this study.

- **Computing power and data universe:** Computing power and data universe is classified as a component of *Digital Health* by Topol (2013). According to the definition of *Digital Health,* as detailed in section 3.4.1., *Digital Health* facilitates the management of patient health information by healthcare stakeholders, patients and their families. Therefore, *Digital Health* will require that information be accessed at different times, and from different places. To facilitate this process, Digital health will require high computing power and storage capabilities.

- **Information systems:** Topol (2013) points to information systems as a component of *Digital Health*. Measures are added constantly to enhance healthcare services (Brennan, et al., 2009). One such measure is the introduction of information systems within the healthcare domain. Information systems form part of *Digital Health* as it represents an example of technologies which can be used to monitor patients' health.
- **Imaging:** Topol (2013) confirms imaging as a component of *Digital Health*.
- **Self-tracking (the quantified self):** Robinson et al. (2015) and Isakovic et al. (2015) highlight the quantified self as a component of *Digital Health*. However, from the definitions of self-tracking and quantified self by Lupton (2013b) and Till (2014), it appears that self-tracking and quantified self refer to the same concept. Lupton (2014d, p. 5) describes self-tracking as the "introduction of digital devices and associated apps, platforms and websites that allow people to monitor and measure their bodily activities and functions and render these into quantifiable digital data." Furthermore, quantified self-tracking enables patients to monitor their health status by adopting a wide range of technologies which facilitate the process (Swan, 2009; Swan, 2013). Barcena et al. (2014) indicate diverse reasons why self-tracking is needed. These include the monitoring of sick patients to determine trends in the ailment. Self-tracking (the quantified self) is a component of *Digital Health* as it allows patients to manage their own health.
- **Wearable computing/sensors and wearables:** Robinson et al. (2015) and Isakovic et al. (2015) identified wearable computing as a component of *Digital Health*. Patient monitoring is made possible by sensors included in the wearable device (Appelboom et al., 2013). In healthcare, sensors and wearables facilitate the prevention of diseases (Fletcher & Edygahi, 2010), as they relay health information to medical practitioners at another location. A literature review by Appelboom et al. (2014) reveal that wearables and sensors are important in healthcare. Sensors and wearables have been developed to monitor several diseases and ailments, including Autism Spectrum Disorder (ASD). Fletcher & Edygahi (2010) describe the use of Electrodermal Activity (EDA) sensors to monitor and track the triggers to, and early signs of, ASD attacks. In addition, wearable technology can help in the early detection of breast cancer (Porter et al., 2016) and the MONARCA wearable system can assist in the early detection of bipolar attacks (Puiatti et al., 2011). The monitoring of blood pressure (Shaltis et al., 2006) and the detection of vital signs (Yilmaz et al., 2010) are also actioned using wearables and sensors.

There is ongoing research into a wearable device which can detect "temperature and pressure within the skull and then dissolve harmlessly into the cranial fluid" (Comstock, 2016). This device will specifically be used to monitor patients who have undergone cranial surgery. Comstock (2016) adds that this device can monitor the patient internally for a specific time before it is removed from the body. Sensors and wearables are categorised as components of *Digital Health* as they facilitate the sharing of patient monitoring which is in line with the definition of *Digital Health* for this study, as presented in section 3.4.1.

- **Health information technology:** Robinson et al. (2015) identify health information technology as a component of *Digital Health*. Villalba-Mora et al. (2015, p. 478) describe health information technology as the:

  > *application of Information* and *Communication Technologies (ICT) involving both computer hardware* and *software that deal with the processing, storage, retrieval, sharing* and *use of healthcare information, data,* and *knowledge for communication* and *decision making.*

  From this description, it can be concluded that hardware and software facilitate decision making in the healthcare delivery process and should be classified as a component of *Digital Health*.

- **Big data:** Robinson et al. (2015) identify big data as a component of *Digital Health*. Snijders et al. (2012, p. 1) define big data as a "term used to describe data sets so large and complex that they become awkward to work with using standard statistical software." Ularu et al. (2012) postulate that the benefit of big data is that it enables people to improve decision making in businesses that handle huge sets of data. While big data can be utilised in different fields (Ularu et al., 2012), Raghupathi & Raghupathi (2014) emphasise that big data can also be applied within the healthcare context. The healthcare sector encompasses a vast range of information gathered from different sources (Matthew & Pillai, 2015). Big data in healthcare can be used as a mechanism to facilitate decision making (Zillner et al., 2014). To make decisions regarding patients' health, it is necessary to gather information from different sources. Big data enables the analysis of patient health information from different sources to assist with decision making processes. As such it should be classified as a component of *Digital Health*.
- **Cloud computing:** Robinson et al. (2015) indicate that cloud computing is related to *Digital Health*. Studies have explained the benefits of implementing

cloud computing (Hu & Bai, 2014; Clouds Standards Customer Council, 2012). The most commonly cited benefit in studies appears to be cost effectiveness. Furthermore, Borenstein & Blake (2011) define cloud computing as “the use of fast, high-bandwidth Internet connections to deploy services that are centrally maintained, often by third parties, and thus minimise the cost and difficulty of IT administration and support for the organisations that consume those services.” Cloud computing can be used to deploy healthcare services to patients (Sultan, 2014) as well as keeping track of patients’ health (Kochabas et al., 2013).

The use of cloud computing in the provision of *Digital Health* services does not only reduce costs, but can also improve the way health data is accessed (Chen et al., 2016). The inclusion of “high-bandwidth Internet connections” and “costs”, as noted by Borenstein & Blake (2011), seem to be appropriate within the healthcare domain as healthcare services work with huge volumes of data. Large volumes of health data, and services, can easily be accessed and stored in the cloud. An example of this would be the storage and access of medical imaging (Kagadis, et al., 2013). Furthermore, Rolim et al. (2010) propose cloud computing as a means of improving patient monitoring when providing telemedicine services.

Cloud computing can be classified as a component of *Digital Health* as it facilitates patient self-management using cloud computing services

- **Public health surveillance:** Lupton (2014a) refers to public health surveillance as part of the outcomes of *Digital Health* technologies. Public health surveillance is used to gather health information for a specific population (Nsubuga et al., 2006) to facilitate “decision making” (Sheikhali et al., 2016, p. 58) regarding the health of the population in a particular setting. Mondal et al. (2013) suggest that it is better to adopt efficient ways to facilitate the collection of health-related data. Different studies have suggested different approaches to achieving public health surveillance including: the use of SMSs (Mondal et al., 2013), the use of social media platforms (Lee et al., 2015) and adopting the enterprise architecture method (Sheikhali et al., 2016).

  Public health surveillance thus forms part of *Digital Health* as it facilitates the management of patients’ health by the healthcare provider.

- **Health promotion strategies:** Health promotion strategies are part of *Digital Health* (Lupton, 2014a). Studies have explored health promotion in different settings including: barber shops and salons (Browne, 2006; Arriscado et al., 2014; Núñez, 2015), healthcare (Fernandez et al., 2015; Tinkham, 2015; Maijala et al., 2016), nutrition (Bittner & Kulesz, 2015; Davison et al., 2015), sports (Roussel, 2014; Van Hoye et al., 2016) and schools (Layzer et al., 2014; Hoare & Decker, 2016). These studies conclude that health promotion is necessary to maintain a healthy lifestyle among individuals. The use of social media as a means of health promotion has also been elaborated upon in literature (Suomi et al. 2014; Norman, 2012). For example, Norman (2012) indicates that using social media as a means of health promotion is beneficial as more people can be reached in the process.

Health promotion strategies form part of *Digital Health* as it emphasises strategies that help patients improve their well-being. This is in line with the definition of *Digital Health* for this study, as stated in section 3.4.1.

- **Electronic health records (EHRs):** Isakovic et al. (2015) point to electronic health records (EHRs) as a component of *Digital Health*. EHRs have been used in both developing and developed countries (Hernández-Ávila et al., 2012; Jha et al., 2009). A description of EHR by Barrett (2015) suggests that EHRs consist of all the combinations of patient health information from past, and previous visits to a health institution which can be presented to a medical practitioner in order to make decisions regarding a patient's health. Rinner et al. (2016) report that a shared EHR can potentially improve information sharing amongst different healthcare providers in Austria.

There are competing views on the importance of EHRs. Poissant et al. (2005) indicate that the introduction of EHRs does not improve the process of capturing patient data. However, Hayrinen et al. (2008) suggest that the introduction of EHRs can indeed improve the process of capturing patient data.

EHRs, therefore, represent one of the ICT tools for recording patient health information and can be used to monitor the patients. As a result, EHRs can be a classified as part of *Digital Health*.

- **Electronic medical records (EMRs):** Thomas & Bond (2014) point to Electronic Medical Records (EMRs) as components of *Digital Health*. EMRs are "computerised medical information systems that collect, store and display patient information" (Boonstra & Broekhuis, 2010, p. 1). Furthermore, EMRs enhance the eligibility of patient records and have also been used to improve decision making in emergency departments (Ben-Assuli et al., 2012). While Garets & Davis (2006) posit there is a difference between EHRs and EMRs, Ajami & Bagheri-Tadi (2013) postulate that in most healthcare studies, EHRs and EMRs refer to the same concept.

EHRs and EMRs can be used to keep patient records. Thus, EHRs can be classified as part of *Digital Health*.

- **Health analytics:** Monitor Deloitte (2015, p. 2), in addition to telemedicine and m-health, adds health analytics as a component to *Digital Health.* Health analytics, which is described as "software solutions and analytical capabilities needed to assimilate big data," is useful in estimating healthcare outcomes based on existing data (Raghupathi & Raghupathi, 2013, p. 9).
- **Digitised health systems:** Monitor Deloitte (2015, p. 2) postulates that digitised health systems are also components of *Digital Health* and described digitised health systems as "*Digital Health* information storage and exchange of digitised patient medical records."
- **Gamification:** Deterding et al. (2011, p. 10) define gamification as "the use of game design elements in non-game contexts." Therefore, the application of gaming techniques is not limited to gaming environments. The use of gamification in different environments, including education (Botha et al., 2014; Botha & Herselman, 2015), business (Gears & Braun, 2013; Petridis et al., 2014) and healthcare (Lister et al., 2014; Cudney et al., 2015), has been discussed. Cugelman (2013) states that the application of gaming techniques in a specific environment does not necessarily mean users will be enticed to participate in a certain activity. Cugelman (2013, p. 6) however, suggests that "in order for gamification to be considered effective, gamified technology must outperform other design patterns, in terms of its ability to influence people's beliefs, attitudes, or behaviour." Games have been incorporated in ailment management, such as Parkinson's disease (Krause et al., 2013) and diabetes (Boulos et al., 2015). Gaming can be applied to addressing different illnesses, including asthma and diabetes (Lieberman, 2001). Baronowski et al. (2008) suggest that children are familiar with how games work and they can thus be incorporated in helping children adopt certain changes towards a healthy lifestyle. Apart from managing patient health, games can also be used as tools for preventing illnesses (Enah et al., 2013).

  Gamification, therefore, is a component of *Digital Health* as it encourages patient involvement in the healthcare delivery process.

- **Interoperability:** It should be able to share **i**nformation gathered from different e-health systems. Furthermore, Gibbons et al*.* (2007) define interoperability under three different contexts namely:

- **Technical Interoperability**: This refers to the underlying hardware components of different healthcare systems being able to exchange information.
- **Semantic Interoperability:** This refers to the information transmitted between different healthcare systems being understood in the same manner from source to destination.
- **Process interoperability**: This refers to well interpreted information, which has been exchanged across different healthcare systems, being aligned to set-down rules and policies guiding an organisation. This means that the information can easily be integrated with the current processes being utilised in the organisation, wherever such information is required.

Based on these descriptions, it is clear that despite the ability of health institutions to use and disseminate information internally, it is also necessary for these systems to share information externally. The process of sharing information between different institutions encompasses technical, semantic and process oriented contexts in which said information can be shared towards meaningful use within the context. Jardim (2013), however, reports that although it is important for health information systems (HISs) to interoperate, interoperability is not often easy to implement. The different techniques and mechanism, according to which different systems read and interpret information varies, and hence it is challenging to share and interpret information (Benson, 2012). Jardim (2013, p. 946) suggests that the requirements of interoperability should be “privacy, security and confidentiality of information about each patient.”

For information to be shared from device to device, and from different platforms, not only mobile connectivity, bandwidth and Internet is important but *interoperability* is essential. For *Digital Health* to operate, *interoperability* is a pre-requisite and thus can be considered as a component of *Digital Health*.

- **Health and wellness apps:** Handel (2011) explains that health and wellness apps refer to mobile applications used for disseminating health information to patients to facilitate health management by the patient. Different studies agree that health and wellness apps aid in improving patients’ health and encourages them to take an active approach in the process (Handel, 2011; Mosa et al., 2012). In addition, Isakovic et al. (2015) emphasise that wellness apps constitute *Digital Health*. A review of wellness and fitness apps reveals that expensive wellness and fitness apps are more frequently accepted by users than less expensive apps (West et al., 2012) because they include more *functions*. A systematic review of health and wellness apps also reveals that, while health and wellness apps are used by patients, efforts should be made to examine existing health and wellness apps (Payne et al., 2015). Taking into consideration the definition of *Digital Health,* as explained in section 3.4.1., health and wellness apps empower patients to management their own health and hence they can be classified as a component of *Digital Health*. Handel (2011) reviewed different health and wellness apps available to both Android and Apple devices users. His findings show that the use of these apps improve the outcome of patient health. Health and wellness apps are thus considered a part of *Digital Health* as they facilitate patient self-management.

- **Privacy and security:** Bahtiyar & Çağlayan (2014) insist that privacy should be addressed when implementing e-health systems. A study conducted by Wilkowska & Ziefle (2012) concluded that users of e-health systems expect privacy and security to be embedded into these systems. Kahn & Sheshadri (2008, p. 50) explain that the security of medical information can be breached during "transmission and access." They describe *transmission* as the process in which medical information is shared between systems and *access* as the process in which medical information can be used by an individual. Daglish & Archer (2009) and Oladimeji et al. (2011) have identified privacy and security as components which should be embedded in e-health systems to secure patient health information which is stored on these systems. Privacy and security cannot be ignored when patient health information is involved and therefor constitute part of *Digital Health*.

3.4.3. Summary of the components of Digital Health relevant to this study

Having overviewed the selected literature, Table 3-1 presents the identified components of the concept *Digital Health*.

Table 3-1: Summary of the components of *Digital Health* relevant to this study.

Components identified	Sources
e-health	Robinson et al. (2015), Lupton (2014b), Thomas & Bond (2014), Oh et al. (2005); Esposito et al. (2014), Ruxwana et al. (2010), Majeed et al. (2009), Scott & Mars (2013), Isakovic et al. (2015).
m-health	Robinson et al. (2015), Lupton (2014b), Lupton (2014c), Monitor Deloitte (2015), Ahsan et al. (2013), Kazi & Jafri (2015), Harrison & Lee (2006), Vital Wave Consulting (2009), Ouma et al. (2011), Johnson (2014), Morris et al. (2010), Free et al. (2013), Arcilla et al. (2015), Imran et al. (2016), Miele et al. (2015), Isakovic et al. (2015), Kikidis et al. (2015), Anantharam (2015).
Telemedicine/telehealth	Monitor Deloitte (2015), Lupton (2013a), Lupton (2014b), Kahn et al. (2016), Demaerschalk et al. (2012), Tachakra et al. (2003), Isakovic et al. (2015).

Components identified	Sources
Health 2.0/Medicine 2.0	Robinson et al. (2015), Lupton (2013a), Bottles (2009), Van De Belt et al. (2010), Hughes et al. (2008), Eysenbach (2008), Popoiu et al. (2012), Sadeghi et al. (2011).
Wireless health/ wireless sensors	Robinson et al. (2015); Topol (2013), Alemdar & Esroy (2010), Sarkar & Misra (2016), Yilmaz et al. (2010), Simm et al. (2016).
Internet	Topol (2013), Cline & Haynes (2001), Powell et al. (2003), Eysenbach (2000), Houston & Allison (2002), Pandey et al. (2003), Escoffrey et al. (2005), Hixson et al. (2015), Sillence et al. (2004).
Genomics/ personalised medicine	Topol (2013), Academy of Medical Sciences (2015), Kannry & Williams (2013), Bauer et al. (2014).
Mobile connectivity and bandwidth	Topol (2013).
Social networking/Social media/Health and medical platforms	Topol (2013), Lupton (2014b), Swan (2009), Rubinelli et al. (2013), Lin et al. (2016), McCarroll et al. (2013), Ventola (2014), Chomutare et al. (2013), Zou et al. (2016), Quincey et al. (2016), Wang et al. (2016), Palsdottir (2016).
Computing power and data universe	Topol (2013).
Information systems	Topol (2013), Brennan et al. (2009).
Imaging	Topol (2013).
Self-tracking (the quantified self)	Robinson et al. (2015), Lupton (2013b), Till (2014), Lupton (2014d), Swan (2009), Swan (2013), Barcena et al. (2014), Isakovic et al. (2015).
Wearable computing/sensors and wearables	Robinson et al. (2015), Appelboom et al. (2013), Fletcher & Edygahi (2010), Puiatti et al. (2011), Shaltis et al. (2006), Yilmaz et al. (2010), Comstock (2016), Porter et al. (2016), Isakovic et al. (2015).
Health information technology	Robinson et al. (2015), Villalba-Mora et al. (2015).
Big data	Robinson et al. (2015), Snijders et al. (2012), Ularu et al. (2012), Raghupathi & Raghupathi (2014), Matthew & Pillai (2015), Zillner et al. (2014).
Cloud computing	Robinson et al. (2015), Hu & Bai (2014), Clouds Standards Customer Council (2012), Borenstein & Blake (2011), Sultan (2014), Kagadis et al. (2013), Rolim et al. (2010), Kochabas et al. (2013), Chen et al. (2016).
Public health surveillance	Lupton (2014a), Nsubuga et al. (2006), Sheikhali et al. (2016), Mondal et al. (2013), Lee et al. (2015).
Health promotion strategies	Lupton (2014a), Browne (2006), Arriscado et al. (2014), Núñez (2015), Fernandez et al. (2015), Tinkham (2015), Maijala et al. (2016), Bittner & Kulesz (2015), Davison et al. (2015), Roussel (2014), Van Hoye et al. (2016), Layzer et al. (2014), Hoare & Decker (2016), Suomi et al. (2014), Norman (2012).
EHRs	Hernández-Ávila et al. (2012), Jha et al. (2009), Barrett (2015), Rinner et al. (2016), Poissant et al. (2005), Hayrinen et al. (2008), Isakovic et al. (2015).
EMRs	Thomas & Bond (2014), Boonstra & Broekhuis (2010), Ben-Assuli et al. (2012), Garets & Davis (2006), Ajami & Bagheri-Tadi (2013).
Health analytics	Monitor Deloitte (2015), Raghupathi & Raghupathi (2013).
Digitised health systems	Monitor Deloitte (2015).
Gamification	Deterding et al. (2011), Botha et al. (2014), Botha & Herselman (2015), Gears & Braun (2013), Petridis et al. (2014), Lister et al. (2014), Cudney et al. (2015), Cugelman (2013), Krause et al. (2013), Boulos et al. (2015), Baronowski et al. (2008), Enah et al. (2013).
Interoperability	Gibbons et al. (2007), Jardim (2013), Benson (2012).
Health and wellness	Handel (2011), Mosa et al. (2012), West et al. (2012), Payne et al. (2015),

Components identified	**Sources**
apps	Isakovic et al. (2015).
Privacy and Security	Bahtiyar & Çağlayan (2014), Wilkowska & Ziefle (2012), Kahn & Sheshadri (2008), Daglish & Archer (2009), Oladimeji & Chung (2011).

The next section discusses the concept of *Innovation* as part of the Digital Health Innovation Ecosystem.

3.5. INNOVATION

This section provides an overview of the definitions of innovation as from various authors and then aims to identify the components of the concept *Innovation.*

3.5.1. Defining Innovation

Discussions on innovation have been present in literature for a long period (Lorenzi et al., 1912; Schumpeter, 1934). Therefore, the concept of *innovation* is not new. However, innovation has been defined from different perspectives. The commonality among these different definitions is the idea that innovation is the creation of new ideas to aid in improving the output of an offering (West & Farr, 1990; West & Anderson, 1996; Du Plessis, 2007). For instance, West and Farr (1990, p. 9) define innovation as “the intentional introduction and application within a role, group, or organisation, of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, or wider society.” West & Anderson (1996, p. 682) also define innovation “as the effective application of processes and products new to the organisation and designed to benefit it and its stakeholders.” However, Kimberly (1981) suggests that innovation is a component of an organisation. A recent definition of innovation, per Greenhalgh & Rogers (2010), supports previous definitions as it reveals innovation as “the application of new ideas to the products, processes, or other aspects of the activities of a firm that lead to increased value.” Similarly, Cunningham (2013) agrees that innovation improves quality and states that innovation is “the improvement of products, services, processes, business models, policies and concepts in an existing context (whether social or economic) or their adaptation from one context to another, with the goal of increasing performance or achieving another desired impact.”

Innovation has been applied in different contexts including: innovation in the business context (Casadesus-Masanell & Zhu, 2013), the educational context (Looney, 2009) and in the healthcare context (Omachonu & Einspruch, 2010; Thankur et al., 2012). To provide a comprehensive definition of innovation within business organisations, Baregheh et al. (2009, p. 1334) define innovation as:

> *the multi-stage process whereby organisations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace*.

This study adopts the definition of *Innovation* as provided by Baregheh et al. (2009) as it encapsulates the processes and benefits achieved with innovation. The next section provides a discussion on the concept of *Innovation* as it forms part of the Digital Health Innovation Ecosystem.

3.5.2. Components of the concept of Innovation

The following were identified from selected literature sources as components which constitute the concept of *Innovation*. According to the UNESCO Institute for Statistics (2005), there are four types of innovation. They are described as follows:

- **Product innovation:** Introduction of good/s or service/s that are new, or significantly improved with respect to characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.
- **Process innovation:** Implementation of a new, or significantly improved, production or delivery method. This includes significant changes in techniques, equipment and/or software. The customer does not usually pay directly for the process, but the process is required to deliver a product, or service, and to manage the relationship with the various stakeholders.
- **Marketing innovation**: Implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
- **Organisational innovation**: Implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

The different stages of innovation are: closed innovation, open innovaton and innovation networks systems (Spruijt, 2015), as depicted in Figure 3-5.

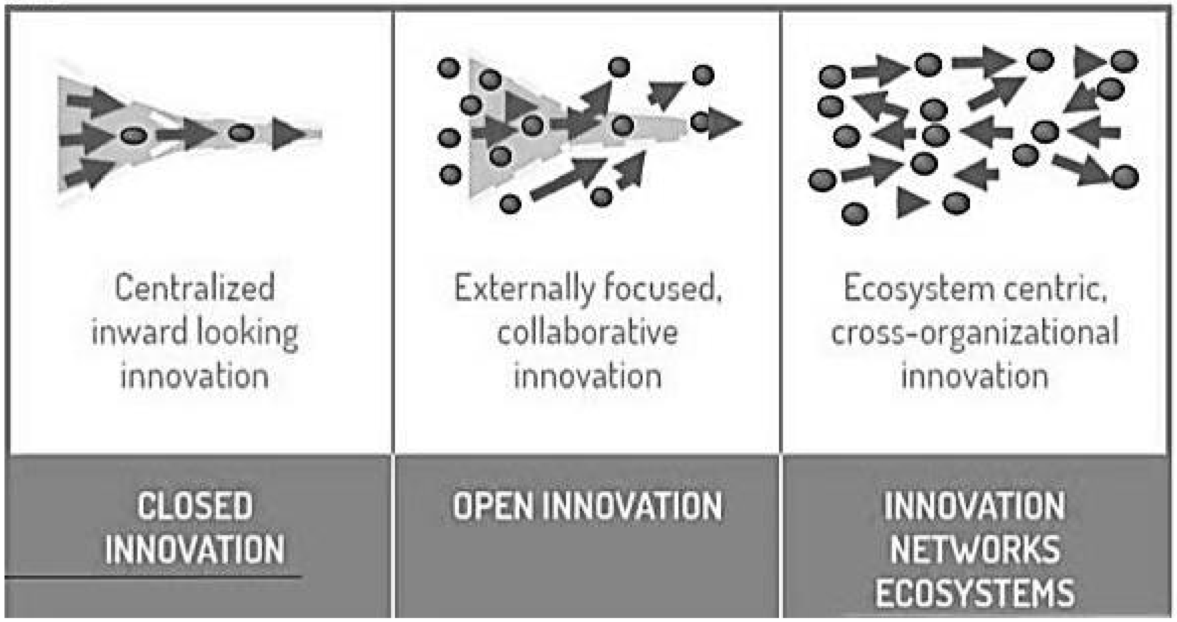


Figure 3-5: Evolution of Innovation adopted from Niglia (2014).

The various evolutions of innovations, from *closed innovation* to *open innovation* to *innovation ecosystems,* are described below. The emergence of Open Innovation 2.0 is included in this outline.

- **Closed innovation**: Bouten (2010) indicates that closed innovation has been practiced for a long time. However, a distinction between closed and open innovation was first made by Chesbrough (2003). Chesbrough (2003) describes *closed innovation* as the process of creating and sharing ideas within an organisation to remain competitive. He specifically emphasised the retention of intellectual properties (IPs) of ideas produced when a closed innovation process is being adopted and hence facilitated organisations into practicing closed innovation (Bouten, 2010). Organisations that practice closed innovation ensure that the shared ideas remain in the company, from inception to output (De man et al., 2008). Correia & Rua (2016) explain that health institutions in Portugal still practice closed innovation.
- **Open innovation:** Chesbrough (2003) first described the concept of *open innovation*. Chesbrough (2003) emphasised that open innovation accommodates the collaboration of different entities, from different organisations, in the innovation process. Chesbrough (2003) established a distinction between open and closed innovation. Marques (2014), amongst others, contests the distinction between open and closed innovation, as the concept of open innovation has long been implemented, despite the term open innovation not having been used. However, for this study, a distinction between the concepts of open and closed

innovation should be made as they adopt different approaches to the innovation process. Chesbrough (2003) distinguishes between open and closed innovation and further states that organisations realise innovation is limited when ideas are generated within a single organisation. While closed innovation focuses on organisations relying on their own research and developments, open innovation relies on research and development from other sources. In general, open innovation facilitates the sharing of ideas from different organisations and thus achieving higher goals for all participants in the innovation process. Closed innovation, on the other hand, concentrates on monopoly and competition. Lee et al. (2010) posit that, although open innovation can be difficult in organisations, efforts should be made to use the benefits provided by open innovation. Bakar (2015) insists that it is difficult to fully implement innovation as there are many challenges involved. These challenges include Intellectual Property (IP) ownership (Van de Vrande et al., 2009; Lichtenthaler, 2010; Bakar, 2015), as a result of sharing of information to external entities in the process of implementing open innovation. Another form of innovation includes innovation networks ecosystems (Spruijt, 2015), which is described below.

- **Innovation networks ecosystems**: In contrast to open innovation, Spruijt (2015) defines an innovation ecosystem as a "dynamic system" which "contains complex feedback loops, causal links, flows, stocks, delays among the agents." In agreement with Sprujit (2015), Jackson (2011, p. 2) believes that an innovation ecosystem is made up of "complex relationships" in which the participants of the innovation ecosystem consists of both technical and non-technical components. Adner (2006) asserts that the power of innovation ecosystems lies in the ability of organisation to achieve that which cannot be achieved in closed innovations.

  Durst & Poutanen (2013) add that communication takes place via the network of connected components which make up the innovation ecosystem. Curley & Salmelin (2014) further advance the concept of open innovation by describing an innovation ecosystem as a collaborative environment in which external members are added to the platform as collaborators, rather than competitors (Curley & Salmelin, 2014). They state that an innovation ecosystem consists of the following:

  - **Individuals**: Individuals in the innovation ecosystem are referred to as members, or a group of members who form a single entity, which could be a business, an institution or a company.
  - **Closed Innovation**: Closed innovation refers to a single entity exploring innovation ideas in isolation (Bouten, 2010).

- **Open Innovation:** Chesbrough (2003) invented the concept “open innovation.” He added that open innovation should allow different entities to interact with an innovation ecosystem.
- **Open Innovation 2.0 (ecosystem centric; cross organisations):** Curley & Salmelin (2014, p. 10) describe open innovation 2.0 as “a new paradigm based on principles of integrated collaboration, co-created shared values, cultivated innovation ecosystems, unleashed exponential technologies and extraordinarily rapid adoption.” Open innovation 2.0 facilitates cooperation and interaction between the different entities of the innovation ecosystem.
- **Different organisations, groupings of interest:** An extended approach of the innovation ecosystem is not limited to organisations with the same interests. Different organisations, with different interests, can also share ideas (Curley & Salmelin, 2014).

Other models of innovation, such as Triple Helix, also exist (Etzkowtiz & Leyesdorff, 1995). Triple Helix is described as follows:

õ **Triple Helix**: Triple Helix is an innovation model developed by Etzkowtiz (1993) and Etzkowiz & Leyesdorff (1995). The concept of Triple Helix idealises that universities, industries and government take centre stage in the innovation process (Etzkowiz, 2003) and so work together as a collaborative network. Mowery & Sampat (2004) indicate that it is necessary for academic institutions to collaborate with industries in order improve the economy. This is illustrated in Figure 3-6:

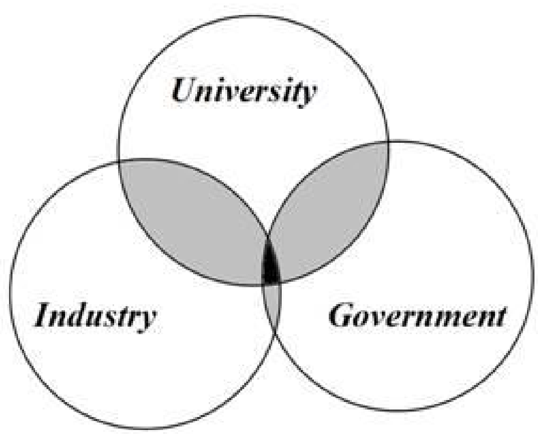


Figure 3-6: Triple Helix system, Lawton and Leydesdorrf (2014).

As indicated in Figure 3-6, the concept of Triple Helix is based on the collaboration of university, industry and government. Farinha and Ferreira (2011) explain that the reason behind Triple Helix systems is to coordinate activities between University, Industry and Government to enhance innovation approach. Ranga & Etzkowitz (2013) emphasise that the Triple Helix system consists of a set of theories which consists of components, relationships between components and functions. Further, the Triple Helix system "accommodates both institutional and individual roles in innovation, and explain variations in the innovative performance" (Ranga & Etzkowitz, 2013, p. 2). This implies that the Triple Helix system is flexible and allows for different types of innovation in its circle, including closed and open innovation.

Carayannis & Rakhmatullin (2014) point out three role players which take part in Triple Helix system. These role players are grouped as components and can be explained as follows:

- **Research and Development (R and D)**: These include R and D centres in Universities, Industries and Government. These role players are responsible for conducting research in the different Triple Helix systems.
- **Non R and D role players**: These role players include individuals that carry out technical activities and produce, and implement, output research findings.
- **Hybrid institutions**: These consist of a combination of R and D and non R and D role players.

Other innovation models, such as Quadruple Helix, also exist (Carayannis & Campbell, 2009). With many studies stressing the need to include users in the innovation process (Füller et al., 2006; Franke & Pillar, 2004), Arnkil et al. (2010) believe that the Quadruple Helix model extends the Triple Helix model. Carayannis & Campbell (2009, p. 206) postulate that there is a need to extend the Triple Helix model to include "media-based and culture-based public." Carayannis & Campbell (2009) emphasise that there is a need to include users to the triple helix. Similarly, Arnkil et al. (2010) explain that users are involved in the innovation process when the Quadruple Helix model is applied. This means that users take part in the innovative activities.

Carayannis et al. (2012, p. 2) propose the Quintuple Helix which extends the concept of the Quadruple Helix to include the "natural-environment-system." Carayannis et al. (2012) posit that the natural environment should be included in the Helix as it contributes to knowledge. However, the inclusion of the Quintuple Helix is not necessary for this study as environmental components such as plants, animals and other natural resources are not needed in the development of a *Digital Health* innovation ecosystem.

Other forms of innovation identified in selected literature:

- **User innovation**: Different authors have provided different perspectives on user innovation (Von Hippel, 1988, 2005; Berthon et al., 2007; Bogers et al., 2010). Von Hippel (1988) explains that users can also participate in the innovation process. Bogers et al. (2010, p. 859) indicates that users in innovation can include intermediate users, users who manufacture products based on the tools derived from sellers and consumer user, users who make use of different products. In general, the concept of user innovation indicates that users participate in the creation of a product. Despite user innovation being a concept that seems productive (Berthon et al., 2007; West & Bogers, 2014), Baldwin & Von Hippel (2011) suggest that user innovations can pose a risk to organisations.

For a couple of years, concerns regarding Intellectual Properties (IPs) in the innovation process have been discussed in literature (Gollin, 1991; Chen & Puttitanum, 2004; Schubert, 2015; Berthon et al., 2015). These studies emphasise IP rights as a means to improve innovation. Schubert (2015) believes that the implementation of IP rights can reduce chances of IPs being stolen by others in an innovation platform. Other terms have been used to describe IPs, such as “emotional properties” (Berthon et al., 2015). Berthon et al. (2015) define IPs as “the ‘emotional investment in an act of creation, and the attachment to the creation itself, such that the creator feels ownership of the creation.” The definition provided by Berthon et al. (2015) is in relation to user innovation where end users act as co-creators of a certain product and hence attain “ownership” of the innovation concept.

Technology plays an important role in innovation and therefore it is necessary to discuss the technological components of innovation. Kalmanek (2012) explains the three important components of technical innovation as follows:

- **Server virtualisation and the cloud**: The increase in web applications has led to an increase in server virtualisation and cloud applications to utilise available resources (Kalmanek, 2012).
- **Mobile application optimisation**: Another innovation in technology is the use of mobile applications. Kalmanek (2012) indicates that mobile applications enable wireless mode of communication and popularly used for accessing Internet services.
- **Mobile speech services**: Kalmanek (2012) explains that the incorporation of the speech functionality in mobile applications is another type of technology innovation to incorporate the new type of users.

Having provided the components of innovation from the selected literature, a discussion regarding innovation in healthcare is pertinent to this study.

3.5.3. Innovation in healthcare

The comprehensive definition of innovation, as provided by Baregheh et al. (2009), cannot be applied to innovation in healthcare as the definition does not include the characteristics specific to the healthcare context. Omachonu & Einspruch (2010), amongst others, define healthcare innovation as “the introduction of a new concept, idea, service, process, or product aimed at improving treatment, diagnosis, education, outreach, prevention and research, and with the long-term goals of improving quality, safety, outcomes, efficiency and costs.” This definition incorporates different aspects of innovation within a health domain, however, it does not encapsulate patients as participants of innovation. Thankur et al. (2012) provide another perspective to the definition of healthcare innovation namely the “adoption of those best-demonstrated practices that have been proven to be successful and implementation of those practices while ensuring the safety and best outcomes for patients and whose adoption might also affect the performance of the organisation.” The definition of healthcare innovation, as provided by Thankur et al. (2012), implies that the health practices, are used for administering health services to patients.

As this study focuses on healthcare, the focus in this section is on healthcare innovation. For this study, innovation is defined as the adoption of those best-demonstrated practices which have proven to be successful and implementation of said practices aimed at improving treatment, diagnosis, education, outreach, prevention and research, with the long-term goals of improving quality, safety, outcomes, efficiency and costs. This definition is adopted from Omachonu & Einspruch (2010) and Thankur et al. (2012).

The application of innovation, within the healthcare domain, provides new ideas regarding the provision and delivery of healthcare services (Bessant et al., 2012). The disadvantages of closed innovation, as described in section 3.6.2., limit the potentials in healthcare innovation. Despite several studies confirming open innovation as a better approach in healthcare innovation (Chesbrough, 2003a), an innovation network ecosystem would be preferable as contributions in healthcare innovation should from a networked collaboration of health institutions, patients, medical practitioners as well as individuals from different organisations. One of the challenges in adopting a collaborative environment, such as a network made up of different health institutions, is that the sharing of ideas in a collaborative environment may result in the loss of IP (Atkinson, 2014). However, if there are policies governing IPs in an innovation network ecosystem, it will help facilitate collaborations between individuals and institutions.

Omachonu & Einspruch (2010) presented the different components of innovation in healthcare. Firstly, they described the key stakeholder components of healthcare innovation (which includes the physician and other healthcare givers, patients, organisations, innovator companies and regulatory agencies). The needs, wants and expectations of key stake holders in healthcare innovation are described in Table 3-2 below.

Table 3-2: Components of key stakeholders in healthcare innovation as per Omachonu and Einspruch (2010, p. 9).

Stakeholders	**Needs, wants and expectations.**
Physicians and other care givers	Improved clinical outcomes, improved diagnosis and treatment.
Patients	Improved patient experience, improved physiological well-being, reduced waiting time, reduced delay.
Organisations	Enhanced efficiency of internal operations, cost containment, increased productivity and quality and outcomes improvement.
Innovator companies	Profitability, improved outcomes.
Regulatory agencies	Reduced risks and improved patient safety.

Just like user innovation has been established in other fields, as described in section 3.5.2., *patient innovation* is also required in healthcare (Kanstrup et al., 2015). Sanders & Stappers (2008) agree that in healthcare innovation there is a shared design responsibility between the healthcare stakeholders (based on the initial design) and healthcare practitioners (who make the final decisions). This means that healthcare practitioners are involved in the innovation process.

Based on the discussion on innovation in section 3.5.2 and healthcare innovation in section 3.5.3, it is important to identify the relevant innovation components relevant to this study. The next section explains these components.

3.5.4. Components of innovation relevant to this study

Different innovation components have been identified in section 3.5.3. The relevant components to this study include: process, product and structure**.** Process, product and structure are relevant to this study because Varkey et al. (2008) consider them relevant to the healthcare delivery process. Process innovation “entails innovations in the production or delivery method. The customer does not usually pay directly for process, but the process is required to deliver a product or service and to manage the relationship with the various stakeholders” (Varkey et al., 2008, p. 383). They further explain that product innovation is the product that “the customer pays for and typically consists of goods or services” and that “structural innovation usually affects the internal and external infrastructure, and creates new business models” (Varkey et al., 2008, p. 383).

Omachonu & Einspruch (2010) point to Information Technology (IT) as an important component of innovation in healthcare.

The evolution of innovation is also considered in healthcare and includes concepts such as closed innovation, open innovation, open innovation 2.0, innovation network ecosystems, Triple Helix system, Quadruple Helix and user innovation, as described in section 3.5.3.

Components of innovation, as identified by Rabelo & Bernus (2015, p. 2252), are described below:

- **Role players**: refer to all entities and their (social and economic) relations which play various roles in, and related to, the innovation ecosystem.
- **Capital:** financial assets provided by some role players.
- **Infrastructure**: physical, technical conditions and general resources to support the ecosystem and the innovation developments "inside" it.
- **Regulations**: laws and rules which frame the ecosystem's functioning and the innovation environment.
- **Knowledge**: existing supporting theoretical foundations, tacit and explicit, formal and informal and specialised knowledge which is used, generated (and eventually organised and managed), made available and learned along the innovation value chain.
- **Ideas**: intentional thoughts that trigger innovation actions and around which the whole ecosystem works, also involving inventions and discoveries.
- **Interface**: an ecosystem can be viewed as an open environment composed of a collection of disparate entities, organised in such a way as to achieve economic and social operational and strategic goals. Each ecosystem's actor should have an *interface* (a channel) through which to interact with other Role players, including customers, stakeholders and civil society. This interaction should also consider the usual large heterogeneity of role players, their cultures and idiosyncrasies.
- **Culture**: nowadays this component is considered a key aspect and one of the most important ingredients to a successful innovation ecosystem.
- **Architectural principles**: refer to the way in which all mentioned ecosystem elements are combined, orchestrated and how the cultural component is reflected on them.

3.5.5. Summary of components of the concept Innovation relevant to this study

Table 3-3 is a summary of *Innovation Components* relevant to this study.

Table 3-3: Components of Innovation.

Components identified	Sources
Process innovation	Varkey et al. (2008), UNESCO Institute for Statistics (2005).
Product innovation	Varkey et al. (2008), UNESCO Institute for Statistics (2005).
Structure innovation	Varkey et al. (2008).
Information technology	Omachonu & Einspruch (2010).
Closed innovation	Spruijt (2015), Bouten (2010), Chesbrough (2003), De man et al. (2008), Correia & Rua (2016).
Open innovation	Chesbrough (2003), Marques (2014), Lee et al. (2010).
Open innovation 2.0	Curley & Salmelin (2014).
Innovation network ecosystems	Spruijt (2015), Jackson (2011), Adner (2006), Durst & Poutanen (2013).
Triple Helix	Etzkowtiz (1993), Etzkowiz & Leyesdorff (1995), Etzkowiz (2003), Mowery & Sampat (2004), Farinha & Ferreira (2011), Ranga & Etzkowitz (2013), Carayannis & Rakhmatullin (2014), Carayannis & Campell (2009), Füller et al. (2006); Franke & Pillar (2004).
Quadruple Helix	Arnkil et al. (2010), Carayannis et al. (2012).
User innovation	Kanstrup et al. (2015), Bogers et al. (2010), Von Hippel (1988).
Intellectual property	Schubert (2015).
Role players	Rabelo & Bernus (2015).
Capital	Rabelo & Bernus (2015).
Infrastructure	Rabelo & Bernus (2015).
Regulations	Rabelo & Bernus (2015).
Knowledge	Rabelo & Bernus (2015).
Ideas	Rabelo & Bernus (2015).
Interface	Rabelo & Bernus (2015).
Culture	Rabelo & Bernus (2015).
Architectural principles	Rabelo & Bernus (2015).

The next section discusses the findings on digital ecosystems.

3.6. DIGITAL ECOSYSTEMS

As outlined in section 1.4.1., one of the objectives of this study is to identify the components of a digital ecosystem. To arrive at a complete understanding of digital ecosystems, it is important to discuss *what* an ecosystem is and *how* they have been applied in the digital context. The next section provides an overview of ecosystems, as explained in the selected literature.

3.6.1. Describing ecosystems

Willis (1994), Willis (1997) and Brush (2014) explain that the history of ecosystems can be traced back to 1930, when Clapham A. insists, in a letter addressed to his son, that he had informally coined the term *ecosystem* during an interaction with Tansley. A. G. Tansley (1935) formally used the term *ecosystem* to describe the interaction between living organisms and their environment in which living organisms cannot be discussed without reference to their environment.

Studies have explicitly described the components which make up an ecosystem to include abiotic and non-biotic factors (Christopherson, 1997; Muoghalu, 2003). For example, Christopherson (1997, p. 23) explicitly describes the components of an ecosystem as "a natural system consisting of all plants, animals and microorganisms (biotic factors) in an area functioning together will all the non-living physical (abiotic) factors of the environment." Ecosystems can either be terrestrial, or aquatic (Brush, 2014). When describing ecosystems, the "boundaries" and limits of an ecosystem must be defined (Likens, 1992, p. 8).

Chang & West (2006) and Boley & Chang (2007) have similar perceptions as to what an ecosystem is. Boley & Chang (2007, p. 398) describe an ecosystem as "a loosely coupled, domain clustered environment inhabited by species, each proactive and responsive regarding its own benefit while conserving the environment." Similarly, Chang & West (2006, p. 6) believe that an ecosystem should possess the following four essences:

- **Interaction and engagement**: Different living and non-living species within the environment need to interact and communicate with each other.
- **Balance**: Some form of unity needs to exist within the ecosystem, between the living and non-living species, to facilitate continuation of the ecosystem structure. Darking (2007, p. 2) postulates that the choice of species in a digital ecosystem should reflect a "balance of interest amongst diverse stakeholders" to thus facilitate activities.
- **Domain clustered and loosely coupled**: Species should not be coerced or mandated to participate in the ecosystem, but rather allowed to participate at their convenience. Chang & West (2006) and Boley & Chang (2007) explain that a digital ecosystem should be loosely coupled. Dini et al. (2008, p. 11) emphasise that a digital ecosystem should be loosely coupled because it relies on a distributed, rather than a centralised, transaction manager.
- **Self-organisation**: Living species should be able to make decisions on their own.

A definition by Chang & West (2006) depicts organisms in an ecosystem as being able to manage and control interactions within the ecosystem. Other descriptions of ecosystems in literature refer to the communication that takes place among biological organisms within a specific environment (Chang & West, 2006; Serbanati et al., 2011). Similarly, Serbanati et al. (2011, p. 628) define an ecosystem as a "biological community" in which the different organisms that make up the community, communicate with each other.

Chang & West (2006, p. 3) state that an ecosystem has two components, namely:

- **Species:** The species in an ecosystem are depicted by living organisms with organs, in which these organs interact with each other.
- **Environment:** The environment that supports the ecological needs of species so that they can continue to exist, generation after generation.

More insight is provided on digital ecosystems in the next section.

3.6.2. Digital ecosystems

Digital ecosystem is a concept introduced by the European Union to improve Small, Medium Enterprises' (SME) output using ICTs (Dini et al., 2005). The digital ecosystem simulates the actions portrayed by organisms in a natural ecosystem (Hadzic et al., 2007). Furthermore, Hadzic & Dillon (2008, p. 543) define *digital ecosystems* as "the dynamic and synergetic complex of digital communities consisting of interconnected, interrelated and interdependent digital species situated in a digital environment, that interact as a functional unit and are linked together through actions, information and transaction flows." Hence, the different components found in digital ecosystems should be connected ecosystems. Most descriptions refer to digital ecosystems as *complex* (Lurgi 2010; Hadzic et al., 2007). The complexity of digital ecosystems could be attributed to the differences in the objectives of those participants who take part in the activities of the digital ecosystem (Ion et al., 2008).

McLaughlin et al. (2009, p. 295) hold the opinion that "entities that sometimes compete and sometimes collaborate, interacting with each other to negotiate, transact and share knowledge." This means that activities within the digital ecosystem could be in alignment, or contrast, with activities of other species in the digital ecosystem. Hence, Serbanatti & Vasilateanu (2011, p. 628) define a digital ecosystem as "a self-organising digital infrastructure aimed at creating a digital environment for networked organisations that supports the cooperation, the knowledge sharing, the development of open and adaptive technologies and evolutionary business models."

While most definitions of digital ecosystems agree that participants of a digital ecosystem should be connected, Briscoe & De Wilde (2006) insist that participants in a digital ecosystem need not be in a specific location to be considered *connected*. In agreement with Chang & Wang (2006), Benedict & Schlieter (2015, p. 233) suggest that for digital ecosystems to be fully applied within a healthcare domain, they should be operated in an “open” platform. By “open” platform, Benedict & Schlieter (2015) mean a digital ecosystem within a healthcare domain which allows for the participation of digital species, without stringent processes. Thus, the different species can participate at will.

Digital ecosystems are described as an improvement to the existing architecture. Hussain et al. (2007, p. 598) describe a digital ecosystem as “a new-networked architecture and collaborative environment that addresses the weakness of client–server, peer-to-peer, grid and web services.”

Although Debay et al. (2012) believe that the concept of digital ecosystems help facilitate communication among different entities in a digital environment, the driving force which facilitates digital species to participate in a digital ecosystem is still unknown (Um et al., 2015).

Um et al. (2015) admit that in a digital ecosystem environment, digital species can connect to the digital ecosystem at will. Similarly, Hadzic & Dillon (2008) indicate that a similar approach can be adopted within a healthcare context.

The concept of *ecosystems* has been applied in different contexts. Examples include: business ecosystems (Peltoniemi & Vuori, 2004; Peltoniemi, 2006; Gueguen, 2009), electronic learning (e-learning) ecosystems (Dong et al., 2009; Finger et al. 2010), software ecosystems (Barbosa & Alves, 2011) and digital ecosystem (Hadzic & Dillon, 2008). The concept of *digital ecosystems* has been applied in different contexts such as agriculture (Ginige et al., 2016) and healthcare (Hadzic et al., 2007; Hadzic & Chang, 2010). Various studies have proposed different approaches to how a digital ecosystem may be applied within the healthcare domain (Hadzic & Dillon, 2008; Serbanati et al., 2011). For example, a study by Lau (2009) describes how a digital ecosystem can be applied within a health setting. Lau (2009) articulates how a web application can be used to connect different digital species (parents and doctors) with the aim of improving the lifestyle of children living with cerebral palsy. Bastide et al. (2010) further propose a framework on how a digital ecosystem may be applied, within a healthcare setting, to improve homecare services for aged citizens. The study illustrated and described the different digital species which exist within different environments. In a similar fashion, Serbanatti et al. (2011) propose a model that explains the processes of implementing a digital ecosystem within a healthcare domain. They deduce that the digital ecosystem is a complex environment and hence propose a model that does not only consists of patients and medical practitioners, but also includes the interaction of different digital species relevant to the healthcare domain including medical devices as well as other health institutions. Although not implemented, they suggest that a digital ecosystem within the healthcare domain can support an approach which places the patient as the main actor.

These studies conceptualise the different digital species in a healthcare environment. The benefits of applying the concepts of digital ecosystems within the healthcare domain is that different stakeholders interact with each other, as well as with other different components within the *Digital Health* ecosystem such as medical hardware and software.

3.6.3. Defining Digital Ecosystems

Adopting definitions of Hadzic & Dillon (2008) and Serbanati et al. (2011) and for this study, a digital ecosystem can thus be defined as a “network of digital communities consisting of interconnected, interrelated and interdependent digital species, including stakeholders, institutions and digital devices situated in a digital environment, that interact as a functional unit and are linked together through actions, information and transaction flows.”

Components of a *Digital* Ecosystem are discussed in section 3.6.4.

3.6.4. Components of the concept Digital Ecosystems relevant to this study

This section discusses the components of digital ecosystem, as described in selected literature. The following were identified in selected literature as components which constitute digital ecosystems. Components of digital ecosystems were selected based on two criteria:

- The components were stated as relating to digital ecosystems by the authors or
- Descriptions, or the purpose, of the components were in alignment with the definition of digital ecosystems for this study.

The following outlines the components of Digital Ecosystems:

- **Agents:** Different studies point to agents as components of digital ecosystems (Boley & Chang, 2007; Chang & West, 2006). Boley & Chang (2007) describe agents as participants who take part in activities within the digital ecosystem at their own will, without any form of coercion. Agents could refer to individuals, institutions or organisations who agree to take part in activities within the digital ecosystem.
- **Species:** Species, per Boley & Chang (2007), constitute a part of digital ecosystems as they represent a specific group of agents. Species in an ecosystem share the same characteristics (Chang & West, 2006; Dong et al. 2011a). Dong & Hussain (2011) and Dong et al. (2011b) postulate that a species can acquire services from other species within the digital ecosystem and serve other species within the digital ecosystem. Hence, the duties of species are not fixed within the digital ecosystem. Lurgi & Estanyol (2010, p. 263) explain that the

species in a digital ecosystem "are represented by pieces of software that exchange information in order to find appropriate links of collaboration." Chang & West (2006) further point to the different species found in a digital ecosystem:

- **Biological species:** This refers to people who participate in the digital ecosystem.
- **Economic species:** This refers to different companies and institutions who participate in the digital ecosystem.
- **Digital species:** This refers to digital devices, software and hardware used by people and different companies and institutions who participate in the digital ecosystem.

Digital species also refer to the tools needed by stakeholders in the digital ecosystem (Serbanati & Visilateanu, 2011). These tools include software and hardware devices (Hadzic & Dillion, 2008). Therefore, Serbanati & Visilateanu (2011) point out that the following stakeholders also form part of the digital species within a healthcare domain:

- Hospitals,
- health services,
- general practitioners,
- pharmacies,
- health systems and
- health information resources.

These stakeholders are responsible for carrying out activities in the digital ecosystem within a health domain.

Dong et al. (2011a) report that species in a digital ecosystem need not be in a single location to communicate. Consequently, Waluyo et al. (2011) also point to mobile clients as part of species in a digital ecosystem. Waluyo et al. (2011) postulate that these mobile clients consist of mobile devices. Dong et al. (2011b) and Briscoe & Wilde (2006) insist that participants in a digital ecosystem need not be in a specific location to be connected. Mobile clients could thus serve to foster such a connection.

Per Serbanati & Visateanu (2011, p. 2), within the healthcare domain, other digital species include "medical devices and clinical software applications such as clinical decision systems, electronic medical records, imaging software, billing software," which Serbanati & Visateanu (2011) refer to as the *software* and *hardware* in a digital ecosystem.

- **Digital environment:** Digital species interact with each other in a digital environment to carryout various tasks (Hadzic & Dillion, 2008). This is also depicted in biological ecosystems (Chang & West, 2006).
- **Interoperability:** Dorloff (2010) posits that interoperability is needed in digital ecosystems because information needs to be shared among the different species in the digital ecosystems. Lurgi & Estanyol (2010) believe species, within a digital ecosystem, should be able to collaborate. This is possible when the information in a digital environment can interoperate.
- **Trust:** Delina et al. (2012) indicate that trust is needed for transactions to be conducted in a digital ecosystem. Ion et al. (2008) postulate that the reason why trust is needed in a digital ecosystem is the dynamic nature of the digital ecosystem in which members can come and go at will. As such there is a real need for trust to be implemented in digital ecosystems (Malone et al., 2010; McLaughlin & Malone, 2010). Giannoutakis & Petrou (2007) emphasise the need for trust in digital business ecosystems. McLaughlin et al. (2009) and Malone (2007) emphasise that for trust to be maintained in a digital ecosystem, a means of identifying species in the digital ecosystem is mandatory. Malone & Jennings (2008) explain that *accountability* can be used to enforce trust in digital ecosystems. Telesca & Koshutanski (2007) agree that *trust* is an important component in a digital ecosystem. While Pranata et al. (2011a) emphasise that resources and species should be protected in a digital ecosystem, Pranata et al. (2011b) propose *trust* as a component of a digital ecosystem. Fachrunnisa & Hussain (2013) suggest that trust is required to enhance activities and propose a framework for maintaining trust in a digital ecosystem. Hussain et al. (2007) postulate that trust should be present in digital ecosystems to reduce risks when conducting transactions in said ecosystem.
- **Security:** Savola & Sihvonen (2012) posit that security is part of a digital ecosystem and as such it should be considered before the development of the digital ecosystem.
- **Ecosystem-oriented architecture:** Ion et al. (2008) postulate that a digital ecosystem needs an ecosystem-oriented architecture because of the dynamic nature of digital ecosystems in which different entities communicate with each other. Ion et al. (2008, p. 461) postulate that an ecosystem oriented architecture "support[s] the interoperability and the integration of the different processes that characterise a DE [digital ecosystem]". Briscoe & De Wilde (2006) and Briscoe et al. (2011) further developed an Ecosystem-Oriented Architecture, which is an extension of the Service-Oriented Architecture (Briscoe & De Wilde, 2006).
- **Self-organisation:** Most definitions and descriptions of digital ecosystems suggest that species in a digital ecosystem should be self-organised (Lurgi, 2010;

Telesca & Koshutanski, 2007). Whilst Chang & West (2006) posit that self-organisation is part of an ecosystem, Delina et al. (2012) emphasise that self-organisation is an essential characteristic of digital ecosystems. Living species should be able to make decisions on their own. Hussain et al. (2007, p. 598) describe a digital ecosystem as "self-organising."

- **Semantic web:** Dong et al. (2011a) explain that for web contents to be interpreted to the participants in a digital ecosystem, there is a need to incorporate semantic web in the development of digital ecosystems.

The components of a digital ecosystem, as described by King (2011), are depicted in Figure 3-7.

Figure 3-7: Components of a *Digital Ecosystem* (King, 2011).

The components of a digital ecosystem, as described by King (2011), are as follow:

- **Community:** Community in digital ecosystems refer to the entire species available within the digital ecosystem environment (King, 2011).
- **Digital content:** Content in digital ecosystems refer to information, or services, which are of use to the species available within the digital ecosystem (King, 2011). Kannan et al. (2010, p. 264) posit that digital ecosystems "refer to any information that is published or distributed in a digital form, including text, data, sound recordings, photographs and images, motion pictures, and software." Kannan et al. (2010) explain that digital content is needed in a digital ecosystem.

- **Technology:** Technology in digital ecosystems refers to hardware and software responsible for the information interchange within the digital ecosystem (King, 2011).
- **Practice:** For the different species to be comfortable and operate freely, practice is required (King, 2011).

A summary of digital ecosystems, relevant within the healthcare context is presented in the next section.

3.6.5. Summary of components of the concept Digital Ecosystems relevant to this study

Table 3-4 presents a summary of the components of the concept Digital Ecosystems relevant to this study.

Table 3-4: Summary of components of the concept Digital Ecosystems.

Components identified	**Sources**
Agents	Boley & Chang (2007), Chang & West (2006).
Species	Boley & Chang (2007), Chang & West (2006), Dong et al., (2011a), Dong & Hussain (2011), Dong et al. (2011b), Lurgi & Estanyol (2010).
Biological species	Chang & West (2006).
Economic species	Chang & West (2006), Serbanati & Visilateanu (2011), Hadzic & Dillion (2008).
Digital species	Chang & West (2006), Serbanati & Visilateanu (2011) Hadzic & Dillion (2008), Dong et al. (2011a), Dong et al. (2011b), Waluyo et al. (2011), Briscoe & De Wilde (2006).
Mobile clients	Waluyo et al. (2011).
Digital environment	Hadzic & Dillion (2008), Chang & West (2006).
Interoperability	Dorloff (2010), Lurgi & Estanyol (2010).
Security	Savola & Sihvonen (2012).
Trust	Delina et al. (2012), Ion et al. (2008), Malone et al. (2010), McLaughlin & Malone (2010), Giannoutakis & Petrou (2007), McLaughlin et al. (2009), Malone (2007), Malone & Jennings (2008), Telesca & Koshutanski (2007), Pranata et al. (2011a), Pranata et al. (2011b), Fachrunnisa & Hussain (2013), Hussain et al. (2007).
Ecosystem-oriented architecture	Ion et al. (2008), Briscoe & De Wilde (2006), Briscoe et al. (2011).
Self-organisation	Lurgi (2010), Telesca & Koshutanski (2007), Chang & West (2006), Delina et al. (2012), Hussain et al. (2007).
Semantic web	Dong et al. (2011a).
Digital content	Kannan et al. (2010), King (2011).
Community	King (2011).
Technology	King (2011).
Practice	King (2011).

Having outlined the definitions and components of the concepts of Digital Health, Innovation and Digital Ecosystem, the following section presents the proposed definition of a Digital Health Innovation Ecosystem.

3.7. PROPOSED DEFINITION OF A DIGITAL HEALTH INNOVATION ECOSYSTEM

Working definitions of *Digital Health, Innovation* and *Digital Ecosystems* have been provided. A proposed definition of *Digital Health Innovation Ecosystems* should contain the essence of the definitions for *Digital Health, Innovation* and *Digital Ecosystems*. Based on the discussions related to *Digital Health, Innovation* and *Digital Ecosystems*, a *Digital Health Innovation Ecosystem* can be defined as follows:

> *A Digital Health Innovation Ecosystem is a network of Digital Health communities consisting of interconnected, interrelated* and *interdependent Digital Health species. These species include healthcare stakeholders, healthcare institutions* and *Digital Healthcare devices situated in a Digital Health environment, who adopt the best-demonstrated practices that have been proven to be successful. Implementation of those practices takes place through the use of ICTs to co-create, monitor* and *improve the wellbeing* and *health of patients, to empower patients in the management of their health* and *that of their families through innovation processes.*

The following section presents a Concept Map for a *Digital Health Innovation Ecosystem*.

3.8. CONCEPT MAP FOR A DIGITAL HEALTH INNOVATION ECOSYSTEMS

The overall concept of *Digitfal Health Innovation Ecosystems* was deconstructed into three concepts namely: *Digital Health, Innovation* and *Digital Ecosystems.*

To synthesise the components of *Digital Health, Innovation* and *Digital Ecosystems*, it is imperative to explain the connection between the different components of each of the concepts, as illustrated in Figure 3-8.

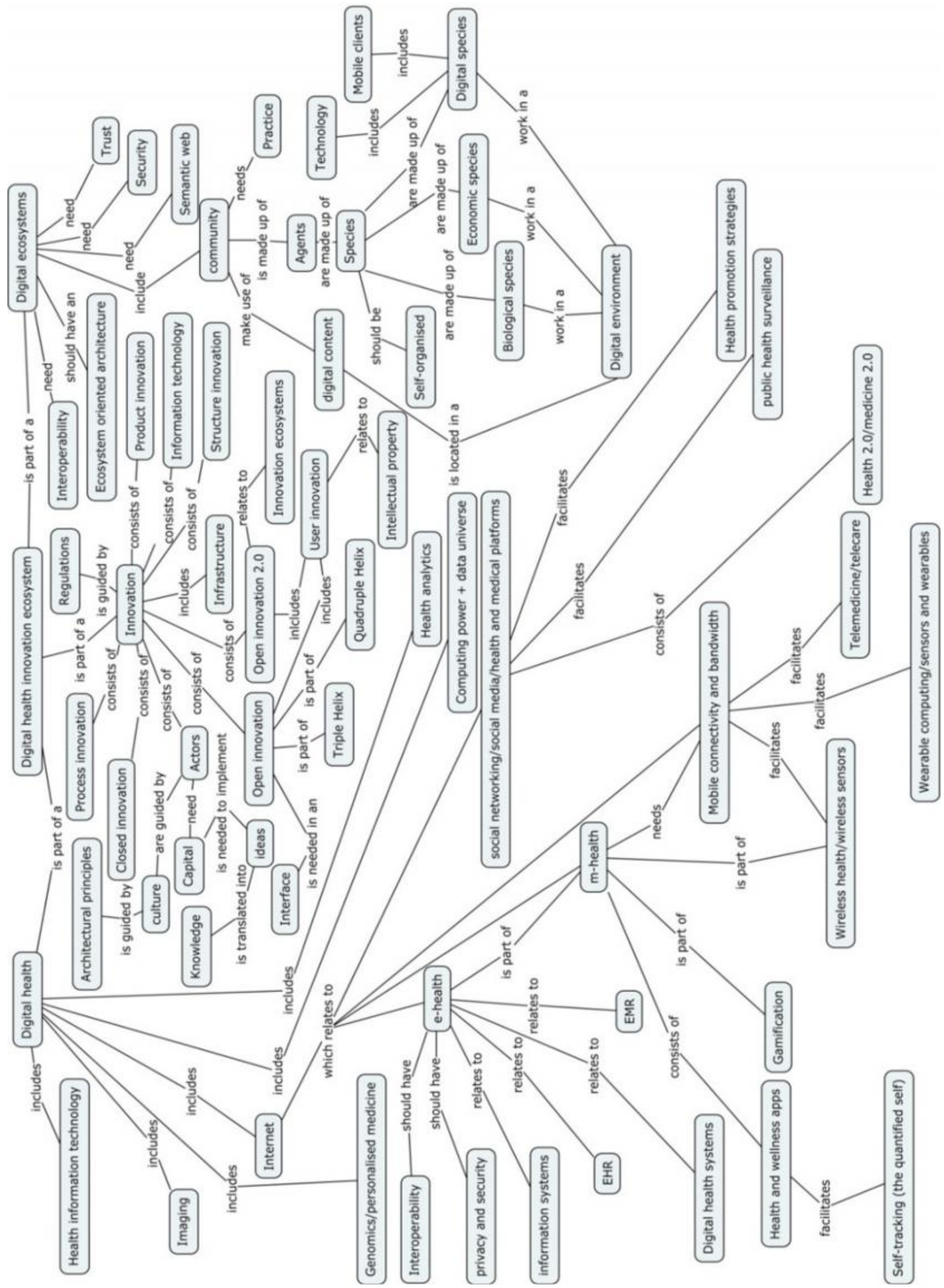


Figure 3-8: Concept Map of components of *Digital Health, Innovation* and *Digital Ecosystems*

Vanides et al. (2005, p. 27) describe a concept map as a “graphical representation of the relationship among terms.” Vanides et al. (2005) suggest that one of the benefits of using concepts maps is to grasp the concept of a topic. To understand the connection between the different components of *Digital Health, Innovation* and *Digital Ecosystems*, a concept map was used, as presented in Figure 3.16. Digital health is made up of components such as health information technology, imaging, genomics, which is also referred to as personalised medicine, the Internet, health analytics and computing power and data universe.

The Internet is a component of the e-health as Oh et al. (2005) explain that e-health utilises the Internet to function. Social networking, referred to as social media or health medical platforms also make use of Internet technologies to function. M-health is similar to e-health, except that it uses mobile phones to provide healthcare services (Ahsan et al., 2014). M-health utilises the Internet to function, which in turn needs mobile connectivity and bandwidth for patients and healthcare service providers to use the functionalities of m-health services. Mobile connectivity and bandwidth is also dependent on the Internet. E-health is made up of different information systems and digitised health systems. As illustrated in Figure 2, interoperability is a functionality needed when deploying e-health systems. E-health also extends to the development of EHRs and EMRs. E-health requires privacy and security to protect vital information located in e-health systems, such as EHRs and EMRs. Health and wellness apps, gamification, wireless health/wireless sensors are part of m-health as they utilise mobile technologies to function. Furthermore, telemedicine/telecare, wireless health/wireless sensors and wearable computing/sensors and wearables are facilitated by mobile connectivity and bandwidth as it requires users, or devices worn by users, to constantly communicate with healthcare practitioners or healthcare systems at a distant location (Kahn et al., 2016). Health 2.0/medicine 2.0, public health surveillance and health promotion strategies are all part of social networking, social media and health and medical platforms.

As illustrated in Figure 3-8, innovation consists of different components such as process innovation, product innovation and structure innovation. UNESCO’s Institute for Statistics (2005) state that innovation also includes marketing and organisational innovation. These concepts were not considered components of innovation relevant to healthcare as they do not directly involve healthcare. Varkey (2008) postulates that process innovation, product innovation and structure innovation are part of healthcare innovation. Per Omachonu & Eispruch (2010), IT should be considered as a component of innovation and hence, it is considered as a component of innovation in this study. Innovation should be guided by regulations. Innovation also includes different forms of innovation such as open innovation, open innovation 2.0 and closed innovation. Innovation needs an infrastructure in which activities can be carried out. Innovation requires role players. Role players could be people involved in the innovation process (Rabelo & Bernus, 2015). Knowledge is translated into ideas. Role players also need capital (Rabelo & Bernus, 2015) to implement ideas. Role players are guided by the culture practiced within the innovation platform. Interface is needed in an open innovation platform. Culture is guided by architectural principles. Triple Helix and Quadruple Helix are part of open innovation. Open innovation and open innovation 2.0 also include user innovation. Open innovation relates to innovation ecosystems. User innovation relates to intellectual property.

Digital ecosystems need interoperability (Dorloff, 2010), trust (Delina et al., 2012), security (Savola & Sihvonen, 2012) and semantic web (Dong et al., 2011a) to function. Ion et al. (2008) indicate that digital ecosystems should have an architecture which is like that of an ecosystem-oriented architecture. Digital ecosystems include community in which a community of individuals works together in the digital ecosystems platform (King, 2011). Community is also made up of agents, and these agents are made up of species (Boley & Chang, 2007). The community needs practice (King et al., 2011). Species in a digital ecosystem should be self-organised (Lurgi, 2010). These species can be either biological species namely the people who work in the digital ecosystem (Chang & West, 2006), economic species, organisations and institutions involved in activities within the digital ecosystem (Chang & West, 2006), digital species, these include technology (Chang & West, 2006), as well as mobile clients (Waluyo et al., 2011). Digital species also work in a digital environment. Digital content accessed by the community in a digital ecosystem is located in a digital environment.

The concept map (Figure 3-8) highlights the interrelationships as well as the detailed connections between the three main concepts (*Digital Health, Innovation* and *Digital Ecosystems*).

3.9. SUMMARY

The purpose of this chapter was to provide a systematic literature overview of the concepts: *Digital Health, Innovation* and *Digital Ecosystems*. It provides a definition of *Digital Health, Innovation* and *Digital Ecosystems* relevant to this study as well as proposes a definition, and a concept map, for a *Digital Health Innovation Ecosystem*.

Chapter 4 will provide an overview of the concepts: *Digital Health, Innovation* and *Digital Ecosystems* as these are applied and used in developing and developed countries.

CHAPTER 4. COMPARISON OF DEVELOPED AND DEVELOPING COUNTRIES WITH REGARDS TO DIGITAL HEALTH INNOVATION ECOSYSTEMS

4.1. INTRODUCTION

This chapter aims to answer the second sub-research question which was posed in *section 1.4.1*: *What does the existing literature communicate about Digital Health, Innovation,* and *Digital Ecosystems in* ***developed*** and ***developing*** *countries?*

As explained in Chapter 2, this study adopts the design science research methodology. Figure 4-1 below highlights the phase which is covered in Chapter 4 (encircled in green). As illustrated in Figure 4-1, this chapter contributes towards the development of the initial framework (artefact), the findings from Chapters 3 and 4 will form the basis of Chapter 5.

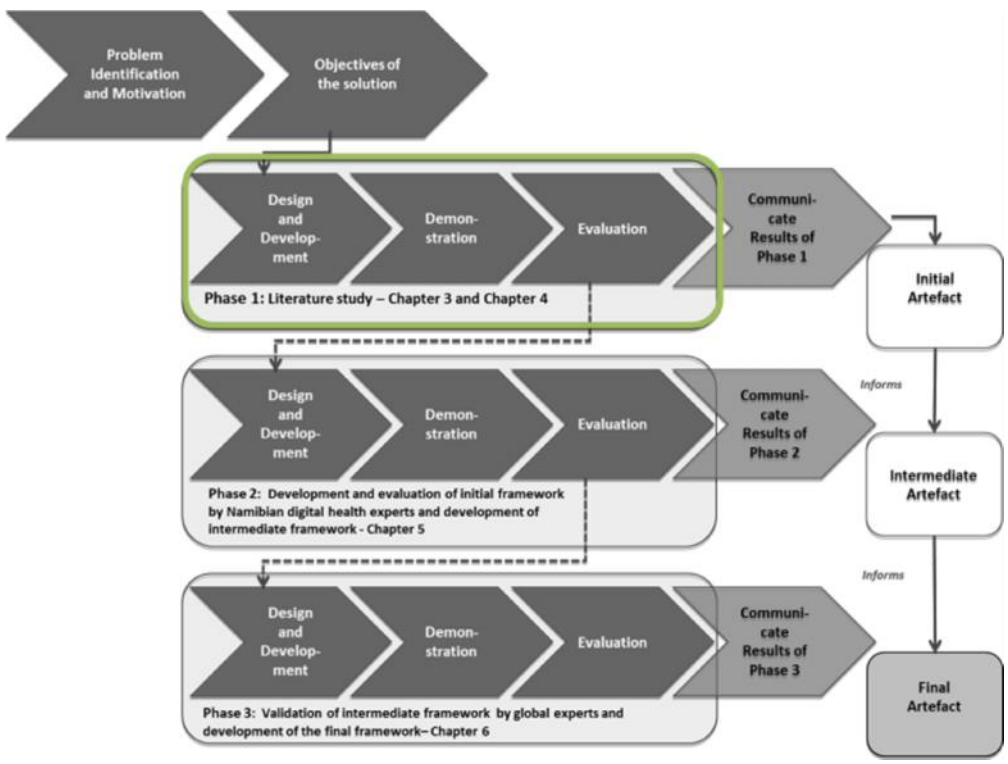


Figure 4-1: Phase 1 of the study consisting of Chapters 3 and 4.

4.2. OVERVIEW OF CHAPTER 4

This chapter is divided into five parts. Part 1 (section 4.3) discusses the different types of literature reviews that were selected for this chapter. Part 2 (section 4.4) presents a discussion on millennium development goals in existence as well as those specific goals relevant to developing countries. This is followed by a discussion on the health system challenges that developing countries are currently facing. Part 3 (section 4.7) provides a scoping review of *Digital Health Innovation Ecosystems* in developed and developing countries, while Part 4 (section 4.8) proposes guidelines with approaches for implementing a *Digital Health Innovation Ecosystems* in developing countries. Part 5 provides an overview of how the initial *Namibian Digital Health Innovation Ecosystem Framework* was developed based on results from Chapters 3 and 4.

4.3. LITERATURE REVIEW ADOPTED IN CHAPTER 4

This chapter discusses literature that describes developed and developing countries, including discussions on the Millennium Development Goals (MDGs), the need for *Digital Health Innovation Ecosystems* in achieving health related MDGs in developing countries and health systems challenges faced by developing countries. This chapter also discusses *Digital Health, Innovation* and *Digital Ecosystems* in developed and developing countries. Section 4.10 proposes guidelines with approaches for implementing *Digital Health Innovation Ecosystems* in developing countries. This chapter utilises literature from different types of literature reviews, as discussed by Grant et al. (2009). Per Grant et al. (2009) the different types of literature include: critical reviews, literature reviews, mapping reviews or systematic mappings, meta-analysis, mixed studies review or mixed methods reviews, overviews, qualitative systematic reviews or qualitative evidence syntheses, rapid reviews, scoping reviews, state-of-the-art reviews, systematic reviews, systematic search and reviews, systematised reviews and umbrella reviews. In the light of all the possibilities, it is important to explain which literature review type was applied to this chapter. Based on the different types of reviews, as pointed out by Grant et al. (2009), literature review and scoping review will be applied in this chapter. The description of a literature review was dealt with in Chapter 3 (section 3.3). However, Grant et al. (2009, p. 94) point out that a literature review does not necessarily have to follow a specific approach in search for the literature but can employ a “narrative” process for presenting the findings.

Conversely, a scoping review was applied to search for the literature dealing with *Digital Health, Innovation* and *Digital Ecosystems* in developed and developing countries as per section 4.7. The next section describes the concepts of developed and developing countries.

4.4. DESCRIBING DEVELOPED AND ***DEVELOPING COUNTRIES***

The focus of this chapter is to review *Digital Health, Innovation* and *Digital Ecosystems* in developed and developing countries, and hence, *developed* and *developing* countries need to be described. It is important to explain the characteristics of developed and developing countries to understand *how* each of them perceive *Digital Health, Innovation* and *Digital Ecosystems*, and *why* the implementation of *Digital Health Innovation Ecosystems* might differ in developed and developing contexts.

According to Nielson (2013, p. 1090), the International Monetary Fund (IMF) defines emerging markets and developing countries as countries “that are not advanced.” However, Nielson (2013, p. 1090) states that “there is no explicit definition of what constitutes an advanced country.” In contrast, other studies refer to advanced countries as developed countries, for example, Nielson (2011, p. 6) defines a developed country as a country “with negligible poverty at such a poverty line” and Surbhi (2015) defines a developed country as a country which is “developed in terms of economy and industrialisation.” Furthermore, Surbhi (2015, p. 1) indicates that a developing country is a country “going through the initial levels of industrial development along with low per capita income.”

The definitions of developed and developing countries, as provided by Nielson (2011) and Surbhi (2015), suggest that developed countries experience more economical stability when compared to developing countries. However, the level of economic stability is not the only characteristic used for determining a country’s development level. The United Nations Development Programme (UNDP) uses a combination of life expectancy, education and gross national income, referred to as the Human Development Index (HDI) (UNDP, 2015), to measure the development of a country.

Todaro & Smith (2006) point out the level of technological advancement and political issues as factors which can be used to measure the development level of a country. Therefore, for this study the definition of a developed or developing country should reflect the different factors that characterise a developed or developing country. Thus, adopting definitions of Nielson (2011, p. 34), Surbhi (2015, p. 1) and Todaro & Smith (2006, p. 17), the definition of a *developed* country is “a country with a high level of economic and financial stability which also experiences a high level of life expectancy, education, gross national income, technological advancement and political stability.” The definition of a *developing* country is “a country with a lower level of economic and financial stability which also experiences, lower levels of life expectancy, education, gross national income, technological advancement and political stability.”

Although Nielson (2011) maintains that there is no standard for distinguishing developing and developed countries, Surbhi (2015) comments that developing countries have less infrastructural development when compared to developed countries. Surbhi (2015) further highlights the difference between developed and developing countries, as described in Table 4-1.

Table 4-1 Comparison between developed and developing countries (Adapted from Surbhi, 2015).

Basis for comparison	**Developed countries**	**Developing countries**
Meaning	A country having an effective rate of industrialisation and individual income.	A country which has a slow rate of industrialisation and low per capita income.
Unemployment and poverty	Low.	High.
Rates	Infant mortality rate, death rate and birth rate is low while the life expectancy rate is high.	High infant mortality rate, death rate and birth rate, along with low life expectancy rate.
Living conditions	Good.	Moderate.
Generates more revenue from	Industrial sector.	Service sector.
Growth	High industrial growth.	Reliant on developed countries for their growth.
Standard of living	High.	Low.
Distribution of income	Equal.	Unequal.
Factors of production	Effectively utilised.	Ineffectively utilised.

From Table 4-1, it is evident that the comparison between developed and developing countries can be made based on criteria which includes: unemployment and poverty rate, infant mortality rate, death rate and birth rate, life expectancy, living conditions, how income is distributed, growth, standard of living, distribution of income and factors of production. Table 4-1 also reveals that unemployment rate, poverty rate, infant mortality rate and death rate are lower in developed countries when compared to developing countries. However, life expectancy, living conditions, growth, standard of living and distribution of income are usually better in developed countries than developing countries. Additionally, income is evenly distributed in developed countries, unlike developed countries where income is distributed unequally. Means of production in developed countries are not effectively utilised in developing countries, compared to developed countries.

As per section 4.4, developing countries have lower levels of education when compared to developed countries. Similarly, the Centre of Universal Education suggests that developed countries have higher levels of education compared to developing countries (Appiah, 2015) (see Figure 4-2).

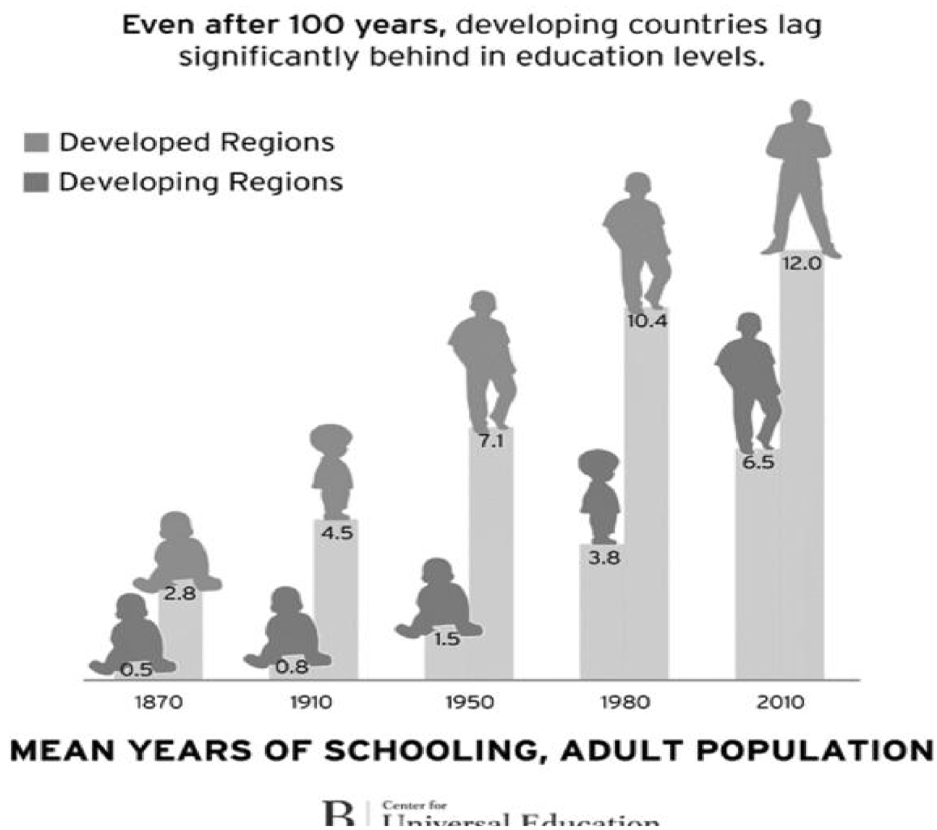


Figure 4-2: Educational levels of developing and developed countries (adapted from Appiah, 2015).

Figure 4-2 shows that despite the increase in educational levels in developing countries, from the 1870s to the 2010s, developed countries still maintain higher educational levels.

The definition of a developing and developed country for this study, as explained in section 4.4, suggests that life expectancy in developed countries is higher than in developing countries as illustrated in Figure 4-3 (Reading, 2014).

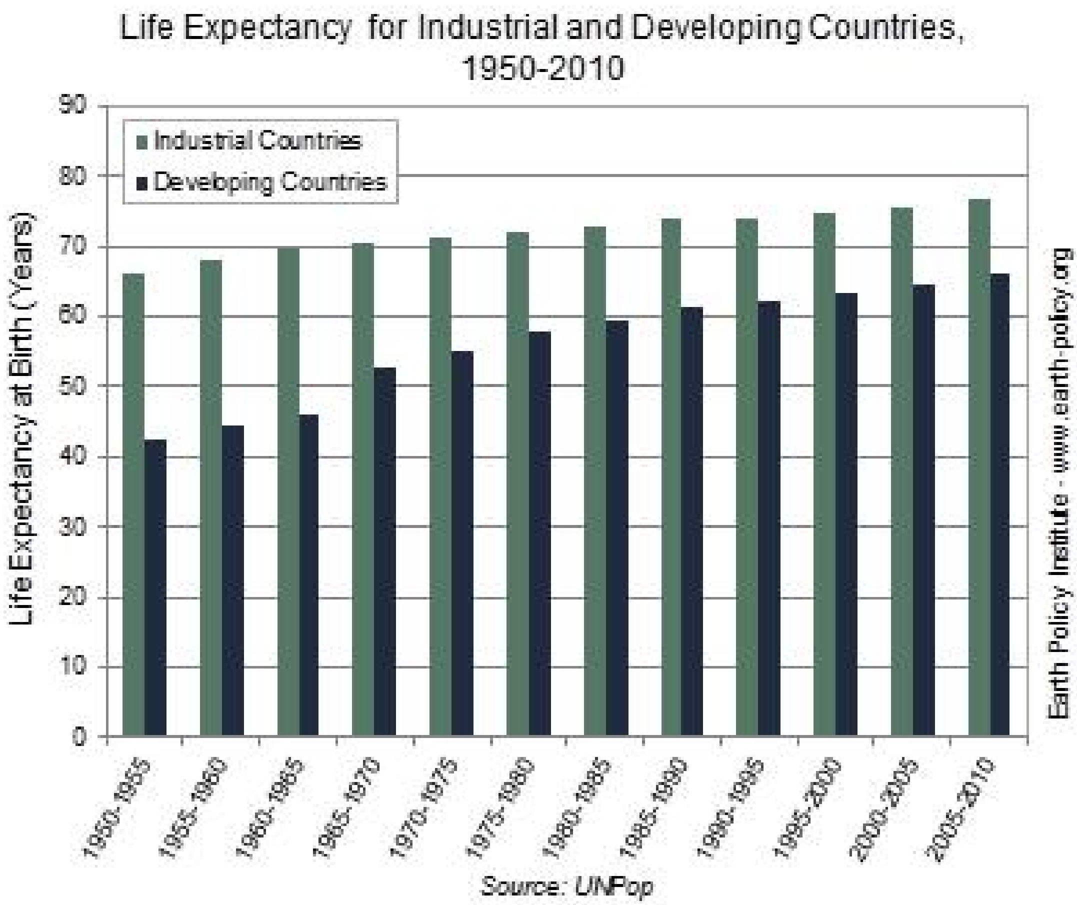


Figure 4-3: Life expectancy in different parts of the world (Reading, 2014).

Figure 4-3 illustrates the informal, significant gap in life expectancy between developed and developing countries from the 1950s to 2010s (Reading, 2014). Figure 4-3 also reveals that developed countries have a higher life expectancy rate compared to developing countries.

The World Bank classifies countries to be: low income, lower middle income, upper middle income or high income (Fantom & Serajuddin, 2016). According to Scott (2015) countries are classified based on the following gross national income:

- Low income: gross national income, equal or less than $US 1 045.
- Lower middle income: gross national income between $US 1 046 and $US 4 125.
- Upper middle income: gross national income between $US 4 126 and $US 12 745.
- High income: gross national income higher than $US 12 745.

Fantom & Serajuddin (2016) indicate that the World Bank's use of gross national income to group a country is a relevant approach.

As at 2015, the World Bank (2016a) reported that Namibia has a gross national income of $ 5 210 which places Namibia, the focus country of this study, as an upper middle income country. Vasquez & Sumner (2012) assert that although the OECD Development Assistance Committee adopts the World Bank's approach to classifying countries, the Committee categorises high income countries as mainly developed countries, while low income, lower middle income and upper middle income countries are categorised as developing countries. This places Namibia, an upper middle income country, as a developing country. Figure 4-4 shows the African continent encircled, and Namibia in a square (Mantena, 2014). The map also indicates that Namibia is an upper middle income country.

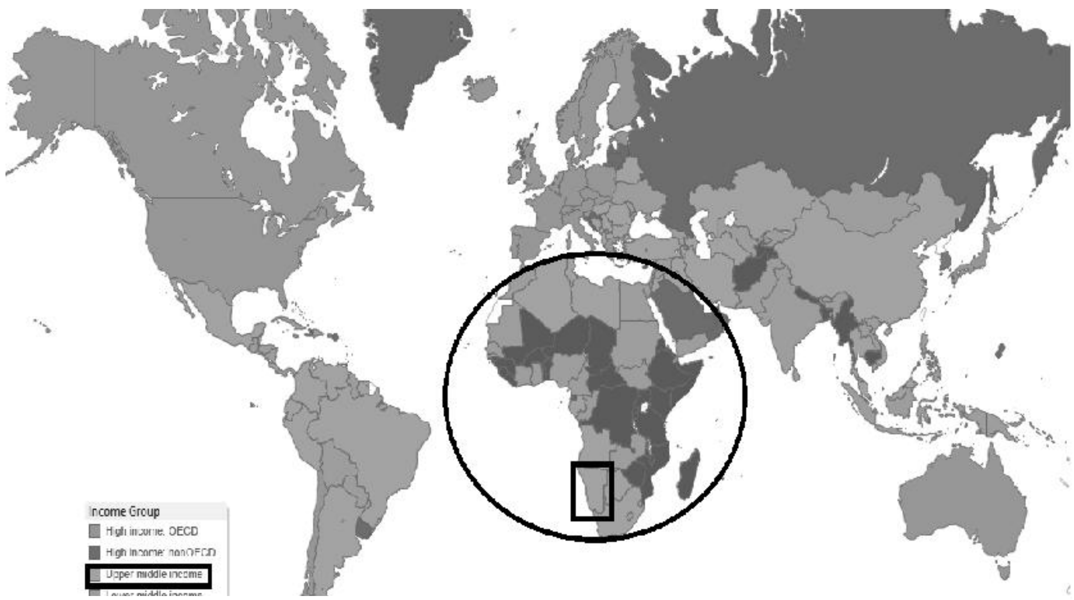


Figure 4-4: World Bank classification of countries (adapted from Mantena, 2014).

UNDP categorises countries, based on their Human Development Index, as follows (Vasquez & Sumner, 2012):

- Low human development countries: countries with human development index less than 0.52.
- Medium human development countries: countries with human development index between 0.52 and 0.698.
- High human development countries: countries with human development index between 0.698 and 0.79.
- Very high human development countries: countries with human development index higher than 0.79.

The Human Development Report (2016) highlights the global Human Development Index (HDI) for 2014. The report also indicates which countries fall within the low human development countries, medium human development countries, high human development countries and very high development countries. The list of medium human development countries is presented in Table 4-2. The table lists Namibia as a medium human development country (Human Development Report, 2016).

Table 4-2: List of medium human development countries as at 2014 (adapted from Human Development Report, 2016).

		Human Development Index (HDI)	Life expectancy at birth	Expected years of schooling	Mean years of schooling	Gross national income (GNI) per capita	GNI per capita rank minus HDI rank
HDI Rank	Country	Value	(years)	(years)	(years)	(2011 PPP $)	
		2014	2014	2014	2014	2014	
MEDIUM HUMAN DEVELOPMENT							
106	Botswana	0.698	64.5	12.5	8.9	16,646	-41
107	Moldova (Republic of)	0.693	71.6	11.9	11.2	5,223	23
108	Egypt	0.690	71.1	13.5	6.6	10,512	-12
109	Turkmenistan	0.688	65.6	10.8	9.9	13,066	-28
110	Gabon	0.684	64.4	12.5	7.8	16,367	-42
110	Indonesia	0.684	68.9	13.0	7.6	9,788	-9
112	Paraguay	0.679	72.9	11.9	7.7	7,643	-3
113	Palestine, State of	0.677	72.9	13.0	8.9	4,699	21
114	Uzbekistan	0.675	68.4	11.5	10.9	5,567	10
115	Philippines	0.668	68.2	11.3	8.9	7,915	-7
116	El Salvador	0.666	73.0	12.3	6.5	7,349	-3
116	South Africa	0.666	57.4	13.6	9.9	12,122	-29
116	Vietnam	0.666	75.8	11.9	7.5	5,092	15
119	Bolivia (Plurinational State of)	0.662	68.3	13.2	8.2	5,760	4
120	Kyrgyzstan	0.655	70.6	12.5	10.6	3,044	29
121	Iraq	0.654	69.4	10.1	6.4	14,003	-44
122	Cabo Verde	0.646	73.3	13.5	4.7	6,094	-1
123	Micronesia (Federated States of)	0.640	69.1	11.7	9.7	3,432	21
124	Guyana	0.636	66.4	10.3	8.5	6,522	-4
125	Nicaragua	0.631	74.9	11.5	6.0	4,457	12
126	Morocco	0.628	74.0	11.6	4.4	6,850	-8
126	Namibia	0.628	64.8	11.3	6.2	9,418	-21
128	Guatemala	0.627	71.8	10.7	5.6	6,929	-11
129	Tajikistan	0.624	69.4	11.2	10.4	2,517	27
130	India	0.609	68.0	11.7	5.4	5,497	-4
131	Honduras	0.606	73.1	11.1	5.5	3,938	7
132	Bhutan	0.605	69.5	12.6	3.0	7,176	-17

		Human Development Index (HDI)	Life expectancy at birth	Expected years of schooling	Mean years of schooling	Gross national income (GNI) per capita	GNI per capita rank minus HDI rank
133	Timor-Leste	0.595	68.2	11.7	4.4	5,363	-6
134	Syrian Arab Republic	0.594	69.6	12.3	6.3	2,728	21
134	Vanuatu	0.594	71.9	10.6	6.8	2,803	19
136	Congo	0.591	62.3	11.1	6.1	6,012	-14
137	Kiribati	0.590	66.0	12.3	7.8	2,434	21
138	Equatorial Guinea	0.587	57.6	9.0	5.5	21,056	-84
139	Zambia	0.586	60.1	13.5	6.6	3,734	2
140	Ghana	0.579	61.4	11.5	7.0	3,852	-1
141	Lao People's Democratic Republic	0.575	66.2	10.6	5.0	4,680	-6
142	Bangladesh	0.570	71.6	10.0	5.1	3,191	5
143	Cambodia	0.555	68.4	10.9	4.4	2,949	7
143	Sao Tome and Principe	0.555	66.5	11.3	4.7	2,918	8

From the information presented in Table 4-2, it is evident that the calculation of the Human Development Index is based on a combination of different factors which include life expectancy at birth, education (expected years of schooling and mean years of schooling) and gross national income. Table 4-2 also indicates that Namibia is ranked 126 with a human development index of 0.628 and that its human development index rank is at -21, This places Namibia as a middle human development country.

The International Monetary Fund (IMF) classifies a country as either an advanced economy, an emerging market or a developing country (IMF, 2008). Per Fantom and Serajuddin (2016, p. 15), the IMF uses a "hybrid measure of GDP together with other measures, to assess the financial contributions of members, their voting power, their access to financing, and their share of general SDR allocation." The IMF (2016a, 2016b) classifies Namibia as an emerging market and developing country.

Having described *developed* and *developing* countries, it is also important to take the Millennium Development Goals (MDGs) into consideration and to examine *which* health related MDGs are yet to be achieved and *how Digital Health* innovation ecosystems can be used to meet the MDGs in developing countries. A discussion of the MDGs and *Digital Health* innovation ecosystems is presented in the next section.

4.5. MILLENNIUM DEVELOPMENT GOALS (MDGS)

In 2000, the UN held a meeting during which a set of Millennium Development Goals (MDGs) were created. These were meant to be implemented by the end of 2015 (UN, 2015). The MDGs include:

- Eradicate extreme poverty and hunger.
- Achieve universal primary education.
- Promote gender equality and empower women.
- Reduce child mortality.
- Improve maternal health.
- Combat HIV/AIDs, malaria and other diseases.
- Ensure environmental stability.
- Develop a global partnership for development.

While the UN (2015) conceded that some of these goals have reached fruition, much still needs to be done to meet the goals, especially in developing countries. For example, Say et al. (2014) report that a World Health Organisation (WHO) analysis suggests that maternal health in developing countries need to be improved. Similarly, a recent Global Health Policy (2016) report reveals that HIV rates in the Eastern and sub-Saharan Africa regions remains the highest with 19 million people living with HIV. The World Health Organisation (WHO) (2014, 2016) also reveals that the child mortality rate in Africa is still on the increase, compared to other continents.

Having highlighted the outstanding health related MDGs which are yet to be achieved by developing countries, it is important to explain how pivotal the development of a *Digital Health Innovation Ecosystem* is in achieving said MDG goals in developing countries.

4.5.1. Digital Health innovation ecosystems addressing health related MDGs in developing countries

A definition of *Digital Health Innovation Ecosystems* was proposed in Chapter 3 (section 3.7). It will, however, be repeated in this section to reinforce the relevance of a *Digital Health Innovation Ecosystem* towards achieving the MDGs in developing countries. A Digital Health Innovation Ecosystem is "a network of *Digital Health* communities consisting of interconnected, interrelated and interdependent *Digital Health* species, including healthcare stakeholders, healthcare institutions and *Digital Health*care devices situated in a *Digital Health* environment, who adopt the best-demonstrated practices that have been proven to be successful, and implementation of those practices through the use of ICTs to monitor and improve the wellbeing and health of patients, to empower patients in the management of their health and that of their families."

The definition of a *Digital Health* innovation ecosystem, as proposed in Chapter 3 (section 3.7), suggests that not only one *Digital Health* stakeholder is needed to form the ecosystem, but an interconnection of different stakeholders. Thus, to achieve the health related MDGs in developing countries, an interconnective group of *Digital Health* stakeholders (which may comprise *Digital Health* stakeholders from different parts of the world, including developed and developing countries) must share ideas in an effort to tackle the health challenges in developing countries.

These interconnected *Digital Health* stakeholders should be ready to adopt best–demonstrated practices, which have proven to be successful. In order to “reduce child mortality,” “improve maternal health” and “combat HIV/AIDs, malaria and other diseases” (UN report, 2015, p. 13) whilst taking into consideration the economic and financial levels of developing countries as highlighted by the World Bank (Fantom & Serajuddin, 2016), the UN (Vasquez & Sumner, 2012) and IMF (Fantom & Serajuddin, 2016), developing countries need to adopt the best-demonstrated practices, as established by developed countries, using their available resources. However, these best-demonstrated practices cannot be adopted without the use of ICTs, as the use ICTs in healthcare have been proven to be beneficial in developed countries (Burney et al., 2010; Rouleau et al., 2015). ICTs could refer to *Digital Health* technologies such as m-health, e-health, health and wellness apps and wearable computing or sensors and wearables. For example, m-health technologies are being used to provide healthcare services to pregnant women in developed countries (Maitra & Kuntagod, 2013; Sajjad & Shahid, 2016; Su et al., 2016) and have also shown to impact on developing countries (Entsieh et al., 2015). Furthermore, to “reduce child mortality,” “improve maternal health” and “combat HIV/AIDs, malaria and other diseases” as highlighted in the UN report (2015, p. 12), patients need to take an active role in the management of their health. These active roles can be facilitated by *Digital Health* technologies such as m-health, wearables sensors and wireless computing, telemedicine, social media, health 2.0/medicine 2.0, health and medical platforms, health and wellness apps and self-tracking (the quantified self). The definition of *Digital Health Innovation Ecosystems* proposes those concepts needed to tackle the outstanding health related goals of the MDGs.

The still outstanding health related MDGs, that need to be addressed in developing countries, highlight the fact that *Digital Health* innovation ecosystems can aid in achieving said MDGs. It is important to identify health system challenges in developing countries as per the next section.

4.6. HEALTH SYSTEM CHALLENGES IN DEVELOPING COUNTRIES

Descriptions of health systems, from the early 2000 to mid-2000, agree that health systems are meant to enhance overall health outcomes (WHO, 2000; WHO, 2007). For example, WHO (2000, p. 3) describes a health system as a system which “includes all activities with the purpose to promote, restore and maintain health” and WHO (2007) describes a health system as “the sum total of all the organisations, institutions and resources whose primary purpose is to improve health.” The need to have an effective health system in place has been recognised, and as a result, measures are being taken to improve healthcare services (Brennan et al., 2009). WHO (2007) provides six building blocks to a health system. They are described as follows:

- **Health services:** Good health services are those which deliver effective, safe, quality personal and non-personal health interventions to those that need them, when and where needed, with minimum waste of resources.
- **Health workforce:** A well-performing health workforce is one that works in ways that are responsive, fair and efficient to achieve the best possible health outcomes, given available resources and circumstances (i.e. there are sufficient staff who are fairly distributed, competent, responsive and productive).
- **Health information:** A well-functioning health information system is one that ensures the production, analysis, dissemination and use of reliable and timely information regarding health determinants, health system performance and health status.
- **Medical products, vaccines and technologies:** A well-functioning health system ensures equitable access to essential medical products, vaccines and technologies of assured quality, safety, efficacy and cost-effectiveness, and their scientifically sound and cost-effective use.
- **Health financing:** A good health financing system raises adequate funds for health, in ways that ensure people can use needed services, and are protected from financial catastrophe or impoverishment associated with having to pay for them. It provides incentives for providers and users to be efficient.
- **Leadership and governance:** Leadership and governance ensure that strategic policy frameworks exist and that they are combined with effective oversight, coalition building, regulation, attention to system-design and accountability.

The six building blocks of a health system, as provided by the WHO (2007), form the basis upon which good health systems are built. This means that good health systems should be able to show progress reports regarding the six building blocks provided by the WHO (2007). Health system challenges in developing countries have been evaluated based on the six building blocks of a health system (Moxon et al., 2015; Beran et al., 2015; Busse et al., 2014; Dickson et al., 2014).

The challenges of health systems in developing countries can be categorised based on the six building blocks of health systems as identified from literature:

4.6.1. Health workforce

One of the keys to successfully maintaining a good health system in developing countries is maintaining a stable health workforce (Bangdiwala et al., 2010). However, the shortage of personnel has been identified as a health system challenge in developing countries. For example, Moxon et al. (2015) identified a dearth of neonatal professionals in Cameroon, DRC, Kenya, Nigeria, Uganda, Bangladesh, Nepal, Pakistan and Vietnam. Similarly, Beran et al. (2015) postulate that there is a dearth of professionals in diabetes care in Zambia and Sri Lanka. Despite the shortage of medical personnel identified in the capital city of Nigeria, there is an uneven distribution of medical practitioners in urban and rural areas as well. More medical practitioners were found in urban hospitals and clinics compared to the rural areas (Obembe et al., 2014).

Bangdiwala et al. (2010) postulate that developing countries struggle to maintain a stable workforce because of financial challenges. These may hinder the management of health workers. Similarly, Awofeso (2010) and Innocent et al. (2014) indicate that trained health workers in developing countries, like Nigeria, have migrated to developed countries. Awofeso (2010) points to low incomes for health workers as one of the causes of health workers' migration to developed countries. However, Abdulraheem et al. (2012) explain that although there are trained health workers in developing countries, such as Nigeria, their approach to applying skills in the healthcare sector is out of date.

4.6.2. Medical products, vaccines and *technologies*

A lack of adequate medical products, vaccines and technologies seem to be a constant challenge to health systems in developing countries. There are many causes for shortages of medical products, vaccines and technologies in developing countries (Tekki, 2013) and these include outdated technologies (Innocent et al., 2014) and cost factors (Innocent et al., 2014; Tekki, 2013). Tekki (2013) also identifies irregular electricity supply as a challenge in developing countries which impacts on the development of medical products and vaccines. For example, Innocent et al. (2014) state that most of the technologies used in health centres are often out of date and, in most cases, the prices of medication are exorbitant.

4.6.3. Health financing

Health financing remains a critical issue when it comes to health systems in developing countries and the topic is widely discussed in the health literature of developing countries (Innocent et al., 2014; Berman et al., 2010; Obansa & Orimisa, 2013; Ataguba & Akazili, 2010; Addae-Kornakye, 2013). In Nigeria for example, limited funds are allocated to healthcare and, as such, the quality of health services provided is lacking (Innocent et al., 2014). Berman et al. (2010) report that health financing remains a challenge in India, despite efforts to increase the overall health budget. Health financing challenges has also been reported to impede on the provision of proper health services to the community (Addae-Korankye, 2013). Literature points out that developing countries experience health financing challenges because there are usually few avenues from which income can be generated to boost the health budget (Addae-Korankye, 2013).

4.6.4. Health service

Per Moxon et al. (2015), poor health service delivery in developing countries leads to other critical issues, such as child mortality. A study in Nigeria suggests that adequate health service delivery is impeded by factors which include the poor welfare of healthcare practitioners and expensive medical products (Alagbonsi et al., 2013).

4.6.5. Health information

Lack of proper information systems, to be used in healthcare management, is also seen as a health system challenge (Moxon et al., 2015).

4.6.6. Leadership and *governance*

Moxon et al. (2015) explain that the lack of key stakeholders, who should be involved in the management of healthcare administration, is a challenge in developing countries. This implies that there is a leadership vacuum which poses a threat to the functioning system as there is less guidance in health systems in developing countries.

4.6.7. Overcoming health system challenges in developing countries

As indicated in section 4.4.3, health financing is a major challenge in developing countries and measures should thus be taken to enhance health financing. Some studies have proposed National Health Insurance (Addae-Konrankye, 2013; Jain, 2013) to tackle the issue of health financing in developing countries. For example, national health insurance in Namibia supports the working population in healthcare funding (Brockmeyer & Stiftung, 2012). To improve the quality of care and health service delivery in developing countries, Alagbonsi et al. (2013) suggest that efforts should be made to improve the income of healthcare practitioners. Moxon et al. (2015) propose the use or recent medical products to improve quality care in developing countries. Beran (2015) suggests that Ministries of Health in developing countries are responsible for managing their health systems.

The characteristics of developed countries influence their approach towards *Digital Health, Innovation* and *Digital Ecosystems,* as does the characteristics of developing countries. Developed countries have access to resources and better platforms which may assist in the development of *Digital Health* innovation ecosystems. Developing countries lack these resources which limits the implementation of *Digital Health, Innovation* and *Digital Ecosystems*. Therefore, it is important to instigate *partnerships* between developed and developing countries. Different studies have shown that these partnerships do not only benefit developing countries (WHO, 2009), but developed countries also learn how resources can be managed in a resource-constrained environment (Syed et al., 2012; Busse et al., 2014). Developing countries can also gain valuable knowledge from partnerships with other developing countries (Khoja & Naseem, 2009).

The WHO (2007) and Kaseje (2006) explain that it is necessary for partnerships between countries in order to curtail several health issues. Studies on lessons learnt in healthcare have pointed to developed countries learning from developing countries (Syed et al., 2012; Busse et al., 2014). There are instances where developing countries have provided innovative approaches to tackling health-related problems and these have served as valuable lessons for both developed and other developing countries. For example, the United States adopted an approach from Zambia to improve care for HIV/AIDs patients (Syed et al., 2012). Syed et al. (2012) further reveal that the successes of m-health implementations, in developing countries, can also serve as a lesson which developed countries can adopt. Partnerships between developed and developing countries have also resulted in the personal growth of medical practitioners from developed countries (Busse et al., 2014). For example, Busse et al. (2014) explain that medical practitioners from the US, Canada and South Africa, who assisted in an Ethiopian hospital, improved their experience. Another example of lessons learnt from developing countries is the treatment of mentally ill patients without stigmatising them (Rosen, 2006). Richman et al. (2008) report that the United States can learn from India's implementation of low cost healthcare services. Developed, as well as developing countries, can benefit from studying Ethiopia's unique approach towards providing care for chronically ill patients (Mamo et al., 2007). Mamo et al. (2007) explain that, despite scarce resources, trained healthcare workers can still assist chronically ill patients in rural communities. As explained in section 4.3.1, the challenges faced by developing countries include a scarcity of specialised medical practitioners. Mamo et al.'s (2007) study however shows that a shortage of specialised medical practitioners is not a barrier to improving healthcare.

An example of an international healthcare partnership, between developed and developing countries, is the African Partnerships for Patient Safety (APPS) which was initiated by the WHO (2007). The aim of this partnership is to enhance patient safety in Africa. Another partnership between developed and developing countries is the European and Developing Countries Clinical Trials Partnership (EDCTP) (Cassnetplus, 2016). EDCTP was established to create a link between Africa and Europe in terms of research and development. This has also impacted positively in developing countries in terms of funding, research output and clinical trials conducted in developing countries because of the collaboration (Cassnetplus, 2016).

To close, the Meeting Report (2015) indicates that developing countries (such as Kenya, Nigeria and Uganda) have made efforts to implement *Digital Health* though the use of mobile technologies.

4.6.8. Digital Health innovation ecosystems in developing countries

The current state of developing countries, as described in section 4.4, suggests that they face challenges in many different sectors. Section 4.6 further iterates this problem by explaining different health system challenges in developing countries. Poor healthcare service delivery (Moxon et al., 2015) and maternal and child mortality in developing countries (Say et al., 2015; WHO, 2016c) demand innovative responses to reduce these problems. Hence, *Digital Health Innovation Ecosystems* provide useful concepts which can be used to improve healthcare in developing countries. For example, the concept of *Digital Health* can be used to improve health management of patients in developing countries. Different technologies can be used to manage patients' health and innovation can be used to create new ideas which can facilitate better approaches in healthcare within developing countries. *Digital Health Innovation Ecosystems* have the potential of providing a platform from where innovative practices can be applied in the administration, governance and delivery of healthcare in developing countries (Herselman et al., 2016).

4.6.9. Factors affecting the implementation of Digital Health innovation ecosystems in developing countries

This section explores potential factors which may impede on the implementation of *Digital Health Innovation Ecosystems* in developing countries.

In Chapter 3, *Digital Health* is related to technologies, as most of the components are technology related (Robinson et al., 2015; Lupton, 2014b; Alemdar & Esroy, 2010; Till, 2014; Appelboom et al., 2013). This further places an issue on costs. The implication is that for *Digital Health* to be deployed in a context, several technologies need to be in place to facilitate the process. In certain countries, cost might thus hinder the implementation. Hence, health financing must be improved to facilitate the implementation of *Digital Health* technologies.

A lack of qualified healthcare practitioners in developing countries has been identified as a challenge as per section 4.6.1 Human resources, such as skilled healthcare practitioners, might also pose a threat to the implementation of *Digital Health Innovation Ecosystems* in developing countries. Practitioners with adequate skills regarding *Digital Health Innovation Ecosystems* are needed to run the program and, as such, healthcare practitioners in developing countries might have to update their skills.

Leadership and governance in the drive towards health innovation ecosystems are important. As indicated in section 4.6.6, leadership and governance in healthcare management is a challenge in developing countries and, as such, it might also be a challenge when implementing *Digital Health Innovation Ecosystems* in developing countries. As such, adequate plans should be made to manage leadership and governance in health systems in developing countries and to so facilitate *Digital Health* innovation ecosystems. Concepts, like *open innovation,* where ideas are shared across organisations (European Union, 2016), have a role to play in this regard.

The next section explains *Digital Health Innovation Ecosystems* in developed and developing countries.

4.7. DIGITAL HEALTH INNOVATION ECOSYSTEMS IN DEVELOPED AND *DEVELOPING COUNTRIES*

This section explains *how Digital Health Innovation Ecosystems* have been applied in developed, and developing, countries as explored through the application of a scoping review (as explained in section 4.3).

Colquhoun et al. (2014, p. 1292) define a scoping review as "a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting, and synthesising existing knowledge." This definition is similar to descriptions of scoping reviews from other studies which state that said reviews aim to establish the current state of research in a particular subject area (Grant & Booth, 2009; Davis et al., 2009). Davis et al. (2009, p. 1386) explain that "non-research material" could also contribute to scoping reviews. Furthermore, Arksey & O'Malley (2005, p. 6) point to the following reasons for conducting a scoping literature review:

- To examine the extent, range and nature of the research activity.
- To determine the value of undertaking a full systematic review.
- To summarise and disseminate research findings.
- To identify research gaps in the existing literature.

A scoping review was applied in this chapter (section 4.7) to examine the extent, range and nature of research activities on *Digital Health, Innovation* and *Digital Ecosystems* in developed and developing countries, as it forms the basis of *Digital Health Innovation Ecosystems* as per Chapter 3 (section 3.8). Since there has been no previous study regarding the evidence of *Digital Health Innovation Ecosystems*, an emerging field, in developed and developing contexts, it is important to summarise the current literature on the topic. In addition, applying a scoping review to this chapter could be helpful as it has been applied in similar health related studies (Murphy & Gardner, 2016; Mitton et al., 2009; Pesut et al., 2016; Sinclair et al., 2016). We can thus conclude that adopting a scoping review for this section of the chapter, is deemed suitable.

Armstrong et al. (2011, p. 148) explain the differences between a *systematic* and a *scoping* review outlined in Table 4-3.

Table 4-3: Difference between a systematic literature review and scoping review (Armstrong et al., 2011.)

Systematic review	**Scoping review**
Focused research question with narrow parameters.	Research question(s) often broad.
Inclusion/exclusion usually defined at outset.	Inclusion/exclusion can be developed post hoc.
Quality filters often applied.	Quality not an initial priority.
Detailed data extraction.	May or may not involve data extraction.
Quantitative synthesis often performed.	Synthesis more qualitative and typically not quantitative.
Formally assesses the quality of studies and generates a conclusion relating to the focused research question.	Used to identify parameters and gaps in a body of literature.

As described in Table 4.3, applying a scoping review for section 4.7 is appropriate as it meets the requirements for searching for relevant literature on the topic. The chapter also provides general information related to Digital Health, Innovation and Digital Ecosystems in developed and developing countries. The process of synthesising publications, retrieved from the search, was qualitative in nature.

Table 4-4: Arskey & O'Malleys's scoping review framework (2005).

Stages in the Arksay and O'Mallay framework	**Description and scoping review stage**
Identify the research question. Applied to section 4.7.1 in this study.	The scoping review question must be clearly defined as it plays a role in all subsequent stages, including the search strategy. To examine and summarise breadth, scoping review questions are broad.
Identify relevant studies. Applied to section 4.7.2 in this study.	This stage involves identifying the relevant studies and developing a plan to govern the search, which terms to use, which sources to search, time span, and language. Sources include: electronic databases, reference lists, hand searching of key journals, and organisations and conferences. Comprehensiveness and breadth is important; however, so too are the practicalities of time, budget and personnel resources. Decisions need to be made upfront regarding which (and how) feasibility issues will impact upon the search.

Study selection. Applied to section 4.7.3 in this study.	Study selection involves post-hoc inclusion, and exclusion criteria. These criteria are based on the specifics of the research question and on a newly found familiarity with the subject matter through reading the studies.
Chart the data. Applied to section 4.7.4 in this study.	A data charting form is developed and used to extract data from each study. A ''narrative review'' or ''descriptive analytical method" is used to extract contextual, or process-oriented, information from each study.
Collate, summarise and report the results. Applied to section 4.7.5 in this study.	An analytic framework, or thematic construction, is used to provide an overview of the breadth of the literature. A numerical analysis of the nature and extent of studies using tables and charts is presented. A thematic analysis is then presented. Clarity and consistency are required when reporting results.
Consultation. Not applied in this study.	This optional stage provides opportunities for consumer and stakeholder involvement to suggest additional references, and provide insights beyond those found in the literature.

Arskey & O'Malley (2005) provided a framework for performing scoping review which was adopted in this chapter

The next section explains *how* Arskey and O'Malley's scoping review framework was applied in this section.

4.7.1. Identifying the research questions:

The research question for this study, which aided in the scoping review, was posed in Chapter 1: What does the existing literature communicate about *Digital Health, Innovation* and *Digital Ecosystems*?

4.7.2. Identifying relevant studies:

To find relevant papers and documents on *Digital Health*, the following databases were used: ACM digital library, IEEE Xplore, Scopus, ScienceDirect and Pubmed. Harzing's Publish or Perish software was also used to identify highly cited studies which were not indexed in the databases. To access other relevant publications on *Digital Health*, a manual search was conducted using the Google search engine. To ensure that a comprehensive search was accomplished, the following key words were used for all searches: "*Digital Health*" AND "Europe"; "*Digital Health*" AND "North America"; "*Digital Health*" AND "South America"; "*Digital Health*" AND "Australia OR Oceania"; "*Digital Health*" AND "Asia"; "*Digital Health*" AND "Antarctica"; "*Digital Health"* AND "Africa". The search period was from 2006 to 2016. Using Harzing's Publish or Perish software, the key words were entered in the *All of the words* section, the *Year of Publication* was indicated as between 2000 and 2016. Manual searches for relevant literature was also conducted to identify academic and non-academic publications. The search was conducted in September 2016.

4.7.3. Study Selection:

The inclusion and exclusion criteria were:

- Publications written in English were *included*.
- Studies referring to specific countries, identified as either developed or developing, as recommended by the World Bank (2016b) were *included*.
- Studies within Digital Health, innovation or digital ecosystems were *included*.
- Studies on Digital Health technologies in a particular context were *included*.
- Studies on innovation related to healthcare, business or any other relevant context were *included*.
- Innovation studies regarding the agricultural sectors and non-technical were *excluded*.
- Studies referring to any form of digital ecosystems, in any context, were *included*.
- Studies which did not refer to a specific context were *excluded*.
- Websites where the authors could not be verified were *excluded*.

Figures 4.5, 4.6 and 4.7 illustrate the search process for retrieving the relevant publications on *Digital Health*, *Innovation* and *Digital Ecosystems.*

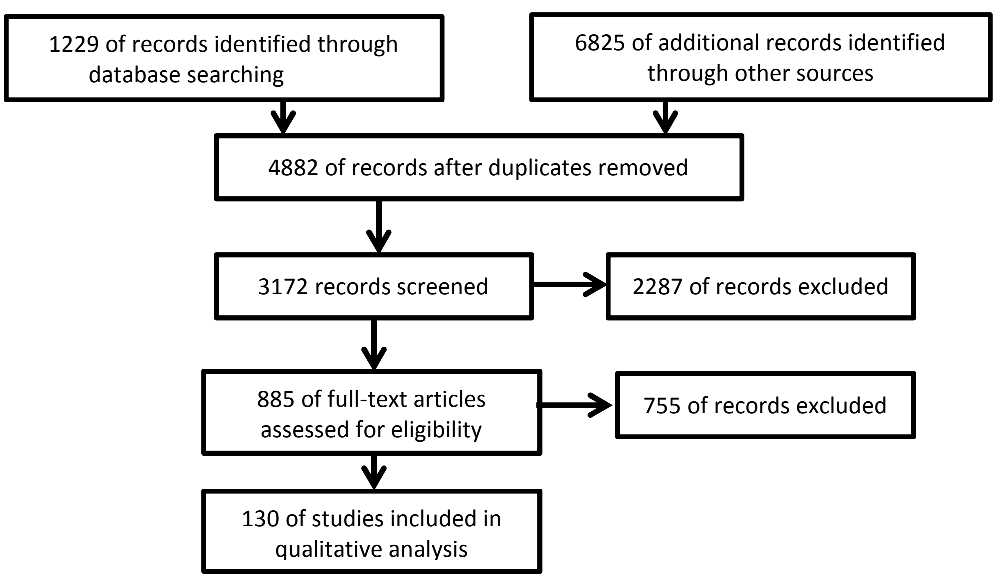


Figure 4-5: Different phases of the scoping review search for studies on digital health in developed and developing countries. (Adapted from Moher et al., 2009).

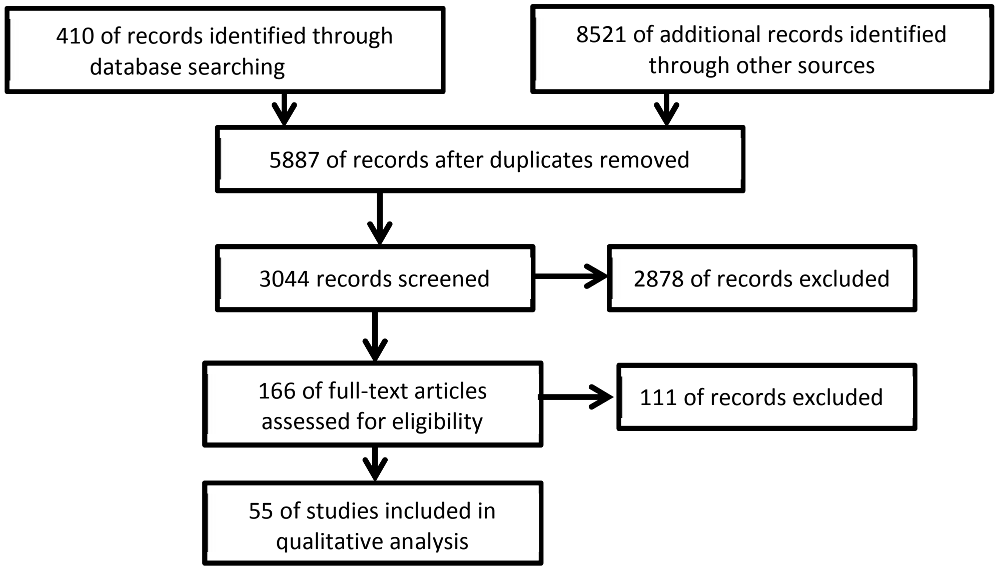


Figure 4-6: Different phases of the scoping review search for studies on innovation in developed and developing countries (Adopted from Moher et al., 2009).

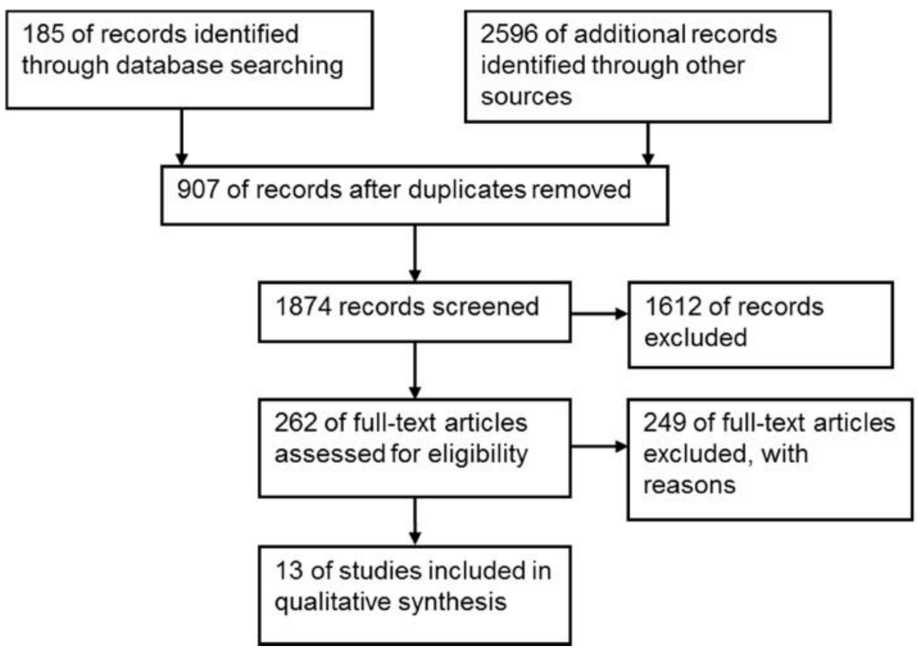


Figure 4-7: Different phases of the scoping review search for studies on digital ecosystems in developed and developing countries (Adopted from Moher et al., 2009)

4.7.4. Charting the data

The data chart for included publications is presented with information about the:

- author,

- publication date,
- title of publication,
- methodology applied,
- publication type and
- key point of the study.

The following tables are relevant to the studies on:

- Digital Health; Table 4-5,
- Innovation; Table 4-6 and
- Digital Ecosystems; Table 4-7.

Table 4-5 outlines publications which met the inclusion criteria for Digital Health.

Table 4-5: Studies which met the inclusion criteria for *Digital Health.*

Country	Publication title	Authors	Methodology	Publication type	Key points of the study
United States	Use of Electronic Health Records in U.S. Hospitals	Jha et al. (2009)	Quantitative	Journal article	The study examined the use of EHRs in American hospitals.
United Kingdom	Potential of electronic personal health records	Pagliari et al. (2007)	Qualitative	Journal article	The study reviewed issues surrounding EHRs in the UK setting.
United States	The digitisation of healthcare: boundary risks, emotion, and consumer willingness to disclose personal health information	Anderson & Agarwal (2011)	Quantitative	Journal article	The study investigates privacy and security issues concerning the digitalising of healthcare.
Denmark	Building nation-wide information infrastructures in healthcare through modular implementation strategies	Aanestad & Jensen (2011)	Qualitative	Journal article	The study examined the failures and successes of two projects which aimed at providing a national EHR for Denmark.
Netherlands	Feedback presentation for mobile personalised digital physical activity Coaching Platforms	Klaassen et al. (2013)	Qualitative	Conference paper	The study discussed the development and evaluation of a self-management/self tracking app which provides responses to the user and is facilitated through wireless sensors.
United Kingdom	FeedFinder: A Location-Mapping Mobile Application for Breastfeeding Women	Balaam et al. (2015)	Qualitative	Conference paper	The study presented the design and evaluation of a mobile application which aided women in searching a location to breastfeed their children where similar nursing mothers are located.
Denmark	How Physicians ‘Achieve Overview’: A Case-based Study in a Hospital Ward	Bossen & Jensen (2014)	Qualitative	Conference paper	The study examined how medical practitioners view comprehensiveness in the use of an electronic patient record and explores design lessons for electronic patient records.
United Kingdom	The Cumbria Rural Health Forum: initiating change and	Ditchburn & Marshall (2015)	Qualitative	Journal article	The study reports on the findings of a forum held by stakeholders to facilitate *Digital*

	moving forward with technology				*Health* in Cumbria, United Kingdom, which also presented a plan to facilitate the process.
Ireland	Low-intensity internet-delivered treatment for generalised anxiety symptoms in routine care: protocol for a randomised controlled trial	Richards et al. (2014)	Mixed method	Journal article	The study examined the use of the internet to treat students with Generalised Anxiety Disorder in Ireland.
Finland, Estonia, South Africa	A Digital Health Innovation Ecosystem for South Africa	Herselman et al. (2016)	Qualitative	Conference paper	The study reviewed *Digital Health* and innovation ecosystems in Finland and Ecosystems which informed research on conceptualising a *Digital Health Innovation Ecosystem* which can be applied to a South African context.
United Kingdom, Norway, Denmark, Sweden	The Electronic Health Record: A Comparison of Some European Countries	Bonomi (2016)	Qualitative	Journal article	The study reviews EHRs in four European countries and comments on issues related to EHRs within the United Kingdom, Norway, Denmark and Sweden.
United Kingdom, Hungary, Spain, Switzerland, Netherlands	Strategies for health data exchange for secondary, cross-institutional clinical research	Elger et al. (2010)	Qualitative	Journal article	The study explored health data exchange in European countries.
Denmark, United States, Sweden, Netherlands, Estonia, Belgium, Austria, Bulgaria, Croatia, Cyprus, Czech Republic, United Kingdom, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Norway, Poland, Portugal, Romania, Slovak Republic Spain	E-prescription across Europe	Kierkegaard (2013)	Qualitative	Journal article	The study extensively investigates e-prescription implementation across European countries. It also provided information about e-prescription in the United States.
Slovak Republic, Sweden, Bulgaria, Germany, France, Austria, Denmark, United Kingdom, Estonia, Finland, Norway, Switzerland, Czech Republic, Spain, Romania,	European countries on their journey towards national eHealth infrastructures	Stroetmann et al. (2011)	Qualitative	Report	The study reports on different e-health issues in European countries ranging from e-health, e-health policy document, e-health legislation, e-health strategy, e-health legal framework, electronic care record, nation wide web based EHR, national patient

Italy					summary, personal health record, EHRs, e-receipt, digital prescription, e-health strategy for telemedicine implementation, telemedicine at national level and telehealth.
Netherlands	Personal health records in Dutch hospitals: is the hype already over?	Dubbink (2013)	Qualitative	Masters Thesis	The study examined the use of personal health records in Dutch hospitals.
Netherlands	Online health anxiety and consultation satisfaction: A quantitative exploratory study on their relations	Tanis et al. (2016)	Qualitative	Journal article	The study examined the use of the internet to search for health information in the Netherlands.
Jordan	eHealth literacy among undergraduate nursing students	Tubaishat & Habiballah (2016)	Qualitative	Journal Article	The study examined the level of e-health literacy among nursing students in Jordan.
United Kingdom	Pilot randomised controlled trial of a web-based intervention to promote healthy eating, physical activity and meaningful social connections compared with usual care control in people of retirement age recruited from workplaces	Lara et al. (2016)	Mixed method	Journal Article	The study applied a randomised controlled trial to examine the outcome of promoting healthy living for retired adults using the web in North England.
Pakistan	Formulation of a National e-Health Strategy Development Framework for Pakistan	Ali (2013)	Qualitative	Masters thesis	The study reviewed relevant literature on e-health and developed an e-health framework for Pakistan.
Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Panama, Peru	e-Health in Latin America and the Caribbean: progress and challenges	Fernández & Oviedo (2011)	Qualitative	Report	The study provided an overview of e-health in Latin American countries revolving around telemedicine, e-health frameworks and m-health.

United Kingdom	Enhanced broadband access as a solution to the social and economic problems of the rural digital divide	Townsend et al. (2013)	Qualitative	Journal article	The study examined the need for extending internet services to rural communities in Britain (UK).
United Arab Emirate	Managing Development for the Health Records to be centralised Electronically, in UAE	Al Rae (2013)	Qualitative	Masters Thesis	The study examines EHRs in the United Arab Emirate.
Italy	E-health and value co-creation: the case of electronic medical record in an Italian academic integrated hospital	Bonomi et al. (2015)	Qualitative	Book chapter	The study explored the advantages attached to implementing EMRs in Italian hospitals.
United States	Who tweets about cancer? An analysis of cancer-related tweets in the USA	Murthy & Eldredge (2016)	Quantitative	Journal article	The study examined the use of tweets in disseminating cancer information in the United States.
Australia, Canada, United Kingdom, United States	Health Information in Ireland: A socio-technical analysis	Craig (2015)	Qualitative	Report	The study explored health information policies in Ireland, Canada, United Kingdom and the United States.
Dominican Republic	Necessity of implementing electronic personal health information privacy regulation in Dominican Republic	Molina (2010)	Qualitative	Masters thesis	The study investigated laws regarding privacy in EHRs.
South Africa	Building the capacity to build capacity in e-health in sub-Saharan Africa: the KwaZulu-Natal experience	Mars (2012)	Qualitative	Journal article	The study examines human resources in e-health within the context of South Africa.
United States	The state of health information technology in the United States	Yu (2014)	Qualitative	Journal article	The study identified that health information technology has been implemented in the United States.
Nigeria	Implementation of an efficient *Digital Healthcare* delivery system in Nigeria	Sarumi & Idowu (2016)	Qualitative	Journal article	The study examines Digital healthcare challenges in Nigeria.

Romania	Online health information seeking during adolescence: A quantitative study regarding Romanian teenagers	Duduciuc (2015)	Quantitative	Journal article	The study investigated the use of social networks to find health information in Romania. Teenagers use this to an extent.
Australia	E-health in Australia and elsewhere: A comparison and lessons for the near future	Gajanayake et al. (2013)	Qualitative	Journal Article	The study identified the need for e-health policy in Australia.
Nigeria	Using mobile technology to improve maternal health and fight Ebola: A case study of mobile innovation in Nigeria	West (2015)	Qualitative	Report	The study described the use of m-health in Nigeria.
China	Mobile health in China: current status and future development	Li et al (2014)	Qualitative	Journal article	The study investigated m-health in China and found that it is emerging.
Denmark, Estonia, Italy, Sweden, France, Belgium, Spain, Slovek Republic, Slovenia, United Kingdom	Patient use of email for healthcare communication purposes across 14 European countries: an analysis of users according to demographic and health related factors	Newhouse et al. (2015)	Quantitative	Journal Article	The study explored the use of email to contact doctors in European countries.
Australia	The introduction of the national e-health record into Australian community pharmacy practice: pharmacists' perceptions	Mooranian et al. (2013)	Qualitative	Journal article	The study examined the use of a personally controlled electronic health record.
Poland	Trends in the use of the Internet for health purposes in Poland	Bujnowska-Fedak (2015)	Qualitative	Journal article	The study examined the use of the internet to search for information in Poland.
United Kingdom	The ownership and clinical use of smartphones by doctors and nurses in the UK: a multicentre survey study	Mobasheri et al. (2015)	Quantitative	Journal article	The study examined the use of mobile devices in healthcare.
Turkey	Reaching and recruiting Turkish migrants for a clinical trial through Facebook: A process evaluation	Ince et al. (2014)	Qualitative	Journal article	The study examined the use of social media to select participants for a clinical trial in Turkey.
United Kingdom	Telehealth for patients at high	Salisbury et al.	Quantitative	Journal	The study examined the use of telehealth in

	risk of cardiovascular disease: pragmatic randomised controlled trial	(2016)		article	England.
Estonia	Digital health record and handling of sensitive data in Estonia	Tikk (2006)	Qualitative	Journal Article	The study examined privacy in *Digital Health* records in Estonia.
Norway	Using the internet to support exercise and diet: a Stratified Norwegian Survey	Wangberg et al. (2015)	Quantitative	Journal article	The study examined the use to of the internet for weight loss.
Switzerland	Swiss food quiz: Inducing nutrional knowledge via a visual learning based serious game	Klaus et al. (2016)	Quantitative	Conference paper	The study examined applying serious games concepts in designing a nutritional education program.
Bangladesh	E-health and m-health in Bangladesh – Opportunities and challenges	Ahmed et al. (2014)	Qualitative	Report	Digital Bangledesh 2021 with e-health strategies incorporated. Bangledesh uses online e-health systems. Mobile phone devices are also being used in Bangladesh to support health workers in rural communities.
China	Mobile health in China - Current status and future development	Li et al. (2014)	Qualitative	Journal article	The study reveals that m-health is needed in China as it holds great potential in that country.
United States	US hospitals on YouTube: A test to the Altruistic marketing approach	Huang (2013)	Qualitative	Journal article	The study describes the use of YouTube as an advertising strategy in United States hospitals.
India	ICT based health governance practices	Nair (2014)	Qualitative	Journal article	The study investigates ICT governance in India regarding healthcare and to provide lessons.
Taiwan	Online Health Information (OHI) Utilisation among Selected Worksite Employees in Taiwan	Hou et al. (2012)	Quantitative	Journal article	The study examines the use of the internet for finding health information.
Bangladesh	mHealth: Blood donation service in Bangladesh	Islam et al. (2013)	Qualitative	Conference paper	The study explains the development of a mobile application to support the management of blood donation.
Uganda	A study of the preconditions for a sustainable implementation of a *Digital Health* system in Uganda	Gardstedt et al. 2013	Qualitative	Bachelors thesis	The study describes the requirements for developing a *Digital Health*care system in Uganda.

Bangladesh	E-health futures in Bangladesh	Sheraz et al. (2012)	Qualitative	Journal article	The study focuses on the views of health stake holders in Bangladesh to determine the plans for e-health.
Bangladesh	Mobile phone interventions for adherence to treatment for diabetics in an urban area of Bangladesh	Sheikh (2015)	Quantitative	PhD Thesis	The study explores the use of mobile phones to improve the treatment of diabetes in Bangladesh.
South Africa	Development of a mobile phone based ophthalmoscope for telemedicine	Blanckenberg et al. (2011)	Quantitative	Conference paper	The study proposes the use of mobile phones in telemedicine eye care.
Malawi	Establishing long-term nursing informatics capacity in Malawi, Africa	O'Connoe et al. (2016)	Qualitative	Journal article	The study explored building a workforce in nursing informatics in Malawi through collaborative efforts.
Indonesia	Midwives and mobiles: using ICTs to improve healthcare in Aceh Besar, Indonesia	Chib et al. (2008)	Qualitative	Journal article	The study explored the benefits of mobile phones for providing midwife care.
India	Health IT in Indian Healthcare System: A New Initiative	Kalpa (2012)	Qualitative	Journal article	The study reviewed the health information system in India.
Swaziland	LabPush: A pilot study of providing remote clinics with laboratory results via short message service (SMS) in Swaziland, Africa – A qualitative study	Hao et al. (2015)	Qualitative study	Journal article	The study explored the use of mobile phones in delivering test results in Swaziland.
India	Mobile Phones for Maternal Health in Rural India	Kumar & Anderson (2015)	Mixed method	Conference paper	The study explored the use of mobile phones for health-related purposes.
Saudi Arabia	Telecare for managing diabetes in Saudi Arabia	Al-Kadi (2012)	Quantitative method	PhD Thesis	The study examined the use of telemedicine in hospitals in Saudi Arabia.
Sudan	Managing scaling of HIS: Implementation of DHIS2 in Sudan	Al-Nashy (2015)	Qualitative	Masters Thesis	The study explored the implementation of a health information system in Sudan.
Saudi Arabia	Technology acceptance issues for a mobile application to support diabetes patients in Saudi Arabia	Alkhudairi (2016)	Mixed method	PhD thesis	The study examined the acceptance of telemedicine in Saudi Arabia using mobile applications.

South Africa	Mhealth implementation in South Africa	Botha and Booi	Qualitative	Conference paper	The study reviewed m-health implementation in South Africa
Malawi	User perceptions on Electronic Medical Record System (EMR) in Malawi	Msukwa (2011)	Mixed method	Masters Thesis	The study examined the perception of EHR in Malawi.
Ethiopia	Need assessment framework for electronic health record management system in Ethiopia	Aklilu (2012)	Mixed method	Masters Thesis	The study examined the need for electronic medical records in Ethiopia.
India	Evaluation and analysis of technology acceptance of healthcare professionals in Karnataka, South India	Hiregoudar et al. (2015)	Quantitative	Conference paper	The study evaluated health information systems in healthcare in India.
Canada	Metabolic Diet App Suite for inborn errors of amino acid metabolism	Ho et al. (2016)	Qualitative	Journal article	The study presented the development of an app, both online and mobile, to chek for inborn errors od amino acid
South Africa	Telemedicine in South Africa	Mars (2009)	Qualitative	Book chapter	This study examines telemedicine in South Africa.
United States	The role of the internet as a tool to aid in U.S adult consumers' weight loss	Kirby (2006)	Qualitative	Masters Thesis	This study examined the use of the Internet to reduce weight in the United States.
Estonia	E-health strategies - Country brief Estonia, in European Commission DG Information Society and Media, ICT for Health Unit	Doupi et al. (2010)	Qualitative	Report	The study reports on e-health in Estonia.
Canada	Open-source health information technology: A case study of electronic medical records	Safadi et al. (2015)	Qualitative	Journal article	The study examines the use of electronic medical records using open source software.
Estonia	Patient online services in Estonia	Karik et al. (2012)	Qualitative	Gray literature	The document provided information about health information systems in Estonia.
Netherlands	Dutch healthcare: An overview and application	Misser (2014)	Qualitative	Conference paper	The study provided an overview of e-health systems in the Netherlands.
Finland	Implementation issues for wireless medical devices	Ashraf (2007a)	Quantitative	Conference paper	The study provided an overview of ongoing research into wireless medical devices implementation.

Finland	Healthcare process management supported by wireless technology	Ashraf (2007b)	Qualitative	Conference paper	The study provided an overview of an ongoing research into wireless sensors for health purposes.
Estonia	Overview of Estonian electronic health record (EHR) system	Estonia E-health Foundation (2010)	Qualitative	Website	The study gives an overview of EHRs in Estonia.
Estonia	Estonia: A model for e-government	Anthes (2015)	Qualitative	Journal article	The study provides an overview of X-road implemented in Estonia.
Estonia	From innovation to implementation	WHO Europe (2016)	Qualitative	Report	The study reports on e-health across different countries.
Finland	E-health strategy and action plan of Finland in a European context	Workshop report (2013)	Qualitative	Report	The study reports on e-health in Finland.
Finland	E-health and e-welfare of Finland	Hyppönen et al. (2015)	Qualitative	Report	The study reports on e-health in Finland.
China, United Arab Emirate, Netherlands	UAE, The Netherlands and China leading the way in *Digital Health* adoption	Gray et al. (2016)	Qualitative	Website	The website reports on the three countries' adoption of *Digital Health.*
Canada	How *Digital Health* is thriving in Canada	Enriquez (2014)	Qualitative	Website	The website reports on Canadian *Digital Health.*
Canada	Telemedicine on the rise across Canada	Glauser et al. (2015).	Qualitative	Website	The website reports on telemedicine use in Canada.
Canada	The impact of telemedicine on primary mental healthcare in Canada	Francisco & Archer (2015)	Qualitative	Report	The study reports on telemedicine use in Canada.
Estonia	Estonia ranked first worldwide in terms of broadband Internet speeds	Kolyako & Riga (2012)	Qualitative	Website	The website contains the report on internet speed in Estonia.
Finland	Finland makes broadband a 'legit right'	British Broadcasting Corporation (2010)	Qualitative	Website	The website reports on Finland making access to the internet a necessity.
United Kingdom	Fastest ever commercial	Vincent (2014)	Qualitative	Website	The website reports internet speed in

	internet speeds in London: Download 44 films in a second				London.
United States	Process evaluation of a mHealth program: Lessons learned from Stop My Smoking USA, a text messaging-based smoking cessation program for young adults	Ybarra et al. (2014)	Qualitative	Journal article	The study reported on an m-health program with the goal to reduce smoking in the Unites States.
United States	Toward an mHealth intervention for smoking cessation	Ahsan et al. (2013).	Qualitative	Conference paper	The study reports on an m-health program to reduce smoking habits.
Canada	Two new TELUS-powered apps for a healthy lifestyle	TELUS (2011)	Qualitative	Website	The website reports on an m-health program which helps to reduce smoking habits.
Finland, Cameroon	Architectural choices for mHealth services in Finland and Cameroon	Veijalainen et al. (2011)	Qualitative	Conference paper	The study reports on m-health in Finland and Cameroon.
United States	Public Health Surveillance in the United States: Evolution and Challenges	Thacker et al. (2012)	Qualitative	Report	The study reports on public health surveillance in the United States.
United States	The past, present, and future of public health surveillance	Choi (2012)	Qualitative	Journal article	The study reports on public health surveillance.
South Africa	On the prioritisation of data quality challenges in e-health systems in South Africa	Botha et al. (2015)	Qualitative	Conference paper	The study explored ranking data quality challenges in South Africa.
Nigeria	Scale up of networked HIV treatment in Nigeria: Creation of an integrated electronic medical records system	Chaplin et al. (2015)	Qualitative	Journal article	The study explores the use of EMRs for treatment of HIV in Nigeria.
South Africa, Tanzania, Kenya	The Open MRS Implementers Network	Seebregts et al. (2009)	Qualitative	Journal article	The study explored EMRs in different countries.
South Africa, Tanzania	E-health technologies show promise in developing countries	Blaya et al. (2010)	Qualitative	Journal article	The study explored EMRs in different countries.
Kenya	Innovative approaches to application of information technology in disease surveillance and prevention in	Odero et al. (2007)	Qualitative	Journal article	The study describes how adding injury details to an existing EMR could help promote decision making regarding healthcare.

	Western Kenya				
Uganda	Implementation of electronic medical records requires more than new software: Lessons on integrating and managing health technologies from Mbarara, Uganda	Madore et al. (2015)	Qualitative	Journal article	The study explains the challenges involved in implementing and ensuring that medical workers make use of the system in Uganda.
South Africa	Mobile health technology transforms injury severity scoring in South Africa	Spence et al. (2016)	Quantitative	Journal article	This study explains how an electronic trauma health record was implemented in South Africa which replaced paper based records.
Nigeria	Development of a master health facility list in Nigeria	Makinde et al. (2014)	Qualitative	Journal article	The study highlights the need for a unique identifier during the implementation of an electronic routine health information system.
Namibia	Assessment of National Health Information Systems	USAID (2012)	Qualitative	Report	The study reports on the health sector in Namibia.
South Africa	A hospital based surveillance system to assess the burden of trauma in KwaZulu-Natal Province South Africa	Lutge et al. (2016)	Quantitative	Journal article	The study explored the use of a surveillance system to examine trauma cases.
South Africa, Ethiopia, Burkina Faso, Nigeria	A meta-analysis of telemedicine success in Africa	Walama & Augustine (2013)	Qualitative	Journal article	The study explores telemedicine in South Africa and how it can affect Ethiopia, Nigeria and Burkina Faso.
Kenya	Pilot results of a telemedicine social franchise in rural Kenya: Evidence of sustainable livelihood creation	Holmes et al. (2014)	Quantitative	Conference paper	The study explored a telemedicine pilot study in Kenya.
South Africa	Informal m-health: How are young people using mobile phones to bridge healthcare gaps in Sub-Saharan Africa?	Hampshire et al. (2015)	Mixed method	Journal article	The study investigated how young people use mobile phone for healthcare purposes.
Nigeria, South Africa	Evaluation of short message service and peer navigation to improve engagement in HIV care in South Africa: Study protocol for a three-arm cluster randomised controlled trial	Lippman et al. (2016)	Qualitative	Journal article	A preliminary study investigating the use of text messages for treating HIV.

Kenya	Health service delivery In developing countries through ehealth: Making the case For low-cost wireless infrastructures	Iluyemi et al. (2008)	Qualitative	Conference paper	The study explains the use of internet in providing healthcare services in Nigeria and South Africa.
Kenya	The PartoPen in practice: evaluating the impact of digital pen technology on maternal health in Kenya	Underwood (2013)	Qualitative	Conference paper	The study explores the digital Partopen used in administering healthcare services to pregnant women during labour.
Kenya	Exploring the use of mobile phone technology for the enhancement of the prevention of mother-to-child transmission of HIV program in Nyanza, Kenya: a qualitative study	Jennings et al. (2013)	Qualitative	Journal article	The findings from a study conducted by Jennings et al. (2013) with the aim to determine how mobile phones can be used to reduce mother to child transmission of HIV. It suggests that people in Kenya use their mobile phones for healthcare purposes.
Nigeria	Web application by South African health institutions	Gwetu (2009)	Qualitative	Conference paper	The study examined how South African health institutions utilise websites to perform different activities such as advertising their services and providing health information to the public.
Nigeria	Optimising the digital age health-wise: utilisation of new/social media by Nigerian teaching hospitals	Batta & Iwokwagh (2015)	Qualitative	Conference paper	The study examined social media platforms being used in teaching hospitals in Nigeria.
Tanzania	The use of social media among adolescents in Dar es Salaam and Mtwara, Tanzania	Pfeiffer et al. (2014)	Mixed method	Journal article	The study investigates the use of the internet to search for information regarding sexual health.
Nigeria	Use of Internet for health information by physicians for patient care in a teaching hospital in Ibadan, Nigeria	Ajuwon (2006)	Quantitative	Journal article	The study explores the used of the internet in patient care in Nigerian teaching hospitals.
South Africa	An investigation into the use of 3G mobile communications to provide telehealth services in rural KwaZulu-Natal.	Clarke & Mars (2015)	Qualitative	Conference paper	The study is aimed at investigating the use of mobile data networks in rural areas of Kwazulu Natal to provide telemedicine services.
Nigeria	An overview of disease	Isere et al. (2015)	Qualitative	Journal	The study reports on disease monitoring in

	surveillance and notification system in Nigeria and the roles of clinicians in disease outbreak prevention and control			article	Nigeria.
Nigeria	Assessment of integrated disease surveillance and response strategy implementation in selected Local Government Areas of Kaduna state	Abubakar et al. (2013)	Quantitative	Journal article	The study reports on the implementation of the Integrated Disease Surveillance Reporting system in Kaduna State, Nigeria.
Uganda	The implementation of Integrated Disease Surveillance and Response in Uganda: A review of progress and challenges between 2001 and 2007	Lukwago et al. (2011)	Quantitative	Journal article	The study reports on disease surveillance systems in Uganda and their outcomes.
Kenya	A new screening instrument for disability in low-income and middle-income settings: application at the Iganga-Mayuge Demographic Surveillance System (IM-DSS), Uganda	Bachani et al. (2014)	Quantitative	Journal article	The study describes the Iganga-Mayuge Demographic Surveillance System, a demographic surveillance system which keeps track of disability incidence.
South Africa	Evaluation of two influenza surveillance systems in South Africa	Budgell et al. (2015)	Quantitative	Journal article	The study evaluated two surveillance systems deployed in South Africa.
Kenya	Implementation of a cloud-based electronic medical record for maternal and child health in rural Kenya	Haskew et al. (2015)	Qualitative	Journal article	The study described the implementation of a cloud-based electronic medical record to support healthcare management for maternal care in rural hospitals in Kenya.
Namibia	Tele-medicine centre	MoHSS (2016)	Qualitative	Website	The website describes the tele-medicine centre in Namibia.
Kenya	I’ve got 99 problems but a phone ain’t one: Electronic and	Kumar et al. (2016)	Qualitative	Journal article	The papers describe the challenges affecting e-health and m-health in developing

	mobile health in low and middle income countries				countries, focusing on Kenya. It proposes ways in which these problems can be addressed.
Mali	Feasibility and effectiveness of mhealth for mobilising households for indoor residual spraying to prevent malaria: A case study of Mali	Mangam et al. (2016)	Quantitative	Journal article	The study examined whether the use of mobiles phone text messages or voice messages could be used to replace a human based approach to indoor residual spraying.
Nigeria	Evolution of Facebook groups: Informal e-learning among medical laboratory scientists in Nigeria	Cassanati et al. (2014)	Qualitative	Journal article	The study examined the use of Facebook to assist medical laboratory scientists in Nigeria.
Estonia	E-health initiatives in Estonia	Leego (2005)	Qualitative	Journal article	This study presents an overview of e-health in Estonia.
United States	SUNDROP: six years of screening for retinopathy of prematurity with telemedicine	Wang et al. (2015)	Qualitative	Journal article	This study describes telemedicine to monitor patients with retinopathy of prematurity.
United States	Trends in telemedicine use in addiction treatment	Molfenter et al. (2015)	Qualitative	Journal article	This study examines the use of telemedicine in the treatment of addiction related health issues.
Taiwan	A cloud computing based 12-lead ECG telemedicine service	Hsieh & Hsu (2012)	Qualitative	Journal article	This study described a cloud-based computing service for Electrocardiography (ECG) developed in Taiwan.
Denmark, Finland, Sweden, Austria, Estonia, the Netherlands, Belgium, France, Germany, Italy, Spain, Switzerland and the UK	Leveraging cloud computing for healthcare	Cocir (2016)	Qualitative	Report	This study reports on cloud computing and its use within the healthcare sector.
Finland	The success of a management information system in healthcare - A case study from Finland	Kivinen & Lammintakanen (2013)	Qualitative	Journal article	This study explains the use of management information systems within the context of healthcare in Finland.

Having presented publications which met the inclusion criteria for Digital Health, Table 4-6 outlines publications which met the inclusion criteria for Innovation.

Table 4-6: Studies which met the inclusion criteria for Innovation.

Country	Publication title	Author	Methodology	Publication type	Key points of the study
Tanzania, Finland	Building CS research capacity in sub-Saharan Africa by implementing a doctoral training program	Apiola et al. (2015)	Qualitative	Conference paper	The study examined strategies for increasing innovation in Tanzania by setting up a collaborative program with Finland to increase doctoral output.
South Africa	An analysis of the impact of digital community hubs in facilitating ICT diffusion in Peri-urban areas: A case of Inanda Ntuzuma Kwamashu (INK) digital hub, Durban, South Africa	Kariuki (2009)	Qualitative	Conference paper	The study examined the results of implementing ICTs in a rural community in South Africa.
Kenya, Uganda	Computer science research capacity as a driver of ICTD innovation: Institutional factors in Kenya and Uganda	Harsh & Zachary (2013)	Qualitative	Conference paper	The study examined collaboration between two computer science departments in Kenya and Uganda in a bid to support innovation.
South Africa, Brazil	Brazil and South Africa Collaboration for Public Software. Building the South Africa Public Software Ecosystem	Santos & Coasta (2013)	Qualitative	Conference paper	Collaboration between Brazil and South Africa for Innovation purposes.
Kenya, Rwanda, Tanzania, Ghana, Cameroon, Zambia and Uganda	How ICT Hubs have impacted on the technology entrepreneurship development	Moraa & Gathege (2013)	Qualitative	Conference paper	The study examined ICT hub development in countries such as Kenya, Rwanda, Tanzania, Ghana, Cameroon, Zambia and Uganda and how it has improved innovation in business.
Angola, Botswana, Malawi, Mozambique, Namibia, Swaziland Tanzania, Lesotho, Mauritius, Mozambique and South Africa.	Report on innovation spaces and living labs in IST – Africa partner countries	Cunningham & Cunningham (2016)	Qualitative	Report	The examined innovation spaces and living labs in IST- Africa partner countries.
United States	Learning through pop-culture: A	Richardson et	Qualitative	Journal	The study explained how entertainment platforms

Country	Publication title	Author	Methodology	Publication type	Key points of the study
	practical pedagogical methodology for teaching case studies and case analysis	al. (2008)		article	were used to facilitate "case analysis" skills at a University in the United States.
Argentina, Brazil, Chile and Uruguay	Services sectors in the biotechnology firms of South America: A focus in Argentina, Brazil, Chile and Uruguay	Niosi & Bas (2014)	Qualitative	Journal article	An examination of biotechnology innovation in Argentina, Brazil, Chile and Uruguay.
Chile, Colombia, and Peru	Non-technological innovations: Market performance of exporting firms in South America	Pino et al. (2016)	Quantitative	Journal article	The study examines how organisational and marketing innovations impact upon products.
India	Achieving millennium development goals: Role of ICTs innovations in India	Siriginidi (2008)	Qualitative	Journal article	The examined technology helps India to reach MDGs.
Finland	Oulu: Triple Helix Driven Municipal Wireless Network Providing Open and Free Internet Access	Ojala et al. (2011)	Qualitative	Conference paper	The study described the development of a wireless network, following the Triple Helix System.
Australia	Factors influencing technical innovation in construction SMEs: An Australian perspective	Hardie & Newell (2011)	Mixed method	Journal article	The study examined factors that give rise to innovation in SMEs in the construction business.
Australia	Factors affecting the adoption of technological innovation by individual employees: An Australian study	Talukder (2012)	Quantitative	Conference paper	The study identified factors that give rise to innovation by people who work in Australia.
Australia, New Zealand	Factors influencing the success of wood product innovations in Australia and New Zealand	Bull & Ferguson (2006)	Qualitative	Journal article	The study identified the factors driving successful and unsuccessful wood product innovation in Australia and New Zealand.
Australia	A qualitative study of innovations implemented to improve transition of care from maternity to child and family health (CFH) services in Australia	Psaila et al. (2012)	Qualitative	Journal article	The study examined healthcare innovations in Australia.
Finland, Netherlands, Germany, United	Open innovation in secondary software firms: An exploration of	Morgan & Finnegan	Qualitative	Journal article	The study examined open innovation using open source software in European countries.

Country	Publication title	Author	Methodology	Publication type	Key points of the study
Kingdom, Spain, Sweden, Italy, Ireland, France and Switzerland	managers' perception of open source software	(2010)			
Namibia, Finland	NCRST Establishes First Demola in Africa	NCRST (2016)	Qualitative	Website	The website reveals the establishment between Namibia and Finland on applying the Finnish innovation model known as Demola.
Finland	Finland as a Knowledge Economy 2.0 Lessons on Policies and Governance	Halme et al. (2014)	Qualitative	Report	The study reveals insights about Finland's innovation.
Finland, Canary Islands, Mexico, Namibia	Demola oulu - open innovation platform fostering students' creative confidence	Saarelainen (2016)	Qualitative	Masters Thesis	The study discusses Demola open innovation.
Finland	Teaching innovation projects in Universities at Tampere	Pippola et al. (2012)	Qualitative	Conference paper	The study described the incorporation of Demola into university curriculums in Tampere, Finland which had positive outcomes.
Finland	Cities as open innovation platforms for business ecosystems	Tukiainen & Sutinen (2015)	Qualitative	Book chapter	The study explored innovation through collaboration of organisations.
Canada	Profile of innovation in Canada — Key findings from the survey of innovation and business strategy 2009	Government of Canada (2013)	Qualitative	Website	The study explores innovation activities in Canada.
Estonia	Innovation and corporate social responsibility in Estonian organisations	Übiu et al. (2009)	Qualitative	Journal article	The study investigated innovation in Estonian firms.
United States	Healthcare innovations in the United States: what lessons are there for the NHS?	Ham (2013)	Qualitative	Website	The website provided an overview of healthcare innovation in the United States
Estonia	The Most innovative personal health record systems | E-Government – Estonia	Innovation Unit (2013)	Qualitative	Website	The website reviews Estonia innovative projects in healthcare, such as implementing healthcare systems in which patients can access their health records.

Country	**Publication title**	**Author**	**Methodology**	**Publication type**	**Key points of the study**
Finland	A Network-Centric Snapshot of Value Co-Creation in Finnish Innovation Financing	Huhtamäki et al. (2011)	Qualitative	Website	The website discusses the national innovation system which exists in Finland and which consists of different organisations.
United States	Understanding the US national innovation system	Atkinson (2014)	Qualitative	Report	This study explains national innovation in the United States.
Finland	Alto University's open innovation ecosystem in a European context	Anderson et al. (2015)	Qualitative	Book chapter	The study explains open innovation that occurs at an Alto University.
United Kingdom	Open innovation in healthcare management in the UK? Reflecting on the challenges and opportunites	Brodie (2015)	Qualitative	Journal article	The study examines innovation in a healthcare setting.
Estonia	Implementing open innovation in catching-up economies: Evidence form Estonia's ICT sector	Kalvet & Tiits (2012)	Qualitative	Conference paper	The study analyses open innovation in Estonian firms,
Estonia	Some issues of the Estonian innovation and intellectual property policy	Kelli (2012)	Qualitative	Journal article	The study examines intellectual property rights in Estonia.
Finland	Interfacing intellectual property rights and open innovation	Lee et al. (2010)	Qualitative	Journal article	The study examines intellectual property rights within Finnish firms.
Finland	Market failure in the diffusion of consumer-developed innovations: Patterns in Finland	De Jong et al. (2015)	Qualitative	Journal article	The study examines user innovation in Finland.
Nigeria	Technology innovation and Nigerian banks performance: The assessment of employee's and customer's responses	Dauda & Akingbade (2011)	Quantitative	Journal article	The study assesses the employees' and customer's responses to technological innovations in banks in Nigeria.
Nigeria	Impact of Technological Innovation on Delivery of Banking Services in Nigeria	Ilo et al. (2014)	Quantitative	Journal article	The study examines the effects of technological innovation in the banking sector in Nigeria.
South Africa	ICT innovation in South Africa: Lessons learnt from MXit	Kahn (2013)	Qualitative	Conference paper	The study explores MXit as an innovation platform in South Africa.
Nigeria	What drives innovation?	Egbetokun et	Quantitative	Journal	The study explores the factors that contribute to

Country	Publication title	Author	Methodology	Publication type	Key points of the study
	Inferences from an industry-wide survey in Nigeria	al. (2008)		article	innovation.
Nigeria, Kenya	Complementarity in firm-level innovation strategies: a comparative study of Kenya and Nigeria	Egbetokun et al. (2016)	Quantitative	Journal article	The study compares innovation in Nigerian and Kenyan firms.
Nigeria	An investigation of the four dimensions of innovation in small scale firms in Lagos State, Nigeria	Amiolemen et al. (2013)	Quantitative	Journal article	This study explores innovation in firms within Lagos.
Kenya	Product innovation strategies among banks in Eldoret Municipality, Kenya	Selfano & Robert (2014)	Qualitative	Journal article	The study investigated ways in which product innovation is actioned in Kenyan banks.
Nigeria	The impact of knowledge management on product innovation of manufacturing firms in Nigeria	Waribugo et al. (2016)	Quantitative	Journal article	The study investigated knowledge management in relation to product innovation in Nigerian manufacturing firms.
South Africa	R&D as a Source of Innovation in South Africa innovation in South Africa	Gerryts & Buy (2008)	Quantitative	Conference paper	The study investigated research and development as a channel for creating new ideas in South African context.
South Africa	The importance of innovation for firm performance in the automotive component manufacturing industry in South Africa	Van Vollenhoven & Buys (2008)	Qualitative	Conference paper	The study examined innovation from an automotive perspective.
Kenya	Strategic orientation to open innovation practices by small and micro enterprises (SMEs) in Kenya	Ndirangu & Bellah (2013)	Quantitative	Journal article	The study examines open innovation in Kenyan SMEs.
Nigeria	Open Minds: Lessons from Nigeria on intellectual property, innovation, and development	De Beer & Oguamanam (2014)	Qualitative	Book chapter	The study provides useful insights into intellectual property rights in Nigeria.
South Africa	Intellectual property rights and South Africa’s innovation future	Gregory (2008)	Qualitative	Report	The study examines intellectual property rights in South Africa.

Country	**Publication title**	**Author**	**Methodology**	**Publication type**	**Key points of the study**
South Africa	THRIP, a mechanism driving creativity and innovation in South Africa	Doret & Jordaan (2014)	Quantitative	Conference paper	The study of Triple Helix in South Africa.
Kenya, Uganda, Tanzania	Innovation in African development: Case Studies of Uganda, Tanzania and Kenya	Oyelaran-Oyeyinka & Sampath (2007)	Qualitative	Report	The study investigated innovation in three east African countries.
United States	Intellectual property rights in the USA	Intellectual Property Office (2013)	Qualitative	Report	The study describes intellectual property rights in the United States.
Finland	Towards smart regions: Highlighting the role of universities	Markkula & Kune (2015)	Qualitative	Book chapter	The study examined users in the innovation process where collaboration between universities, governments and industries is present.
Kenya, Tanzania, Uganda	Baseline analysis of 3 innovation ecosystems in South Africa	Cunningham et al. (2014)	Qualitative	Conference paper	The study examined innovation ecosystem in Kenya, Tanzania and Uganda.
China	Legal environment, government effectiveness and firms' innovation in China: Examining the moderating influence of government ownership	Jiao et al. (2015)	Qualitative	Journal article	The study examined the influence of government ownership in Chinese companies.
Nigeria	Firm-level openness and innovation performance in Nigeria: An empirical exploration	Egbetokun & Siyanbola (2011)	Qualitative	Conference paper	The study examines the type of innovation experiences in Nigerian firms.
Finland	Actor roles in an Urban Living Lab: What can we learn from Suurpelto, Finland?	Juujärvi & Kaija (2013)	Qualitative	Journal article	This study discusses the concept of Urban Living Labs within the context of Finland.

Having presented publications that met the inclusion criteria for Innovation, Table 4-7 outlines publications which adhered to the inclusion criteria for Digital Ecosystems.

Table 4-7: Studies which met the inclusion criteria for digital ecosystems.

Country	Publication title	Author	Methodology	Publication type	Key points of the study
Ireland	DBE in Ireland: an Irish Open and Connected Digital Ecosystem Initiative	English & Dory (2007)	Qualitative	Report	The report discusses an Irish initiative which aims to facilitate a platform where information can be shared between organisations in Ireland.
India	Evolution of a Digital Ecosystem for Knowledge Services in Indian Agriculture	Chatterjee et al. (2007)	Qualitative	Report	The study describes the implementation of a digital ecosystem in the Indian agricultural sector which involves farmers and computer scientists towards improving farming practices.
United Kingdom	The West Midlands regional catalyst role in the activation of the digital ecosystem	Konda et al. (2007)	Qualitative	Report	The study describes the implementation of a digital business ecosystem in England.
Finland, China	An internationally distributed ubiquitous living lab innovation platform for digital ecosystem research	Tang et al. (2010)	Qualitative	Conference paper	The study describes an architecture for developing international digital ecosystems through the examples in China and Finland.
Australia	Designing a digital ecosystem for the new museum environment: the Virtual Museum of the Pacific	Lawson et al. (2010)	Qualitative	Book chapter	The study describes how a digital ecosystem could be created for a Museum in Australia.
Finland	Fintech reloaded – Traditional banks as digital ecosystems. With proven walled garden strategies into the future	Dapp (2015)	Qualitative	Report	The study explores digital ecosystems within the banking sector and concludes that digital ecosystems can be used to share information in such environments.
Brazil, South Africa	Brazil and South Africa Collaboration for Public Software. Building the South Africa Public Software Ecosystem	Santos & Coasta (2013)	Qualitative	Conference paper	The study explores public software ecosystem between Brazil and South Africa.
South Africa	Trustcv: Supporting reputation-based trust for collective digital business ecosystems	Isherwood (2013)	Quantitative	Masters Thesis	The study emphasises the need for trust in a digital business ecosystem.
Malaysia	A hybrid framework of digital	Khalil et al.	Qualitative	Conference	The study emphasises the need to develop a

	business ecosystem for Malaysian Small and Medium Enterprises (SMEs)	(2011)		paper	digital business ecosystem for Malaysia.
Italy	Taslab: A regional living lab supporting future digital ecosystems	Botto et al. (2008)	Qualitative	Conference paper	The study provides a discussion on digital ecosystems in Trento, Italy.
Australia	A Digital Ecosystem to support children with cerebral palsy	Lau (2009)	Qualitative	Journal article	The study explores the use of digital ecosystems to improve cerebral palsy.
Hungary	Digital business ecosystem prototyping for SMEs	Herdon et al. (2012)	Qualitative	Journal article	The study aimed to ascertain what technologies are needed to develop a digital business ecosystem in SMEs in Hungary.
Australia	Virtual museums and web-based Digital Ecosystems	Eklund et al. (2010)	Qualitative	Conference paper	The study focused on the development of digital ecosystems for an Australian museum.

Section 4.7.5 continues the outline of the publications considered, according to the Arskey and O'Malleys's scoping review framework (2005) presented in Table 4-4.

4.7.5. Collating, summarising and *reporting the results*

This summary and report, per Arskey and O'Malleys's (2005) scoping review framework is presented as:

- A summary of the publications reviewed are presented (section 4.6.5.1)
- A discussion outline on:
  - Digital health in developed countries (section 4.6.5.2)
  - Digital health in developing countries (section 4.6.5.3)
  - Innovation in developed countries (section 4.6.5.4)
  - Innovation in developing countries (section 4.6.5.5)
  - Digital Ecosystems in developed countries (section 4.6.5.6)
  - Digital Ecosystems in developing countries (section 4.6.5.7)

4.7.5.1. Summary of the publications reviewed

Table 4-8 outlines a summary of publications as overviewed in Tables 4-6, 7 and 8.

Table 4-8: Summary of publications reviewed.

Characteristics	**Digital health**	**Innovation**	**Digital ecosystems**	**Total**
Number of studies	130	55	13	198
Number of developed countries identified in the study	29	15	5	49
Number of developing countries identified in the study	34	24	6	64
Methodology				
Quantitative	23	11	0	34
Qualitative	98	44	13	155
Mixed method	9	0	0	9
Publication type				
Journal article	70	24	2	96
Conference paper	23	15	5	43
Report	13	6	4	23
Website	9	5	0	14
Gray Literature (PowerPoint documents, pdf documents)	1	0	0	1
Masters thesis	8	1	1	10
PhD thesis	3	0	0	3
Book chapter	2	4	1	7
Bachelors thesis	1	0	0	1

Figure 4.8 illustrates the summary of studies found in selected literature on *Digital Health, Innovation* and *Digital Ecosystems* in developed and developing countries.

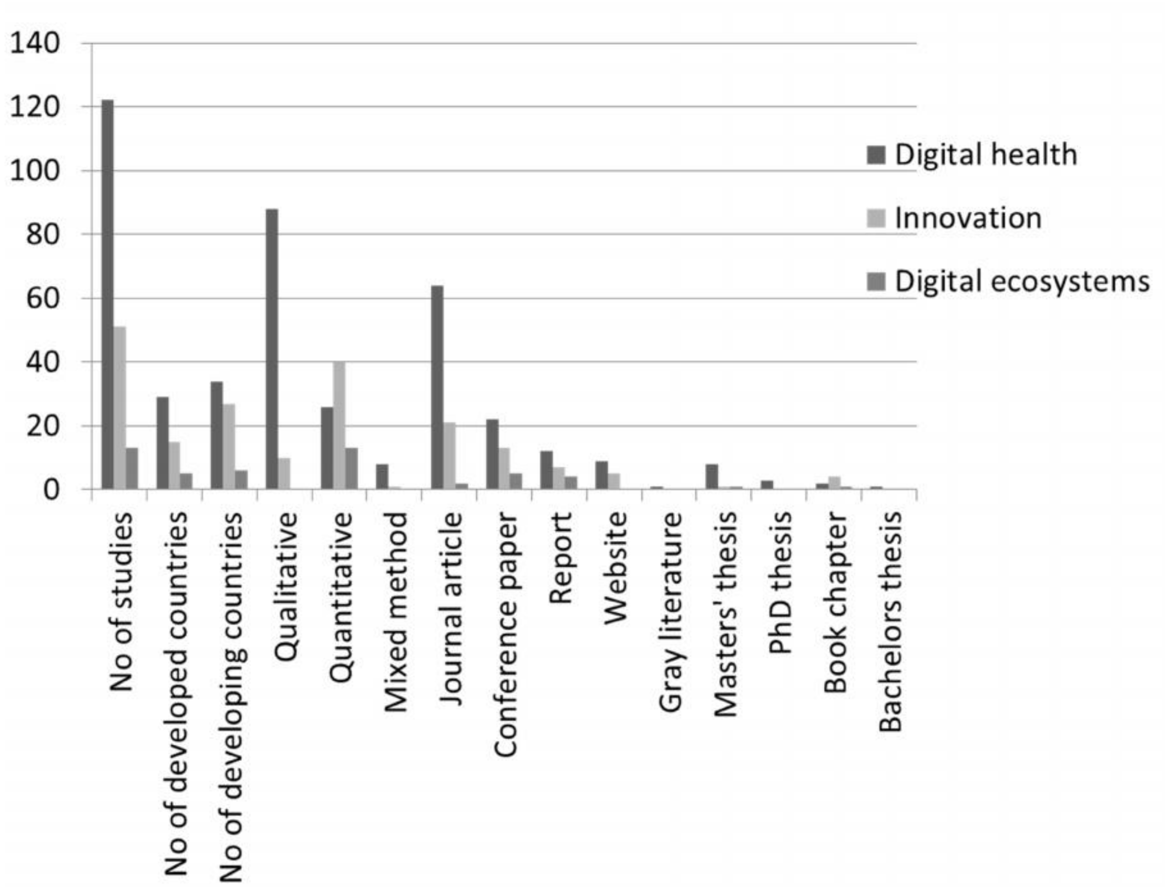


Figure 4-8: Summary of studies on Digital Health, Innovation and Digital Ecosystems.

4.7.5.2. Digital health in developed countries

Britain, Scotland and Northern Ireland have been grouped under the United Kingdom: the findings from selected literature on Digital Health in developed countries referred to 29 developed countries: United Kingdom (n=15), United States (n=12), Estonia (n=11), Finland (n=10), the Netherlands (n=7), Denmark (n=6), Australia (n=7), Italy (n=5), Sweden (n=4), Canada (n=4), Spain (n=5), Norway (n=4), France (n=4), Slovak Republic (n=3), Switzerland (n=4), Belgium (n=3), Austria (n=2), Czech Republic (n=2), Poland (n=2), United Arab Emirates (n=2), Germany (n=3). Ireland, Croatia, Cyprus, Greece, Latvia, Portugal, Chile, and Slovakia all had (n=1) with some studies describing Digital Health in more than one context. Studies on Digital Health discussed within developed countries contexts were categorised under different themes: EHRs, privacy and security, self-management and self-tracking apps, gamification, Digital Health, health and wellness apps, electronic prescription (e-prescription), wireless sensors, e-health, telemedicine/telehealth, health data exchange, Internet, EMRs, social media, cloud computing, health information technology, m-health, interoperability, information systems and public health surveillance.

- EHRs: Studies revolving around EHRs explained the adoption and benefits of EHRs in healthcare (Jha et al., 2009; Pagliari et al., 2007). Other studies described EHRs in countries such as Estonia (Herselman et al., 2016), Finland (Bonomi, 2016; Stroetmann, 2011), Denmark (Bonomi, 2016), Sweden (Bonomi, 2016), Spain (Stroetmann, 2011) and United Arab Emirates (Al Rae, 2011). Other forms of EHRs have been described, such as electronic care records (Stroetmann, 2011), personal health records (Stroetmann, 2011; Dubbink, 2013), personally controlled electronic health records (Mooranian et al., 2013) and electronic personal records (Bossen & Jensen, 2014). The literature also suggests that countries such as the Czech Republic have implemented national web based EHRs, as well as a system for providing patient summaries on a national basis in Sweden (Stroetmann, 2011).

  Doupi et al. (2010) postulate that in Estonia, EHRs have been implemented and patient health information can be accessed by medical practitioners across the country. The sharing of patient health information is facilitated by the mandate of health institutions to send health information to the EHR (Doupi et al., 2010).

- Privacy and Security: The issue of privacy and security of patient health information is also a trending topic in the discussion of EHRs in developed countries (Anderson & Agarwal, 2011; Tikk, 2006). Safadi et al. (2015) assert that security and privacy are embedded in patient health information conveyed to patients using the OSCAR system, as implemented in Canadian clinics. Per Karik et al. (2012), security was taken into consideration during in the development of Estonian HISs for patients. The system allows for patient control and authorises who is given access to these records (Karik et al., 2012). Patient enabled e-health systems, incorporating security features, have also been used in the Netherlands (Misser, 2014).
- Self-management and self-tracking apps: Publication within this theme focused on self-management and self-tracking apps. In the Netherlands, for example, a self-management app is facilitated through wireless sensors to provide users with responses (Klaassen et al., 2013).
- Gamification: Klaus et al. (2016) reported on the effectiveness of applying the concept of serious games to the development of a nutritional educational program in Switzerland.
- Digital health: Studies within this theme emphasise the positive aspects of Digital Health and why its use would be beneficial in a specific context (Ditchburn &

Marshall, 2015; Herselman et al, 2016). It also indicated that *Digital Health* has been implemented in countries such as Finland and Estonia (Herselman et al., 2016).

- Health and wellness apps: Health and wellness apps have been developed in Canada (Ho et al., 2016).
- E-prescription: E-prescription is a technology used in developed countries. In a review of e-prescription usage in Europe, Kierkegaard (2013) found that European countries (such as Denmark, Sweden, Netherlands, Estonia, Austria, Croatia, Cyprus, Czech Republic, England, Finland, France, Germany, Greece, Hungary, Italy, Latvia, UK, Norway, Portugal, Poland, Romania, Spain, Slovak Republic) make use of e-prescription. It is also reported that the United States implemented e-prescription (Kierkegaard, 2013). Other terms used in describing e-prescription are *e-receipt* in Sweden and *digital prescription* in Estonia (Stroetmann, 2011).
- Wireless sensors**:** Ashraf (2007a) and Ashraf (2007b) indicate that there is evidence of the implementation of wireless sensor network within the healthcare domain in Finland.
- E-health: Studies on e-health indicate that there are different policies being put in place towards the realisation of e-health. For example, the creation of e-health policies in countries such as Slovenia and Sweden (Stroetmann, 2011); e-health strategies in the UK, Austria, Slovak Republic, Romania, Spain, Italy and Switzerland (Stroetmann, 2011); e-health legislation in Germany and France (Stroetmann, 2011); e-health legal framework in Denmark, UK, Estonia, Finland and Norway (Stroetmann, 2011) and health information policies in Ireland, Australia, Canada, the UK, and United States (Craig, 2015). Gajanayake et al. (2013) also explained the need to implement e-health policies in the Australian context. Reports on e-health in Estonia reveal that Estonia is the first country to fully implement a complete national e-health system in which patients' health records are recorded from "birth to death" (Estonia E-health Foundation, 2010). Estonia has a national information system, known as X-road (Anthes, 2015). Estonia adopts a different approach to implementing e-health systems as their current e-health system connects to existing e-services within X-road (Leego, 2005). A fully implemented e-health system was introduced in 2008 (Estonia E-health Foundation, 2010). Despite the healthcare sector being divided into different sectors, all medical practitioners are required to send patient health records to a "national health information system" (WHO Europe, 2016).

A recent report on the status of e-health in Finland suggests that e-health is well adopted as patient data is mainly recorded on e-health systems (Hyppönen et al., 2015). Finland has a national archive for health information referred to as KanTa (Workshop Report, 2013).

A recent report by Gray (2016) indicates that the two developed countries, leading in *Digital Health* globally, are the United Arab Emirates and Netherlands.

- Telemedicine/telehealth: Studies revolving around telemedicine in developed countries focus on e-health strategies for developing telemedicine (Stroetmann, 2011). The use of telemedicine in the United Kingdom was noted through a trial study and telehealth had also been implemented and tested in the United Kingdom (Salisbury et al., 2016). Telemedicine has been implemented in the United States. For example, in the United States telemedicine is used to monitor patients with retinopathy of prematurity (Wang et al., 2015). It was reported that this method of diagnosis was precise and thus relevant to healthcare (Wang et al., 2015). A recent study indicates that healthcare practitioners in the United States are interested in including telemedicine as a mode of treatment for patients suffering addiction problems (Molfenter et al., 2015).

  Enriquez (2014) explains that *Digital Health* has been adopted in Canada through the use of telemedicine which enables patients to be attended to, even from a distant location. It is reported that since telemedicine was launched in Saskatchewan and Ontario, it has improved healthcare delivery services (Glauser, Nolan & Remfry, 2015). Glauser et al. (2015) and Francisco and Archer (2015) believe that the use of telemedicine in the delivery of healthcare services in Canada is expanding and Francisco & Archer (2015) emphasise that telemedicine is widely used to support mental healthcare in Canada.

  A 2015 report reveals that different Finnish e-health bodies are responsible for ensuring that there is “networking between Finnish health and social care providers around e-health and e-welfare questions” (Hyppönen et al., p. 43). Hyppönen et al. (2015) also report that the first form of telemedicine in Estonia is through teleradiology.

- Health data exchange: Studies on health data exchange have been conducted in European countries. Elger et al. (2010) explain that patient data needs to be secured when it is being used for other purposes.
- Internet: Studies in developed countries suggest that Internet technologies are being used in the delivery of healthcare services. For example, Lara et al. (2016) conducted a randomised controlled trial for promoting healthy living for retired adults using the web in the UK. In Norway (Wangberg et al., 2015) and the United States (Kirby, 2006), the Internet has also been used to support weight

loss. With regards to finding health information through the Internet, a study in the Netherlands reveals that patients, in addition to obtaining doctors' advice, also use the Internet to source health information (Tanis et al., 2016). Richards et al. (2014) conducted a study to investigate the delivery of treatment to Irish students with Generalised Anxiety Disorder using Internet technologies. Townsend et al. (2013) point out that the Internet is a requirement for providing services in rural communities, as well as in healthcare. The use of email in establishing communication has been reported on in countries such as Denmark, Estonia, Italy, Sweden, France, Belgium, Spain, Slovak Republic, Slovenia and the UK (Newhouse et al., 2015). Estonia is reported to have one of the fastest Internet connections in the world (Kolyako & Riga, 2012). The use of the Internet has not only been recorded in Estonia, but it is a legal right for Finnish citizens (British Broadcasting Corporation [BBC], 2010). The use of the Internet has been recorded in the United Kingdom and it is reported that Internet speed is high (Vincent, 2014).

- Cloud computing: Cocir (2016) identified countries in Europe such as Denmark, Finland, Sweden, Austria, Estonia, the Netherlands, Belgium, France, Germany, Italy, Spain, Switzerland and the UK as countries which have applied cloud computing in their healthcare sectors.
- EMRs: Studies on EMRs show that there is evidence which points to the beneficial implementation of EMRs in Italian hospitals (Bonomi et al., 2015).
- Social media: Studies on social media show that it has been used in different ways in healthcare. For example, in the United States, Murthy & Eldredge (2016) examined the use of Twitter to disseminate cancer information. Hospitals in the United States take advantage of the YouTube platform to advertise their facilities and services (Huang, 2013).
- Health Information Technology: Yu (2014) indicates that health information technologies have been implemented in the United States.
- Information systems: A study by Kivinen and Lammintakanen (2013) indicates that management information systems have been implemented in the context of healthcare within Finland.
- M-health: Mobile phones are used in healthcare in the UK (Mobasheri et al, 2015). M-health is also used extensively in the United States as many reports on its implementation testify. One notable m-health program in the USA, known as *Stop MY Smoking USA,* was reported on by Ybarra et al. (2014) and Ahsan et al. (2013). Ybarra et al. (2014) explained how text messaging was used as a tool to stop smoking habits among young American adults, through a randomised control trial (RCT) approach. Although the findings reveal that some participants had stopped smoking during the program, other participants had continued with

the habit. There were different text messaging programs which referred to different groups of participants. Ahsan et al. (2013) explained the technical components for implementing such an application. A mobile app was developed in the United Kingdom which aimed at improving the breastfeeding experience by finding locations where other nursing mothers were located (Balaam et al., 2015).

A health solution, known as “STOMP”, was developed as a mobile solution to help smokers stop smoking. It was piloted in the Quebec province (TELUS, 2011). The WHO (2011) reveals that Canada has strove to improve healthcare support in Saskatchewan province using mobile devices and the launch of two projects for this purpose.

Finland has succeeded in incorporating mobile technologies into their current e-health services using Short Message Service (SMS) and making calls using mobile devices (Veijalainen et al., 2011).

- Interoperability: Interoperability standards, such as HL7v3, have been implemented in the Estonian national health information systems to facilitate the sharing of health information among medical practitioners (Karik et al., 2012). Doupi, et al. (2010) postulate that in Estonia, EHRs have been implemented and patient health information can be accessed by medical practitioners across the country. The sharing of patients’ health information is facilitated by the mandate sent to health institutions which urge them to send health information to the EHR (Doupi et al., 2010). Interoperability standards, such as HL7v3, have been implemented in Estonia HISs to facilitate the sharing of health information amongst medical practitioners (Karik et al., 2012).
- Public health surveillance: Public health surveillance was first proposed by Shattuck in 1850 (Thacker et al., 2012) and in 1874, Massachusetts was one of the first states to implement public health surveillance of diseases in the United States (Thacker et al., 2012). Choi (2012) reports that United States is ahead of other countries in terms of implementing public health surveillance.

4.7.5.3. Digital health in developing countries

The findings from selected literature on *Digital Health* in developing countries identified 34 developing countries: South Africa (n=16), Nigeria (n=11), Tanzania (n=5), Kenya (n=5), Bangladesh (n=4), India (n=4), Romania (n=3), Uganda (n=3), China (n=3), Hungary (n=2), Bulgaria (n=2), Malawi (n=2), Saudi Arabia (n=2), Ethiopia (n=2), Namibia (n=2) and Taiwan (n=2). Jordan, Pakistan, Argentina, Brazil, Colombia, Costa Rica, Ecuador, Mexico, Panama, Peru, Dominican Republic, Turkey, Indonesia, Swaziland, Sudan, Cameroon and Burkina Faso each have (n=1) with some studies describing *Digital Health* in more than one context. Studies on *Digital Health,* discussed within developing countries' contexts, were categorised under different themes: privacy and security, *Digital Health*, e-prescription, e-health, EMRs, EHRs, information systems, telemedicine, m-health, social media, Internet and public health surveillance.

- Privacy and Security: The issue of privacy and security is also discussed in developing countries, such as the Dominican Republic (Molina, 2010). Molina (2010) investigates privacy and security laws in the Dominican Republic which focuses on patient information. The findings of the study revealed that there were no laws regulating the use of patient information in the Dominican Republic.
- Digital health: Studies on *Digital Health* in developing countries focus on the need to implement *Digital Health* (Herselman et al, 2016) and the challenges in implementing *Digital Health* in developing countries (Sarumi & Idowu, 2016). The term *Digital Health* has been used in describing e-health in different contexts, like Uganda (Gardstedt et al., 2013).
- E-prescription: E-prescription has been implemented in developing countries such as Bulgaria has also (Kieerkegaard, 2013).
- E-health: Studies on e-health in developing countries revolve around e-health literacy among nursing students in Jordan (Tubaishat & Habiballah, 2016), the development of e-health frameworks in Pakistan (Ali, 2013) and Costa Rica (Fernadez & Oviedo, 2011) and e-health strategies in Ecuador (Fernadez & Oviedo, 2011) and the views of stakeholders to determine the plans of e-health in Bangladesh (Sheraz et al., 2012). E-health is being supported in Bangladesh (Ahmed et al, 2014) and being used in developing countries like India (Nair, 2014). In addition, other studies have emphasised the importance of workforce building in the field of nursing information in developing countries, like Malawi (O'Connor et al, 2016). E-health systems have been implemented in South Africa (Botha et al., 2015). Studies around e-health in developing countries, such as South Africa, focus on the human resources in e-health (Mars, 2012).
- EMRs: The perceptions regarding EMRs have been examined in Malawi (Msukwa, 2011). While Chaplin et al. (2015) reported that the adoption of EMRs in Nigeria was slow, they also indicated that the outcomes were beneficial for HIV patients. Seebregts et al. (2009) indicated that OpenMRS, an open source software which helps to manage the records of HIV patients was implemented in South Africa and Tanzania. They further pointed out that the implementation was successful and helped reduce costs.

  Different EMRs have been implemented in Kenya, for example, the Indian Health Service's Vista system and the Mosoriot Medical Record System (Blaya et al., 2010). Blaya et al. (2010) revealed that the use of electronic medical records, rather than paper based records, has the potential to improve data quality and accuracy and so improve decision making in a maternal healthcare setting. Seebregts et al. (2009) state that OpenMRS, an open source software which helps in the management of HIV patients' records, has been implemented in Kenya.

In Kenya, Odero et al. (2007) describe how adding injury details to an existing EMR could help promote decision making regarding healthcare. The study did not only explain the added information to the existing EMR, it also explained how a Geographic Information System was used to keep track of patient injury information and location. However, the implementation of an EMR is not an easy task as Madore et al. (2015) explain. There are many challenges involved in implementing and ensuring that medical workers use the system in Uganda. Despite these challenges, Madore et al. (2015) report that the implementation of an appropriate planning helped in the utilisation of an OpenMRS in Uganda.

- EHRs: Aklilu (2012) identified the need to develop EHRs in Nigeria. This suggests that e-health has been implemented within the Nigerian context. There is evidence of the implementation of EHRs in South Africa as Spence et al. (2016) explain that an electronic trauma health record has been implemented in South Africa which has replaced paper based records. A recent report by Gray (2016) indicates that China is the developing country which leads the field in e-health.
- Information systems: Kalpa (2012) reveals that health information systems are developed in India. Hiregoudar et al. (2015) examined the acceptance of health information systems in India and found that there are challenges affecting the use of health information systems in this country. Makinde et al. (2014) highlight the need for a unique identifier during the implementation of an electronic routine health information system. Makinde et al. (2014) describes the benefits of adding a unique way to identify health facilities in Nigeria which includes easy ways to locating them. Electronic monitoring systems have been implemented in Tanzania (Blaya et al., 2010). Clinical decisions, supported by personal digital assistants, have been implemented in Tanzania (Blaya et al., 2010). The Ministry of Health and Social Services (MoHSS) in Namibia has implemented different information systems which are currently being used within the ministry for healthcare and management purposes (USAID, 2012). Al-Nashy (2015) reveals that health information systems have been developed in Sudan. Information systems, within the South African healthcare context, have also been implemented. For example, Lutge et al. (2016) describe the importance of modifying a district health information system to include information related to

trauma cases. They found the addition of the trauma information useful in the management of trauma incidences.

- Telemedicine: Pilot projects in telemedicine have been reported on in Argentina, and implemented in Brazil, Chile, Costa Rica, Ecuador, Mexico and Panama (Fernadez & Oviedo, 2011). However, in developing countries like Colombia, infrastructural challenges affect the implementation of telemedicine (Fernadez & Oviedo, 2011). A study by Al-Kadi (2012) reveals that telemedicine systems have also been implemented and tested in Saudi Arabian hospitals. Alkhudairi (2016) also evaluated the acceptance of mobile use in telemedicine. The use of telemedicine has also been reported on in South Africa (Mars, 2009). Telemedicine has been implemented in South Africa and Ethiopia (Walama & Augustine, 2013). Although Holmes et al. (2014) emphasised that the implementation of Mashavu, a telemedicine system used in Kenya, could create jobs in rural communities, the focus of the study was on the existence of telemedicine in the Kenyan context. There is a telemedicine centre in Namibia which enables medical education (MoHSS, 2016).
- M-health: Studies in developing countries show that m-health has been implemented in Peru (Fernadez & Oviedo, 2011), Nigeria (West, 2015) and Cameroon (Veijalainen et al., 2011). West (2015, p. 6) indicates that "a mobile electronic medical record system" known as the "Clinical Patient Administration Kit" is being used in four Nigerian states. West (2015) further indicates that the system uses mobile technologies to keep record of patients' medical information during, and after, pregnancy. Mobile devices have been used to support health workers in Bangladesh (Ahmed et al., 2014) and the use of mobile phones assists in diabetes care (Sheikh, 2015). Mobile applications have also been developed in Bangladesh to support blood donation management (Islam et al, 2016). Blanckenberg et al. (2011) suggest the use of mobile phones in telemedicine for eye care in South Africa. Other studies have explored the benefits of mobile phones in midwife care in Indonesia (Chib et al., 2008), delivering lab results in Swaziland (Hao et al., 2015) and the use of mobile phones by pregnant women for health-related purposes in India (Kumar & Anderson, 2015). In South Africa, Botha & Booi (2016) reviewed m-health implementations which have taken place in South Africa. In developing countries, like China, m-health is emerging strongly (Li et al., 2014). Different approaches have been applied in the provision of healthcare services via mobile technology. In South Africa, young people use mobile phones for health-related purposes, such as contacting relevant persons when ill and seeking medical information (Hampshire et al., 2015). South Africa also implemented a mobile application for pregnant women referred to as "Momconnect" (Lippman et al., 2016).

Momconnect provides personalised SMS messages to pregnant women registered on the service (Lippman et al., 2016). Systems such as patient tracking systems and research as well as data collection systems have also been implemented in the South African context using mobile technologies (Blaya et al., 2010). Iluyemi et al. (2008) indicate that South Africa already uses mobile connectivity to provide healthcare services. A study on m-health in Mali revealed that text and voice messaging alone cannot be used as tools for deploying indoor residual spray against malaria, but a combination of text messaging, voice message *and* human based intervention will promote indoor residual spray in Mali (Mangam et al., 2016).

There is an increase in the use of mobile technologies for healthcare purposes in Kenya. For example, a digital pen known as Partopen is used to administer healthcare services to pregnant women during labour (Underwood, 2013). The findings from a study conducted by Jennings et al. (2013), to determine *how* mobile phones can be used to reduce mother to child transmission of HIV, suggests that people within the Kenyan context use their mobile phones for healthcare purposes. Kumar et al. (2016) explain the challenges which affect the implementation of mobile technologies in healthcare in Kenya and ways to address those challenges.

Iluyemi et al. (2008) indicate that Uganda uses mobile connectivity to provide healthcare services.

- Social Media: Studies on social media and healthcare in literature were found to revolve around developing countries such as Romania (Duduciuc, 2015) and Turkey (Ince et al., 2015). South African health institutions have websites/platforms in place which they use to perform different activities such as advertise their services and provide health information to the public (Gwetu, 2009).

  Teaching hospitals in Nigeria also maintain a presence on social media platforms. They use these platforms for different purposes, including advertising their services, seeking patient opinions on services provided and providing useful information on health-related issues (Batta & Iwokwagh, 2015). The use of social media platforms, such as Facebook, has also been used to facilitate learning among medical laboratory scientists in Nigeria (Cassanati et al., 2014).

- Internet: A study in Taiwan reveals that middle-aged workers mostly use the Internet to search for health-related information (Hou et al., 2012). Ajuwon (2006) explains that the Internet is used in patient care in Nigerian teaching hospitals.

Clarke and Mars (2015) conducted a study which investigated the use of mobile data networks in rural areas of Kwazulu Natal to provide telemedicine services. The study revealed that connectivity is slow in these rural areas and not adequate for the use of telemedicine services. The Internet has been used for different purposes in these countries, including providing healthcare services in South Africa (Clarke & Mars, 2015). A study by Pfeiffer et al. (2014) also indicate that the youths in Tanzania access social media to search for information regarding sexual health.

- Public health surveillance: While Nigeria adopts the Integrated Disease Surveillance Reporting system as a tool to report on disease outbreaks (Isere et al., 2015), Abubakar et al. (2013) report that the implementation of the Integrated Disease Surveillance Reporting system in Kaduna State, Nigeria, cannot be used to its full potential due to limited resources.

  Public health surveillance systems, such as the Integrated Disease Surveillance and Response System (Lukwago et al., 2011), and the Iganga-Mayuge Demographic Surveillance System, a demographic surveillance system which keeps track of disability incidences (Bachani et al., 2014), have been implemented in Uganda. Lukwago et al. (2011) state that the Integrated Disease Surveillance and Response System has improved disease surveillance reporting. There is evidence of the implementation of public health surveillance systems in South Africa, such as influenza surveillance systems (Budgell et. al., 2015).

- Cloud computing: Haskew et al. (2015) described the implementation of cloud-based electronic medical records to support healthcare management for maternal care in rural hospitals in Kenya. This example shows that cloud-based computing in healthcare can be used to improve the quality of health records, even when deployed in rural communities. Hsieh & Hsu (2012) also developed a cloud-based 12-lead Electrocardiography (ECG) service which was tested in Taiwan.

4.7.5.4. Innovation in developed countries

Britain, Scotland and Northern Ireland are grouped under the United Kingdom.

The findings from selected literature on innovation in developed countries identified 15 developed countries: Finland (n=13), Australia (n=4), Estonia (n=11), United States (n=4), United Kingdom (n=2). New Zealand, Netherlands, Germany, Spain, Sweden, Italy, Ireland, France, Switzerland, and Canada all had (n=1) with some studies describing innovation in more than one context. Studies on innovation, discussed within the developed countries contexts, were categorised under different themes: increasing innovation by collaboration, innovation through teaching, Triple Helix System, technology innovation, process and product innovation, healthcare innovation, open innovation, intellectual property rights, user innovation and Quadruple Helix System.

- Increasing innovation by collaboration: Developed countries, such as Finland, have engaged in collaborative projects to improve innovation in countries, such as Tanzania (Apiola et al., 2015). Finland has a strong focus on innovation as there are several innovative projects emanating from Finland. An example of this is Demola (Halme et al., 2014; Saarelainen, 2016), which was implemented in 2008 (Halme et al., 2008). The unusual aspect of Demola is that University students can work on industry projects, with a company, and that they can keep the IPs (Halme et al., 2014) which are bought by the company at the end of the project (Pippola et al., 2012). Furthermore, Pippola et al. (2012) explain that incorporating Demola into university curriculums in Tampere, Finland, proved to be beneficial to both students and companies.
- Innovation through teaching: Studies on innovation in developed countries include the United States' focus on teaching though innovative methods. Richardson et al. (2008) investigate the use of entertainment platforms to facilitate the learning of "case analysis" skills at a University in the United States.
- Triple Helix system: Triple helix systems have been implemented in wireless networks in Finland (Ojala et al., 2016). Innovation ecosystems, as well as the Triple Helix system (government, universities and industry), have also been applied within the Finnish context. Tukiainen et al. (2015) indicate that different organisations and institutions are involved in the innovation process.
- Technology innovation: Developed countries, such as Australia, have investigated factors which give rise to technological innovation in construction firms (Hardie & Newell, 2011) as well as people who work in organisations (Talukder, 2012).
- Process and product innovation: Studies on product innovation revolve around countries such as Australia and New Zealand and examine the reasoning behind some innovations being accepted, and others not (Bull & Ferguson, 2006). A Survey of Innovation and Business (SIB), run from 2007 to 2009, reveals that Canadian organisations are active in process and product innovation in the economy (Government of Canada, 2013). The SIB report suggests that Canadian organisations have developed new products and incorporated new approaches to develop these products. Process and product innovation are being practiced in Estonian organisations (Übiu et al., 2009).
- Healthcare innovation: Healthcare innovation has been recorded in developed countries like Australia (Psaila et al., 2012). Ham (2013) reveals that there are significant implementations of health innovation in the United States which

include the implementation of EHRs in different hospitals and commitment by healthcare practitioners to improve the quality and integration of healthcare information. Estonia has established innovative projects in healthcare, such as implementing healthcare systems in which patients can access their health records (Innovation Unit, 2013).

- Open innovation: The concept of open innovation, the use of open source software in software organisations, has been examined in Finland, Netherlands, Germany, UK, Spain, Sweden, Italy, Ireland, France and Switzerland (Morgan & Finnegan, 2010).

Innovation in the United States can be traced back to 1890, with industrial innovation (Atkinson, 2014). An example of collaborative culture is exercised in the US as Universities and industries collaborate in projects through “innovation hubs and clusters” (Atkinson, 2014, p. 10).

Open innovation is a common practice in Finland and includes universities and research institutions acting as innovation hubs (Anderson et al., 2015). Anderson et al. (2015) point to Alto University as a Finnish university which has incorporated open innovation. A recent study indicates that open innovation is being practiced within the British healthcare system (Brodie, 2015). Kalvet & Tiits (2012) reveal that some Estonian organisations have embraced open innovation.

- Intellectual property rights: Kelli (2008) postulates that intellectual property rights are available in Estonia. Intellectual property rights are also available in Finland (Lee et al., 2010). The United States also practice intellectual property rights when it comes to innovation (Intellectual Property Office, 2013).
- User innovation: User innovation is prevalent in Finnish firms. De Jong et al. (2015) postulate that users participate in product creation, also referred to as co-creation.
- Innovation spaces and living labs: The concept of Urban Living labs has been studied within the context of Finland, as indicated by Juujärvi & Kaija (2013). Using Suurpelto, an urban area in Finland as a case study, Juujärvi & Kaija (2013) indicate that various role players can take part in an Urban Living Lab.
- Quadruple Helix system: Markkula & Kune (2015) indicate that a Quadruple Helix system is practiced in Finland, as users also take part in the innovation process.

4.7.5.5. Innovation in developing countries

The findings from selected literature on innovation in developing countries identified 24 developing countries: South Africa (n=9), Nigeria (n=7), Kenya (n=5), Tanzania (n=5), Namibia (n=3), Uganda (n-=3). Rwanda, Ghana, Cameroon, Zambia, Angola, Botswana, Malawi, Mauritius, Mozambique, Swaziland, Lesotho, Argentina, Uruguay, Colombia, Peru, India, Canary Islands and Mexico all had (n=1), with some studies describing innovation in more than one context. Studies on innovation within developing countries' contexts were categorised under different themes: increasing innovation by collaboration, technology innovation, organisational and marketing innovation, influence of government ownership, innovation spaces and living labs, product and process innovation, open innovation, intellectual property rights and Triple Helix systems.

- Increasing innovation by collaboration: Studies within this theme address the issue of increasing innovation by collaboration between developed and developing countries such as Tanzania and Finland (Apiola et al., 2015). For example, Apiola et al. (2015) refer to the collaboration between Tanzania and Finland to improve doctoral output in Tanzania. Increasing innovation, through collaborative efforts, has also been carried out between developing countries such as Kenya and Uganda (Harsh & Zachary, 2013) and, Brazil and South Africa (Santos & Costa, 2013). Santos & Costa (2013) described how a public software ecosystem was developed to facilitate collaboration between South Africa and Brazil, and hence, innovation. Demola has also been established in developing countries including Namibia (Saarelainen, 2016), Mexico and the Canary Islands (Saarelainen, 2016).
- Technology innovation: Studies within this theme show that in some developing countries, technology has been extended to rural areas, as is the case in South Africa (Kariuki, 2009). Another form of innovation in developing countries is the development of ICT hubs in countries like Kenya (Moraa & Gathege, 2013), Rwanda (Moraa & Gathege, 2013), Ghana (Moraa & Gathege, 2013), Zambia (Moraa & Gathege, 2013), Tanzania (Moraa & Gathege, 2013), Cameroon (Moraa & Gathege, 2013) and Uganda (Moraa & Gathege, 2013). Niosi and Bas (2014) indicate that technological innovations were found in Argentina, Brazil, Chile and Uruguay (biotechnology). Siriginidi (2008) describes technological innovations which have been implemented in India, mainly to help achieve MDGs.

  Information technology related innovations are prevalent in Nigeria. Dauda and Akingbade (2011) and Ilo et al. (2014) suggest that the use of technologies in Nigerian banks have improved processes for both workers and clients. Role players, banks and clients, take part in the innovation process. Banks provide the technological infrastructure necessary for innovations (Ilo et al., 2014).

Kahn (2013) also explains that information technology innovation has been implemented in South Africa through MXit. MXit was initially used a platform for instant messaging but the educational, health and financial sectors have adopted it. An example of this is the implementation of Dr Math, a learning platform which helps students with Math homework. Different role players are responsible for different aspects in the innovation process. For example, the MXit innovation illustrates that different organisations can employ technology in different ways and for different reasons but still align the specific technology, and technological infrastructures, to a specific situation (Kahn, 2013).

- Organisational and marketing innovation: Research on innovation in developing countries (like Colombia, Peru and Chile) emphasise the implications of organisational and marketing innovations (Pino et al., 2016).
- Influence of government ownership: studies have examined the role which “government ownership” plays to facilitate innovations in companies (Jiao et al., 2015, p. 16). The study found that “government ownership” facilitated innovation practices in these firms.
- Innovation spaces and Living labs: Cunningham and Cunningham (2016) report that innovation spaces have been implemented in different countries (including Angola, Botswana, Malawi, Mauritius, Mozambique, Namibia, South Africa and Swaziland). Cunningham & Cunningham (2016) also report that living labs have been implemented in countries (such as Tanzania, Botswana, Lesotho, Mauritius, Mozambique and South Africa). The findings from this study suggest that innovation spaces, and living labs, in these countries are capable of supporting innovation.
- Product and process innovation: Innovation is regarded as the driving force for developing economies (Cunningham et al., 2014). Egbetokun et al. (2008) indicate that product innovation is practiced in Nigerian industries. Process innovation is also practiced in Nigeria (Egbetokun et al., 2008; Egbetokun et al., 2016). While Egbetokun et al. (2016) indicate that product innovation is being practiced in Nigeria, Amiolemen et al. (2013) indicate that product and process innovations are not directly linked, although both are being practiced in Nigerian industries. Selfano & Robert (2014) indicate that product innovation is practiced in Kenyan banks, based on the needs of customers.

Open innovation: Egbetokun & Siyanbola (2011) reveal that Nigerian firms do not only rely on innovations *inside* a firm but also embrace innovations influenced *outside* the firm. This indicates that open innovation is being practiced in Nigeria. Egbetokun & Siyanbola (2011) indicate that innovations are also influenced by the people who use the products, thus user innovation. Knowledge management also influences the way in which products are innovated in Nigerian industries (Waribugo et al., 2016). There is evidence of both closed and open innovation in South Africa. Gerryts & Buys (2008) indicate that firms in South Africa share information *within* organisations but also *outside* their organisational domain. Van Vollenhoven & Buys (2010) indicate that the South African automotive industry adopts an open innovation approach. However, lack of resources can affect product innovation (Selfano & Robert, 2014). Ndirangu & Bellah (2013) reveal that firms in Kenya have embraced open innovation. Ndirangu & Bellah (2013, p. 11) further reveal that “shared vision; supportive climate for new ideas; and sharing experiences with other firms” are responsible for open innovation in Kenya firms. Innovation ecosystems were examined in three East African countries: Kenya, Tanzania and Uganda (Cunningham et al., 2014).

- Intellectual property rights: Innovations are also influenced by regulations, such as Intellectual property laws (De Beer & Oguamanam, 2014). The issue of Intellectual Property (IP) laws is not only enforced in the business domain but also within curriculums of law degrees at Nigerian universities (De Beer & Oguamanam, 2014). Innovation in South Africa is governed by regulations such as intellectual property rights (Gregory, 2008). Gregory (2008) indicates that intellectual property rights are practiced in South Africa.
- Triple Helix System: Doret & Jordaan (2014) clearly state that the Triple Helix model is currently being used, within the South African context, to promote innovation through collaborative efforts of university, industry and government. Oyelaran-Oyeyinka & Sampath (2007) indicate that intellectual property rights are being practiced in Kenya.

4.7.5.6. Digital ecosystems in developed countries

The findings from selected literature on digital ecosystems in developed countries identified 5 developed countries: Australia (n=3) and Finland (n=2). Ireland, United Kingdom and Italy all had (n=1), with some studies describing digital ecosystems in more than one context. Studies on digital ecosystems discussed within developing countries’ contexts were categorised under different themes: implementing digital ecosystems, trust and interoperability.

- Implementing digital ecosystems: Studies on digital ecosystems in developing countries emphasise the need to implement digital ecosystems. For example, a study on digital ecosystems focuses on the planning and development of digital ecosystems to support SMEs in European countries, such as Ireland (English &

Dory, 2007). A study by Tang et al. (2010) describe the architecture for developing digital ecosystems between different countries. While a study by Lawson et al. (2010) describe how a digital ecosystem could be created for stakeholders within a museum community in Australia. Eklund et al. (2010) describe the implementation of such an ecosystem. Studies on digital ecosystems in developed countries show that digital ecosystems can be implemented in different forms, such as digital business ecosystems (English & Dory) and digital banking ecosystems (Dapp, 2015).

Botto et al. (2008) discuss digital ecosystems in Trento, Italy. A digital ecosystem was developed to improve the care of cerebral palsy in children in Australia (Lau, 2009). Other studies have been carried out to determine technologies needed to implement a digital business ecosystem for SMEs (Herdon et al., 2012). Furthermore, digital business ecosystems have been developed in the UK (Konda et al., 2007).

- Trust: Studies on implementations of digital ecosystems indicate that trust is needed to get all the stakeholders to commit to the digital ecosystem platform (Konda et al., 2007).
- Interoperability: Dapp (2015) suggests that digital ecosystem platform should be used to share information.

4.7.5.7. Digital ecosystems in developing countries

The findings from selected literature on digital ecosystems in developing countries identified 6 developing countries: South Africa (n=2) whilst India, China, Brazil, Malaysia, and Hungary all had (n=1). Some studies described digital ecosystems in more than one context. Studies on digital ecosystems, discussed within developing countries' contexts were categorised per different themes: implementing digital ecosystems, interoperability, challenges and trust.

- Implementation of digital ecosystems: Publications within this domain emphasise the implementation of digital ecosystems in developing countries. For example, a study in India indicates that digital ecosystems have been implemented in India (Chatterjee et al., 2007). Santos & Costa (2013) describe how a public software ecosystem was developed to facilitate collaboration between South Africa and Brazil. Khalil et al. (2011) emphasise the need to create a digital business ecosystem for Malaysia.
- Interoperability: One study from selected studies in developing countries falls under this theme, the study by Chatterjee et al. (2007). Based on the experiences of implementing digital ecosystems in India, Chatterjee et al. (2007) point out that interoperability is a component that should be present in a digital ecosystem, as it

provides a means for sharing information with all the different stakeholders in a digital ecosystem.

- Challenges: One study from the selected studies in developing countries reflects this theme, which is a study by Chatterjee et al. (2007). Chatterjee et al. (2007) point out different challenges which could hamper the formation of a digital ecosystem in a rural setting such as, literacy levels of the farmers, geographic locations of the farmers and stakeholders, language barriers and expensive technologies.
- Trust: One study from selected studies in developing countries falls under this theme, the study by Chatterjee et al. (2007). Isherwood (2013) emphasised the need for trust in a digital business ecosystem in South Africa.

4.8. COMPARISON OF DIGITAL HEALTH INNOVATION ECOSYSTEMS IN DEVELOPED AND *DEVELOPING COUNTRIES*

This section provides a comparison of the findings from developed and developing countries on *Digital Health, Innovation* and *Digital Ecosystems*.

4.8.1. Digital health

The findings of the scoping review for *Digital Health* reveal that different issues regarding *Digital Health* have been discussed, in both developed and developing countries. While there is evidence of *Digital Health* in developing countries, the literature revealed that studies on self-management and self-tracking apps, gamification, health and wellness apps, wireless sensors, health data exchange, health information and technology and interoperability were more prevalent in developed countries compared to developing countries. The findings also revealed that studies on m-health are prevalent in literature within developing countries. In general, both developed and developing countries have rich literature on *Digital Health*. There is a research gap regarding specific contexts in the areas of big data, genomics, health analytics and health 2.0/medicine 2.0. Table 4.9 summarises the literature on *Digital Health* in developed and developing countries.

Table 4-9: Components of Digital Health identified in developed and developing countries.

Components of *Digital Health* identified	**Developed countries**	**Developing countries**
EHRs	Jha et al., 2009; Pagliari et al., 2007; Herselman et al., 2016; Bonomi, 2016; Stroetmann et al., 2011; Al Rae, 2011; Dubbink, 2013; Bossen & Jensen, 2014; Doupi et al., 2010	Aklilu, 2012; Spence et al., 2016; Gray, 2016
Privacy and security	Anderson, 2011; Tikk, 2006;	Molina, 2010

Components of *Digital Health* identified	**Developed countries**	**Developing countries**
	Safadi et al., 2015; Karik et al., 2012; Misser, 2014	
Digital health	Ditchburn & Marshall, 2015; Herselman et al., 2016	Herselman et al., 2016; Sarumi & Idowu, 2016; Gardstedt et al., 2013
Cloud computing	Cocir, 2016	Haskew et al., 2015; Hsieh & Hsu, 2012
E-prescription	Kierkegaard, 2013; Stroetmann et al., 2011	Kierkegaard, 2013
E-health	Stroetmann et al., 2011; Craig, 2015; Gajanayake et al., 2013; Anthes, 2015; Leego, 2005; Estonia E-health Foundation, 2010; WHO Europe, 2016; Hyppönen et al., 2015; Workshop Report, 2013; Hämäläinen, 2014; Gray, 2016	Tubaishat and Habiballah, 2016; Ali, 2013; Fernadez and Oviedo, 2011; Sheraz et al., 2012; Ahmed et al., 2014; Nair, 2014; O'Connor et al., 2016; Botha et al., 2015; Mars, 2012
Telemedicine/telehealth	Stroetmann et al.,2011; Salisbury et al., 2016; Wang et al., 2015; Molfenter et al., 2015; Enriquez, 2014; Glauser et al., 2015; Hyppönen et al., 2015	Fernadez and Oviedo, 2011; Al-Kadi, 2012; Alkhudairi, 2016; Mars, 2009; Walama & Augustine, 2013; Holmes et al., 2014; MoHSS, 2016
Internet	Lara et al., 2016; Wangberg et al., 2015; Kirby, 2006; Tanis et al., 2016; Bujnowska-Fedak, 2015; Richards et al., 2014; Townsend et al., 2013; Newhouse et al., 2015; Kolyako and Riga, 2012; BBC, 2010; Vincent, 2014	Hou et al., 2012; Ajuwon, 2006; Clarke & Mars, 2015; Pfeiffer et al., 2014
EMRs	Bonomi et al., 2015	Msukwa, 2011; Chaplin et al., 2015; Seebregts et al., 2009; Blaya et al., 2010; Odero et al. 2007; Madore et al., 2015
Social media	Murthy & Eldredge, 2016; Huang, 2013	Duduciuc, 2015; Ince et al., 2015; Gwetu, 2009; Batta & Iwokwagh, 2015; Cassanati et al., 2014
M-health	Mobasheri et al., 2015; Ybarra et al., 2014; Ahsan et al., 2013; Balaam et al., 2015; TELUS, 2011; WHO, 2011; Veijalainen et al., 2011	Fernadez and Oviedo, 2011; West, 2015; Veijalainen et al., 2011; Ahmed et al., 2014; Sheikh, 2015; Islam et al., 2016; Blanckenberg et al., 2011; Chib et al., 2008; Hao et al., 2015; Kumar & Anderson, 2015; Botha & Booi, 2016; Li et al., 2014; Hampshire et al., 2015; Lippman et al., 2016; Blaya et al., 2010; Iluyemi et al., 2008; Underwood, 2013; Jennings et al.,2013; Iluyemi et al., 2008; Kumar et al., 2016; Mangam et al., 2016
Public health surveillance	Thacker et al., 2012; Choi, 2012;	Isere et al., 2015; Abubakar et al., 2013; Lukwago et al., 2011;

Components of *Digital Health* identified	Developed countries	Developing countries
		Bachani et al., 2014; Budgell et al., 2015
Information systems	Kivinen and Lammintakenen (2013)	Kalpa, 2012; Hiregoudar et al., 2015; Makinde et al., 2014; Blaya et al., 2010; USAID, 2012; Al-Nashy et al. 2015; Lutge et al., 2016
Self-management and self-tracking apps	Klaassen et al., 2013	
Gamification	Klaus et al., 2016	
Health and wellness apps	Ho et al., 2016	
Wireless sensors	Ashraf, 2007a; Ashraf, 2007b	
Health data exchange	Elger et al., 2010	
Health information technology	Yu, 2014	
Interoperability	Karik et al., 2012; Doupi et al., 2010	

Table 4.9 highlights the differences in *Digital Health* components as found in developed and developing countries, summarised in Table 4-10.

Table 4-10: Summary of Digital Health in developed and developing countries

Components of *Digital Health* identified	Developed countries	Developing countries
EHRs	✓	✓
Privacy and security	✓	✓
Digital health	✓	✓
Cloud computing	✓	✓
E-prescription	✓	✓
E-health	✓	✓
Telemedicine/telehealth	✓	✓
Internet	✓	✓
EMRs	✓	✓
Social media	✓	✓
M-health	✓	✓
Public health surveillance	✓	✓
Information systems	✓	✓
Self-management and self-tracking apps	✓	×
Gamification	✓	×
Health and wellness apps	✓	×
Wireless sensors	✓	×
Health data exchange	✓	×
Health information technology	✓	×
Interoperability	✓	×

Table 4-9 clearly indicates that developing countries have a dearth of reported progress on components:

- Self-management and self-tracking apps,
- Gamification,
- Health and wellness apps,
- Wireless sensors,
- Health data exchange,
- Health information technology and
- Interoperability.

4.8.2. Innovation

The scoping review identified studies on innovation in both developed and developing countries. While the themes on innovation seem to be similar for both developed and developing countries, the literature suggests that innovation spaces and living labs have been facilitated in developing countries. Healthcare innovation studies were also undertaken in developed countries, however, not identified in selected publications in developing countries. In general, for both developed and developing countries, more research should be done on Quadruple Helix systems within a developing country context. Open innovation, Triple Helix systems, technology innovation, process and product innovation, intellectual property rights and innovation by collaboration have similar studies conducted in both developed and developing countries. Table 4.11 summarises the literature on innovation in developed and developing countries.

Table 4-11: Summary of innovation identified in developed and developing countries.

Components of innovation identified	**Developed countries**	**Developing countries**
Increasing innovation by collaboration	Apiola et al., 2015; Halme et al., 2014; Saarelainen, 2016; Pippola et al., 2012	Apiola et al., 2015; Harsh & Zachary, 2013; Santos & Costa, 2013; Saarelainen, 2016;
Innovation through teaching	Richardson et al., 2008	
Triple Helix systems	Ojala et al., 2016; Tukiainen & Sutinen, 2015;	Doret & Jordaan, 2014; Oyelaran-Oyeyinka & Sampath, 2007
Technology innovation	Hardie & Newell, 2011; Talukder, 2012	Kariuki, 2009; Moraa & Gathege, 2013; Niosi & Bas, 2014; Siriginidi, 2008; Dauda & Akingbade, 2011; Ilo et al., 2014; Kahn, 2013
Process and product innovation	Bull & Ferguson, 2006; Government of Canada, 2013; Übiu et al., 2009	Egbetokun et al., 2008; Egbetokun et al., 2016; Amiolemen et al., 2013; Selfano & Robert, 2014
Healthcare innovation	Psaila et al., 2012; Ham, 2013;	

Components of innovation identified	Developed countries	Developing countries
	Innovation Unit, 2013; Huhtamaki et al., 2011	
Open innovation	Morgan & Finnegan, 2010; Atkinson, 2014; Anderson et al., 2015; Brodie, 2015; Kalvet & Tiits, 2012	Egbetokun & Siyanbola, 2011; Waribugo et al., 2016; Gerryts & Buys, 2008; Van Vollenhoven & Buys, 2010; Selfano & Robert, 2014; Ndirangu & Bellah, 2013; Cunningham et al., 2014
Intellectual property rights	Lee et al., 2010; Intellectual Property Office, 2013	De Beer & Oguamanam, 2014; Gregory, 2008
User innovation	De Jong et al., 2015	
Organisational and marketing innovation		Pino et al., 2016
Influence of government ownership		Jiao et al., 2015
Innovation spaces and living labs	Juujärvi & Kaija, 2013	Cunningham & Cunningham, 2016
Quadruple Helix System	Markkula & Kune, 2015	

Table 4.12 highlights the differences in innovation components found in developed and developing countries.

Table 4-12: Components of Innovation identified in developed and developing countries.

Components of innovation identified	Developed countries	Developing countries
Increasing innovation by collaboration	✓	✓
Innovation through teaching	✓	×
Triple Helix systems	✓	✓
Technology innovation	✓	✓
Process and product innovation	✓	✓
Healthcare innovation	✓	×
Open innovation	✓	✓
Intellectual property rights	✓	✓
User innovation	✓	×
Organisational and marketing innovation	×	✓
Influence of government ownership	×	✓
Innovation spaces and living labs	✓	✓
Quadruple Helix System	✓	×

In developing countries, Innovation tends to be a government driven initiative.

4.8.3. Digital ecosystems

The findings of the scoping review for digital ecosystems reveal that digital ecosystems have been discussed in both developed and developing contexts. While actual implementations of digital ecosystems have been recorded in both developed and developing countries, studies on digital ecosystems in developed countries focus on theoretical aspects of digital ecosystems which describe digital ecosystems, the need to implement digital ecosystems and technologies needed to implement a digital ecosystem. Trust and interoperability seem to be a consistent feature of digital ecosystems, in both developed and developing countries. Challenges of implementing a digital ecosystem have been described in developing countries compared to developing countries. In general, more research is needed on digital ecosystems referring to developed and developing contexts. Table 4.13 summarises the literature on digital ecosystems in developed and developing countries.

Table 4-13: Summary of digital ecosystems identified in developed and developing countries.

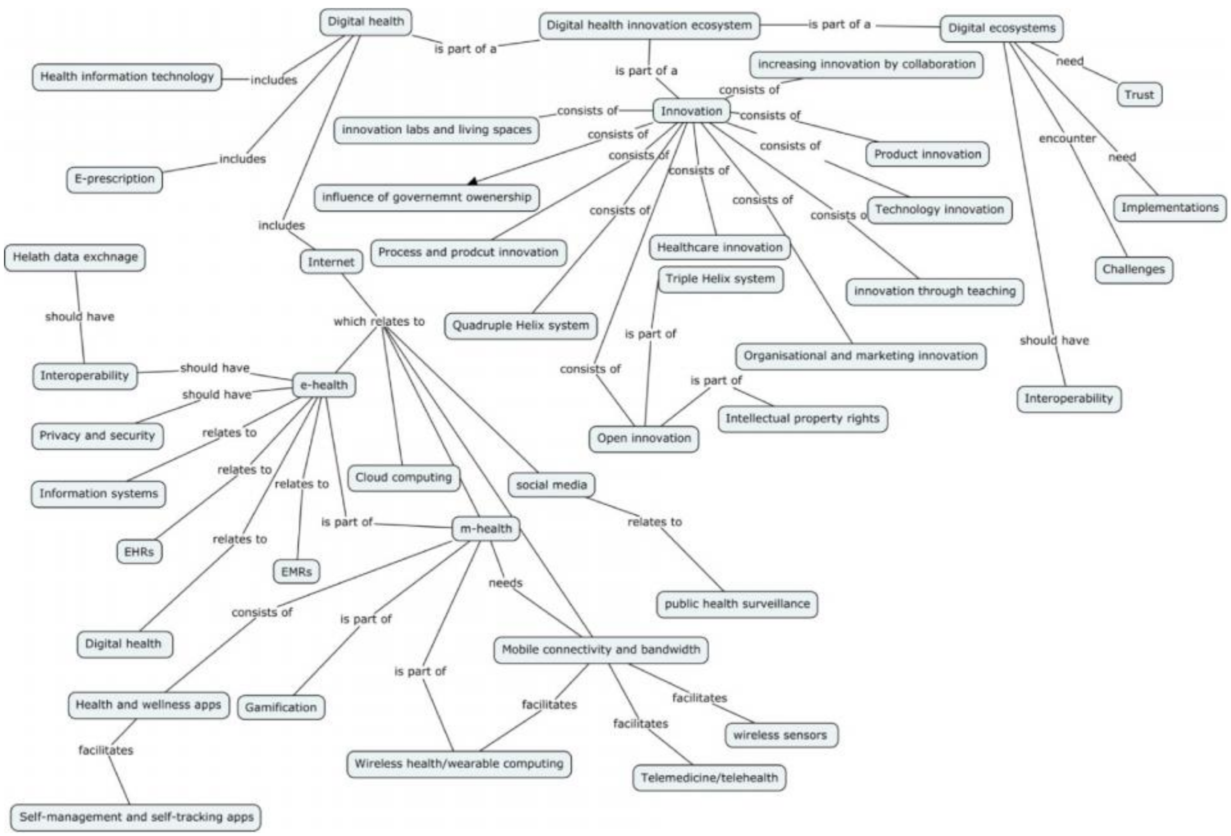
Component of digital ecosystems identified	**Developed countries**	**Developing countries**
Implementing digital ecosystems	English & Dory, 2007; Tang et al., 2010; Lawson et al., 2010; Eklund et al., 2010; Botto et al., 2008; Dapp, 2015; Lau, 2009; Herdon et al., 2012; Konda et al., 2007	Chatterjee et al., 2007; Santos and Costa, 2013; Khalil et al., 2011
Trust	Konda et al., 2007	Chatterjee et al., 2007; Isherwood, 2013
Interoperability	Dapp, 2015	Chatterjee et al., 2007
Challenges		Chatterjee et al., 2007

Table 4-14: Components of digital ecosystems identified in developed and developing countries.

Component of digital ecosystems identified	**Developed countries**	**Developing countries**
Implementing digital ecosystems	✓	✓
Trust	✓	✓
Interoperability	✓	✓
Challenges	×	✓

4.9. CONCEPT MAP FOR DIGITAL HEALTH INNOVATION ECOSYSTEMS IN DEVELOPED AND DEVELOPING COUNTRIES

The concept map consisting of components for *Digital Health Innovation Ecosystems* identified as relevant for Digital *Health Innovation Ecosystems* in developed and developing



countries

Figure 4-10: Concept map of components of the concepts: Digital Health, Innovation and Digital Ecosystems in developed and developing countries.

The concept map illustrates the components of the concepts: *Digital Health, Innovation* and *Digital Ecosystems* as evident in developed and developing countries. As shown in Figure 4.11, the components are similar to the components identified in Chapter 3, Figure 3.8. However, the difference between the concept maps presented in Figure 3.8 and this map is that Figure 4.11 broadly explains all components that should be included in a *Digital Health Innovation Ecosystem,* irrespective of its implementation in any context. It provides a general overview of the components that should be included in a digital health innovation ecosystem. However, the components in Figure 3.8, highlights the components of *Digital Health, Innovation* and *Digital Ecosystems* as found through a systematic literature review for the various countries. Through the scoping review of Chapter 4, more components were identified specific to the specific type (developed versus developing) of country.

Figure 4.11 highlights components such as e-prescription and health data exchange as components of digital health evident in developed and developing countries, respectively. These were not identified in the literature as components of digital health in Chapter 3 and, as such, they extend the initial components of digital health as previously identified in Chapter 3. For innovation, concepts such as innovation spaces and living labs, influence of government ownership, innovation through teaching and increasing innovation by collaboration were important components identified in developed and developing countries. As stated, these concepts were not listed in Chapter 3 as components of innovation. This adds to the existing components of innovation which leads to the creation of the initial framework for this study. Although organisational and marketing innovations were identified as components of innovation, they were not considered as components of innovation, related to the healthcare innovation.

Other relevant components of digital ecosystems, which are evident in developed and developing countries, are implementation and challenges. These were not listed in Chapter 3 but the scoping review, conducted in Chapter 4, revealed the relevance of these components. These components thus extend, and contribute, to all other components which make up the initial *Digital Health Innovation Ecosystem Framework*.

4.10. PROPOSED GUIDELINES WITH APPROACHES FOR IMPLEMENTING A DIGITAL HEALTH INNOVATION ECOSYSTEM IN DEVELOPING COUNTRIES

Different studies have proposed strategies for implementing ecosystems, especially within the marine field (Busch et al., 2003; Fletcher, 2008; Hartje & Klaphake, 2006; PISCES, 2012). While Wilson et al. (2014) propose guidelines for implementing *Digital Health*, Thomas (2012) also provides guidelines on how to implement an innovation ecosystem. Benedict & Schlieter (2015) proposed governance guidelines for *Digital Health* ecosystems. The proposed guidelines for implementing a *Digital Health Innovation Ecosystem* adopted several ideas, drawn from other studies, which best fit within the concept of a *Digital Health Innovation Ecosystem*. These studies include those by Busch et al. (2003), Microsoft (2013), Fletcher (2008), Hartje & Klaphake (2006), PISCES (2012), Thomas (2012) and Wilson (2014) and Benedict & Schlieter (2015). The following guidelines are proposed for implementing a *Digital Health Innovation Ecosystem*:

Table 4-15: Guidelines with approaches to be applied when implementing a Digital Health Innovation Ecosystem.

Guidelines	Description	Approach
Guideline 1: Identification of stakeholders and their role in	Thomas (2012) pointed out that the first step to implementing an	Identify individuals and organisations that will carry out

Guidelines	Description	Approach
the ecosystem.	innovation ecosystem is to identify the participants who will carry out activities in the ecosystem. Benedict & Schlieter (2015) indicate that it is also appropriate to emphasise which activities stakeholders are to perform. Stakeholders are important components in an ecosystem (Busch et al., 2003). In the case of Digital Health innovation ecosystems, stakeholders can be referred to as species (biological species and/or economic species) as per Chang & West (2006). According to PISCES (2012), Fletcher (2008) and Harje & Klaphake (2006), it is important to determine what you want to achieve within an ecosystem. The role of each stakeholder in the Digital Health innovation should thus be defined (PISCES, 2012) at an early stage of ecosystem set-up to ensure that stakeholder aims are aligned.	activities in the *Digital Health Innovation Ecosystem* relevant to a particular context. Early in the process, there should be formal documentation regarding the set-out goals which the stakeholders are aiming to achieve in the *Digital Health Innovation Ecosystem*.
Guideline 2: Connecting international through local.	An ecosystem should not only embrace local strategies, but international strategies as well (PISCES, 2012). Hence, a *Digital Health Innovation Ecosystem* should not only be able to connect local stakeholders, but international stakeholders as well. This will facilitate an open innovation to and interaction from stakeholders outside the borders of a country.	International stakeholders, who take part in the Digital Health innovation ecosystem, should identify themselves. Strategies and policies should also be put into place to explain how international stakeholders can connect to the Digital Health innovation ecosystem.
Guideline 3: Organising Requirements.	Since *Digital Health, Innovation* and *Digital Ecosystems* are suggested as focus areas for Digital Health innovation ecosystems, the relevant components should be prepared in the country that wishes to implement the ecosystem. For developing countries, Wilson et al. (2014) suggest that Ministries of Health need to be actively involved in ensuring that Digital Health technologies are fully implemented. Digital Health should be included as an objective which needs to be met (Wilson et al., 2014).	When implementing a *Digital Health Innovation Ecosystem* in a country, it is important for stakeholders to select which Digital Health and innovation components are important, rather than trying to implement all the components, even those which might not be relevant to the country's context. For example, m-health might be appropriate in some contexts, and inappropriate in others. Similarly, open innovation might be relevant in some contexts and irrelevant in others. Once the components have been identified, the relevant components can then be implemented.
Guideline 4: Defining the operational environment.	Following the guideline provided by Microsoft (2013), the platforms on which the technologies will be deployed, should be assessed.	The architecture, which describes the structure to be implemented, will be unique, depending on the particular

Guidelines	Description	Approach
		context. The technologies to be deployed on the platform, should adapt to the architecture of a particular context.
Guideline 5: Align the existing healthcare applications with the new Digital Health applications.	Following the guideline provided by Microsoft (2013), previous healthcare applications should integrate with the implementation of new Digital Health technologies.	Strategies should exist to govern the integration of existing applications with new applications and thus ensure that there is continuity of workflow with existing healthcare applications. Structured planning would ensure that the existing infrastructure is reviewed for integration with new Digital Health technologies.
Guideline 6: Review, monitoring and ethics.	PISCES (2012) suggests that it is important to evaluate the performance of an ecosystem as this is also vital in maintaining it (Hartje & Klaphake, 2006). PISCES (2012) further suggests the establishment of a maintenance principle to guide this approach. For Digital Health innovation ecosystems, a guiding principle for assessing the performance of the ecosystem after its implementation to ensure that the ecosystem is functioning in alignment with the set-out goals to be achieved by the stakeholders, is vital. Reviewing and monitoring in a *Digital Health Innovation Ecosystem* is also vital to sustaining the ecosystem and its stakeholders. Ethical issues regarding how information is shared and who is given access to information shared within the ecosystems should be addressed.	Stakeholders must set up strategies to ensure that review and monitoring take place. The review can occur at specific times as agreed to by the stakeholders. There should also exist a standard for monitoring activities in the Digital Health innovation ecosystem. Ethical guidelines should be defined with the Digital Health Innovation Ecosystem.

4.11. DEVELOPMENT OF DIGITAL HEALTH INNOVATION ECOSYSTEMS INITIAL FRAMEWORK

The development of the initial framework involves summaries of specific components of the *Digital Health* innovation ecosystems per specific previous chapters. Chapter 3 provided the literature on *Digital Health Innovation Ecosystems.*

4.11.1. Chapter 3

Components of *Digital Health, Innovation* and *Digital Ecosystems* were identified and presented in three different stages, as reflected in Figure 4-14.

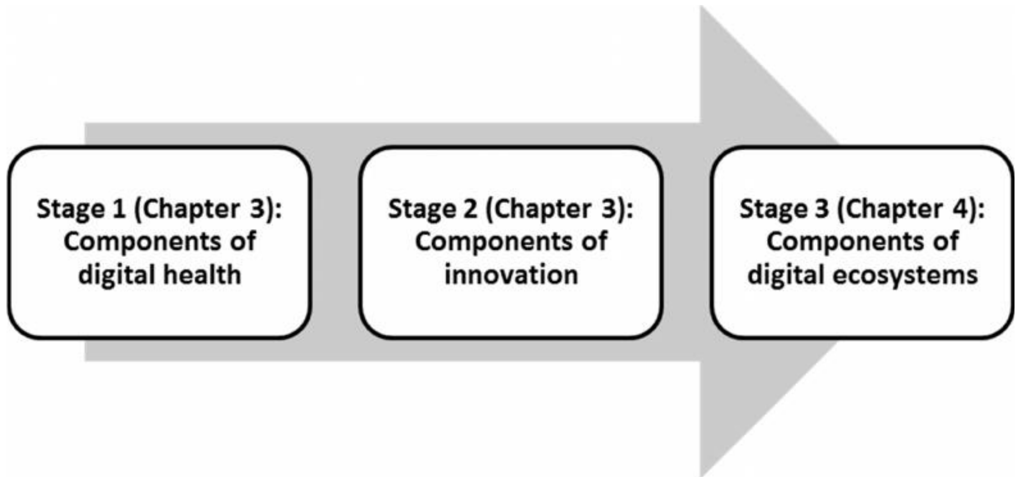


Figure 4-11: Stages in the identification of Digital Health, Innovation and Digital Ecosystems components.

4.11.1.1. Stage 1: Identification of Digital Health components

The components of *Digital Health,* in general, were identified through the systematic literature review. They are summarised below:

- e-Health
- m-Health
- Telemedicine/telehealth
- Health 2.0/medicine 2.0
- Wireless health/wireless sensors
- Internet
- Genomics/personalised medicine
- Mobile connectivity/bandwidth
- Social networking/social media/health and medical platforms
- Computing power and data universe
- Information systems
- Imaging
- Self-tracking (the quantified self)
- Wearable computing/sensors and wearables
- Health information technology
- Big data
- Cloud computing
- Public health surveillance
- Health promotion strategies

- Electronic medical records (EMRs)
- Electronic health records (EHRs)
- Gamification
- Interoperability
- Health and wellness apps
- Health analytics
- Digitised health systems
- Privacy and security

4.11.1.2. Stage 2: Identification of *innovation* components

The components of innovation were identified through a systematic literature review. These are summarised below:

- Process, product and structure innovation
- Closed and open innovation
- Open innovation 2.0
- Information technology
- Innovation networks ecosystems
- Triple Helix systems
- Quadruple Helix systems
- User innovation
- Intellectual property rights
- Role players
- Capital
- Infrastructure
- Regulations
- Knowledge
- Ideas
- Interface
- Culture
- Architectural principles

4.11.1.3. Stage 3: Identification of *digital ecosystems* components

The components of digital ecosystems were identified through a systematic literature review and presented in section 3.6.4. These included:

- Agents
- Biological, ordinary, economic and digital species
- Digital environment and digital content
- Interoperability
- Trust and security
- Economic species
- Digital species
- Mobile clients
- Ecosystem-oriented architecture
- Self-organisation
- Semantic web
- Community
- Technology
- Practice

4.11.2. Chapter 4

Chapter 4 dealt with the literature regarding *Digital Health Innovation Ecosystems* in **developed** and **developing countries**. These components are reflected in Figure 4-13:

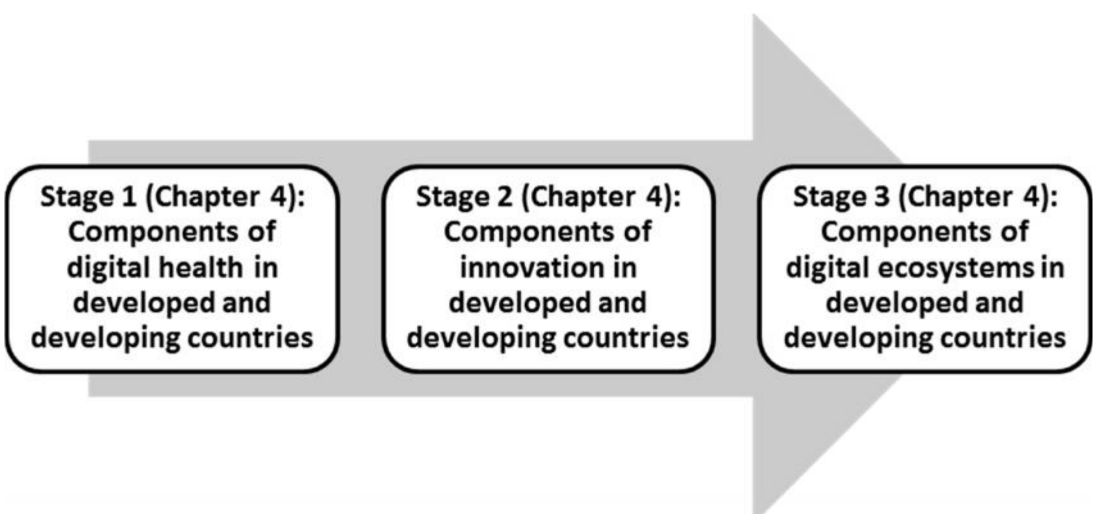


Figure 4-12: Stages in the identification of Digital Health, Innovation and Digital Ecosystems in developed and developing countries.

4.11.2.1. Stage 1: Identification of Digital Health components in developed and developing countries

The components of *Digital Health* in developed and developing countries were identified from the scoping review in Chapter 4. These components were presented in section 4.8.1, as well as Table 4-16.

Table 4-16 Components of *Digital Health* identified in developed and developing countries

Table 4-16: Components of Digital Health identified in developed and developing countries.

Components of *Digital Health* identified	Developed countries	Developing countries
EHRs	✓	✓
Privacy and security	✓	✓
Digital health	✓	✓
Cloud computing	✓	✓
E-prescription	✓	✓
E-health	✓	✓
Telemedicine/telehealth	✓	✓
Internet	✓	✓
EMRs	✓	✓
Social media	✓	✓
M-health	✓	✓
Public health surveillance	✓	✓
Information systems	✓	✓
Self-management and self-tracking apps	✓	×
Gamification	✓	×
Health and wellness apps	✓	×
Wireless sensors	✓	×
Health data exchange	✓	×
Health information technology	✓	×
Interoperability	✓	×

4.11.2.2. Stage 2: Identification of innovation components in developed and developing countries

The components of innovation in developed and developing countries were identified from the scoping review presented in Chapter 4. The table below repeats the components of *Innovation* identified in developed and developing countries, as presented in section 4.8.2.

Table 4-17: Components of innovation identified in developed and developing countries.

Components of innovation identified	Developed countries	Developing countries
Increasing innovation by collaboration	✓	✓

Innovation through teaching	✓	×
Triple Helix systems	✓	✓
Technology innovation	✓	✓
Process and product innovation	✓	✓
Healthcare innovation	✓	×
Open innovation	✓	✓
Intellectual property rights	✓	✓
Organisational and marketing innovation	×	✓
User innovation	✓	×
Influence of government ownership	×	✓
Innovation spaces and living labs	✓	✓
Quadruple Helix systems	✓	×

4.11.2.3. Stage 3: Identification of digital ecosystem's components in developed and developing countries

The components of digital ecosystems in developed and developing countries were identified from the scoping review presented in Chapter 4. The table below repeats the components of *Digital Ecosystems* as identified in developed and developing countries and presented in section 4.8.3.

Table 4-18: Components of Digital Ecosystems identified in developed and developing countries.

Components of digital ecosystems identified	**Developed countries**	**Developing countries**
Implementing digital ecosystems	✓	✓
Trust	✓	✓
Interoperability	✓	✓
Challenges	×	✓

Having identified the components of *Digital Health, Innovation* and *Digital Ecosystems* from the literature and from the perspective of developed and developing countries, the components were merged to form an initial framework for a *Digital Health Innovation Ecosystem.* This is presented in the next section.

4.12. THE INITIAL NAMIBIAN DIGITAL HEALTH INNOVATION ECOSYSTEM FRAMEWORK

As indicated in Chapter 1 (section 1.1), a *framework* for the purposes of this research is a means of presenting identified validated components and their relationship within the Namibian Health domain territory. The initial framework, as presented in Figure 4-14 below, is regarded as the ***Initial Namibian Digital Health Innovation Ecosystem Framework***.

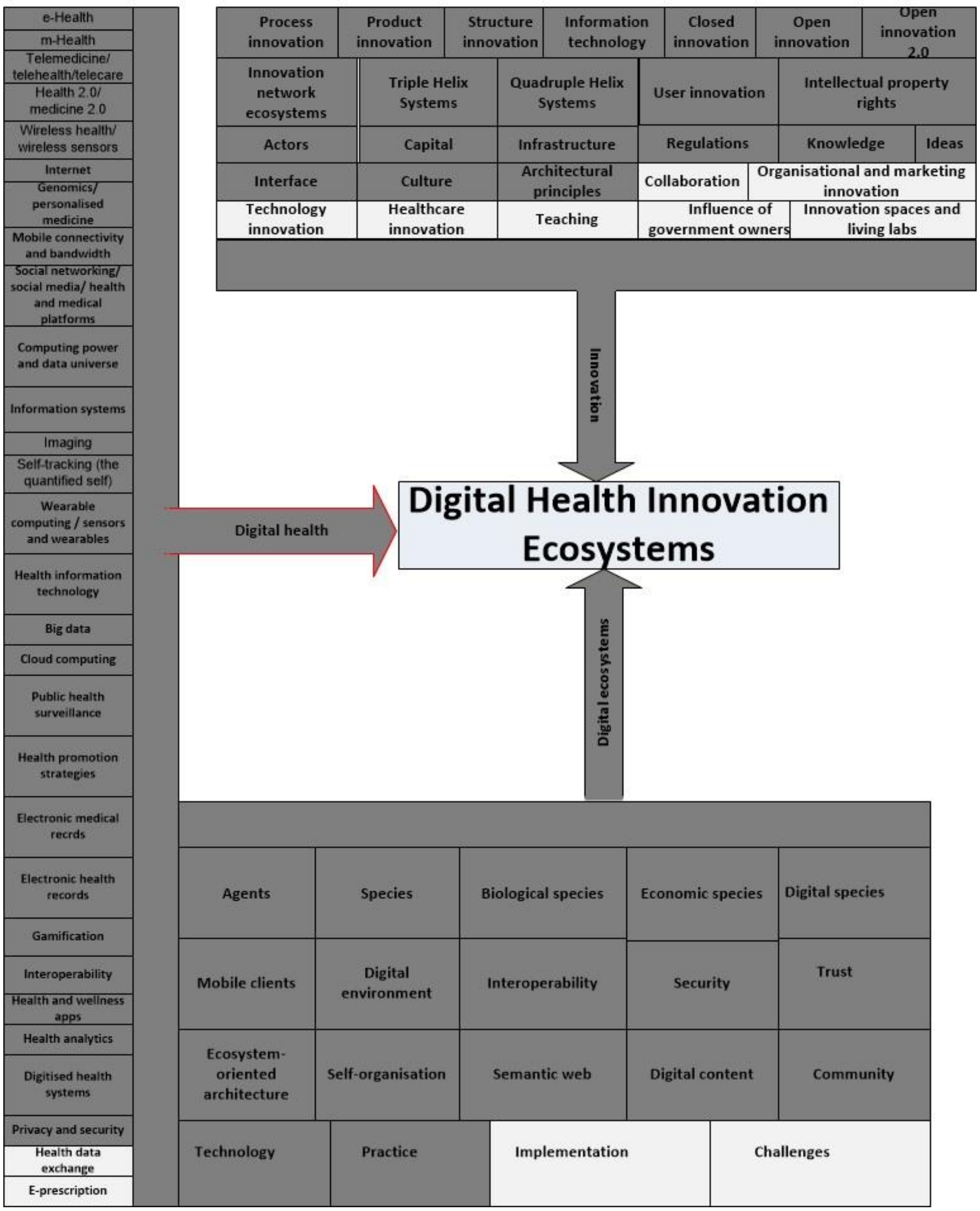


Figure 4-13: Initial Digital Health Innovation Ecosystem framework.

Figure 4-14 can be regarded as the conceptualisation of the initial framework, as explained in Chapter 1 (section 1.10), as well as in the figures at the beginning of Chapters 3 and 4. Conceptualising the initial *Namibian Digital Health Innovation Ecosystem Framework* was developed as part of Phase 1 of this study.

As per Figure 4-14, the components in dark grey constitute components identified in Chapter 3. Components in light grey signify those components identified in Chapter 4, but omitted from Figure 3.8. The next step is for the initial framework to be evaluated by *Digital Health* experts from Namibia. For this study, it is important to comprehend which components of the *Digital Health Innovation Ecosystem* relate to the Namibian context. It is also important to determine how these knowledgeable practitioners (KPs) in the field of *Digital Health* ranked these components to develop a Namibian *Digital Health Innovation Ecosystem*. Before evaluation of this *Digital Health Innovation Ecosystem* can take place within the Namibian context, it is important to describe the Namibian healthcare sector and examine the extent to which *Digital Health, Innovation* and *Digital Ecosystems* have been applied in the Namibian context.

Conceptualising this framework was done in the following way:

- The concept map at the end of Chapter 3 (Figure 3-8) provides a summary of the components of the concepts: Digital Health, Innovation and Digital Ecosystems which was constituted through a systematic literature review. The use and application of these concepts, with their components, were then investigated through a scoping review and visualised in a concept map in Chapter 4 (Figure 4-12).
- Both concept maps, Chapter 3 (Figure 3-8) and Chapter 4 (Figure 4-12), were then combined to constitute the initial Namibian Digital Health Innovation Ecosystem Framework.

The conceptualisation of the initial framework does *not* yet represent the Namibian context but provides a general overview of what components should constitute a *Digital Health Innovation Ecosystem* for any country. Before it can be contextualised, it is imperative to explain what contextualisation involves.

4.13. CONTEXTUALISING A FRAMEWORK

To contextualise the initial framework it is important to consider context specific issues. Various foresight analytical tools like PESTLE, TEEPSE or STEEPV can be applied to ensure that all relevant context areas are considered before contextualising (Miles, 2015). STEEPV, chosen for this study, consists of the following areas: Social, Technological, Economic, Environmental, Political and Value-based.

STEEPV can be applied to refine the context and it can also inform finer elements of the context, whether at local, regional, national or international level. Miles (2015) indicates that one can extend STEEPV to add the two more elements: Educational and Demographic and delete the element of value, which results into the abbreviation: STEEPED. These areas are important when contextualising any model or framework (Miles, 2015) as various stakeholders can be involved in the analysis of these areas. STEEPV, a recognised analytical foresight tool, will be considered when discussing the Namibian context in Chapter 5.

4.14. SUMMARY

This chapter provided a literature review of developed and developing countries, including the differences between them. The health challenges faced by developing countries and how to overcome these challenges were also discussed. MDGs, as well as the importance of *Digital Health Innovation Ecosystems* in developing countries addressing these goals, were provided. The chapter also provided a scoping review of *Digital Health* innovation ecosystems in developed and developing countries and examined the scope of studies which have been conducted within developed and developing countries. A concept map for *Digital Health Innovation Ecosystems* in developed and developing countries was provided. A guideline for implementing a *Digital Health Innovation Ecosystem* was proposed and finally the conceptualising of the initial *Namibian Digital Health Innovation Ecosystem Framework* was provided, and discussed. In Chapter 5 the framework will be contextualised to become an intermediate Namibian Digital Health Innovation Ecosystem.

CHAPTER 5. DEVELOPMENT AND EVALUATION OF A NAMIBIAN DIGITAL HEALTH INNOVATION ECOSYSTEM INTERMEDIATE FRAMEWORK

5.1. INTRODUCTION

Chapters 3 and 4 completed Phase 1 of this study which entailed identifying relevant components of the concepts *Digital Health, Innovation* and *Digital Ecosystems,* and how these components are deliberated in developed and developing countries. The findings from Chapters 3 and 4 provided relevant information which led to the development of the initial framework.

This chapter focuses on the Phase 2 of the study, which highlights the development of the intermediate framework and the presentation of the findings from the evaluation of the components from KPs from the Namibian context. The chapter serves different purposes. Firstly, it aims to answer the third research question posed in section 1.4:

> *What are the components of Digital Health, Innovation and Digital Ecosystems specifically relevant to the Namibian context as identified by knowledgeable professionals (KPs) in Namibia and globally?*

Secondly this chapter also aims to address the following objectives of the study:

- Evaluate the initial framework (artefact) for a *Digital Health Innovation Ecosystem* in Namibia based on the findings from KPs in Namibia.
- Identify the perceived benefits of a *Digital Health Innovation Ecosystem* for Namibia based on the findings from KPs in Namibia.
- Identify potential stakeholders of a *Digital Health Innovation Ecosystem* for Namibia based on the findings from KPs in Namibia.
- Identify strategies to be put into place for *Digital Health* to be established in Namibia, based on the findings from KPs in Namibia.

As explained in Chapter 2, this study adopts the Design Science research methodology. Figure 5-1 highlights the phase which is discussed in Chapter 5 (encircled in green). As illustrated in Figure 5-1, Chapter 5 focuses on evaluating the initial framework (artefact) by KPs in the Namibian context. The findings from this chapter will form the basis of the discussions in Chapter 6.

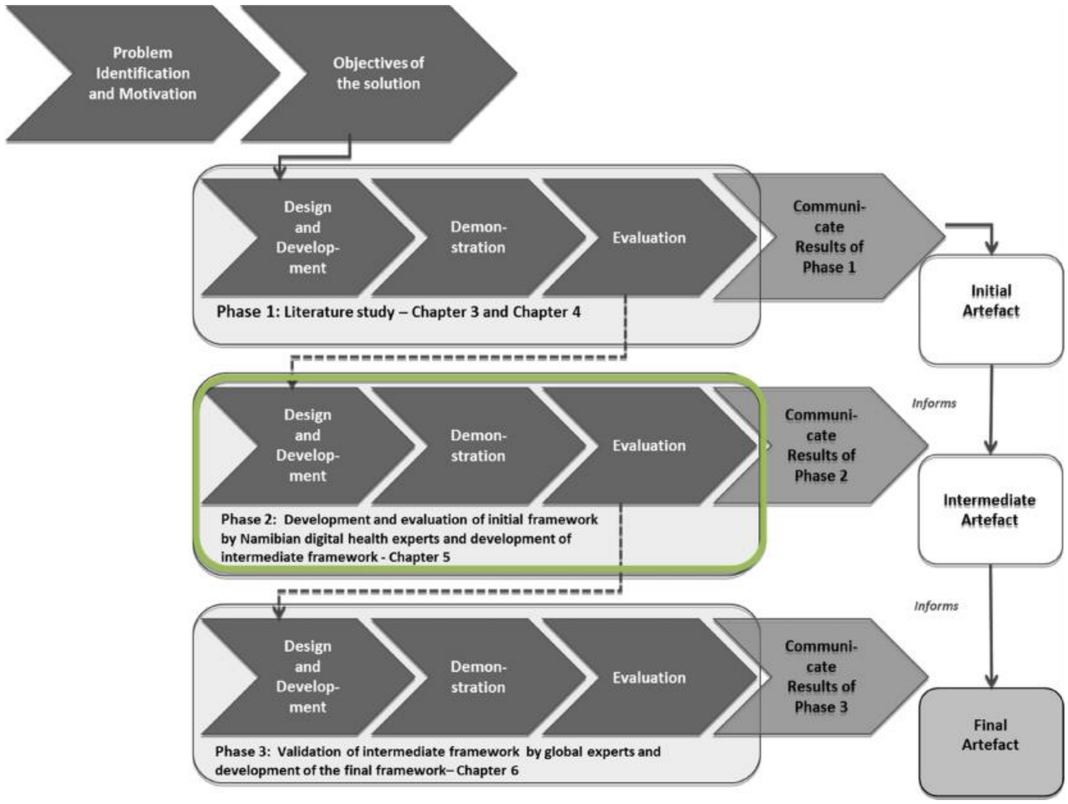


Figure 5-1: Phase 2 of the study articulated in Chapter 5.

The following section provides an overview Chapter 5.

This chapter is divided into three parts. The first part provides a discussion on the Namibian healthcare sector, the second part focuses on the evaluation of the initial framework by KPs within the Namibian context and the third part focuses on the development of the intermediate framework.

The next section provides a discussion on the Namibian healthcare sector.

5.2. THE NAMIBIAN HEALTHCARE SECTOR

This section presents a brief overview of the Namibian context and describes the Namibian healthcare sector. An introduction to the Namibian context is provided first.

5.2.1. Brief overview of the Namibian context

Namibia is a country located in the southern part of Africa. As at 2013, Namibia was estimated to have a population of approximately 2.3 million people (World Bank, 2013). Namibia can be described as a *semi-arid* country with an area comprising of about 825 000 square meters (Government of Namibia, 2002, p. 6).

Namibia is a member state of both the UN and the Southern Africa Development Community (SADC) (Mbuende, 2014). Child mortality rate in Namibia is estimated to be about "44 deaths for every 1 000 births," while maternal mortality is estimated to be about "604 deaths for every 100 000 births" (Nakale, 2014, p. 1).

Namibia is divided into 14 administrative regions (Government of Namibia, 2016) as per map in Figure 5-2. These 14 regions are further sub-divided into 121 constituencies.

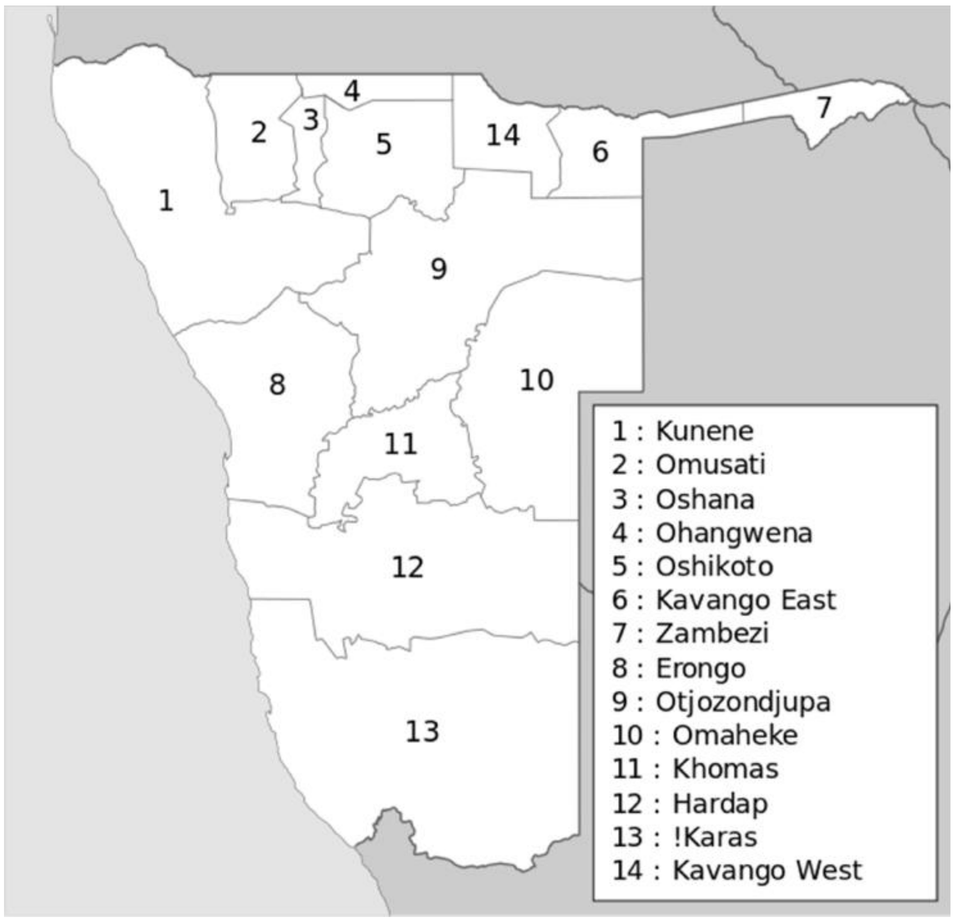


Figure 5-2: Map of the 14 regions of Namibia (adapted from Wikimedia Commons, 2016).

The population of each region, as presented in Figure 5-2, is listed in Table 5-1.

Table 5-1: Population of each region in Namibia (adapted from Geohive, 2016).

Region	**Population**
Zambezi region	90 596
Erongo region	150 809
Hardap region	79 507
!Karas region	77 421
Kavango east region	115 447
Kavango west region	107 905

Region	Population
Khomas region	342 141
Kunene region	86 856
Ohangwena region	245 446
Omaheke region	71 233
Omusati region	243 166
Oshana region	176 674
Oshikoto region	181 973
Otjozondjupa region	143 903

It is evident from Table 5-1 that Omaheke is the most sparsely populated region and Khomas, where the capital Windhoek is situated, the most densely populated. The next section provides some background information to the Namibian healthcare sector.

5.2.2. Background to the Namibian healthcare sector

The Namibian healthcare system is driven by both the private and public healthcare sector. The government-owned hospitals/clinics are managed by the government while the private hospitals/clinics are managed and owned by private entities (World Health Organisation [WHO], 2010). Eighty five percent of the population is dependent on the government for healthcare delivery services, while the remaining 15% of the population make use of the private healthcare sector (WHO, 2010). Private healthcare services are contracted out to medical aid schemes and membership of said schemes is affordable only to working class individuals (Brockmeyer, 2012). Per Hamunyela and Iyamu (2013), the public healthcare sector consists of three levels namely: the National level (National referral hospital), regional level (Intermediate hospitals) and district level within communities (health centres, clinics and mobile clinics). Van Rooy et al. (2012, p. 763) explain that public healthcare is made available through different units such as “clinics, outreach points and district hospitals.” The number of medical facilities found in the public sector is depicted in the table below.

Table 5-2: Number of Public Health facilities in Namibia (adapted from WHO, 2010).

Hospital Type	Number
Outreach Points	1 150
Clinics	265
Health Centres	44
District Hospitals	30
Intermediate Hospitals	3
National Referral Hospitals	1

From the information contained in Table 5-2, it is evident that *outreach points* are the most prolific public health facilities.

Figure 5.3 depicts the typical structure of the Namibian healthcare sector.

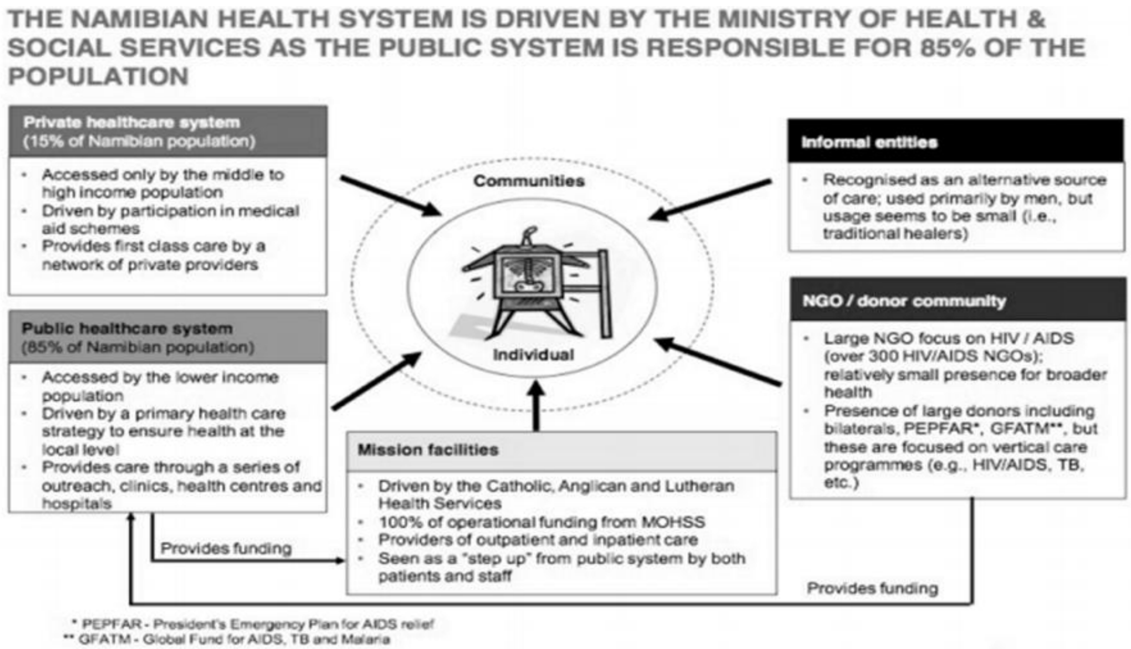


Figure 5-3: The Namibian healthcare system (adapted from Brockmeyer, 2012).

As shown in Figure 5-3, the public healthcare sector is supported by external bodies. There is no coordinated referral system between private and government-owned health institutions as they have different methods of operation. The public healthcare sector is financially supported by its partners. An increase in financial support (from 3% to 19.7%) over the period 1990 to 2011 has been noted (Ministry of Health and Social Services [MoHSS], 2014). Services offered by the private healthcare sector are expensive limiting access to those individuals who can afford to pay for said services. Van Rooy et al. (2012, p. 763) state that "the overall orientation of public health services is towards primary healthcare, where the focus is on community health, preventative measures and treatment that can be provided relatively easily, cheaply and quickly."

As in any developing country, Namibia also faces some public healthcare challenges.

5.2.3. Challenges of the Namibian public healthcare sector

In an effort to determine the relevant components of *Digital Health Innovation Ecosystems* within the Namibian context, it is important to examine the challenges facing Namibian public hospitals.

The large percentage of the population dependent on public healthcare has resulted in this sector being overburdened. The sector must further deal with constant medical staff shortages (Van Rooy et al., 2012), increasing health challenges such as HIV/AIDS (Schellekens et al., 2009) as well as maternal and child mortality (Nakale, 2012). Although

Van Rooy et al. (2015) indicate that there is a dearth of medical practitioners, MoHSS (2014) also reveals a lack of experienced technical staff responsible for the deployment, maintenance and interoperability of e-health systems.

There is a lack of integration of the different e-health systems used in the Namibian public healthcare sector. For example, the Electronic Patient Management System (EPMS) caters for HIV/AIDS patients alone and is not integrated with the other e-health systems. Moreover, the different isolated e-health systems do not, in any way, integrate or communicate with e-health systems used in the private healthcare sector.

Hamunyela and Iyamu (2013) indicate that despite the existence of health information systems in the Namibian health sector, the Ministry of Health and Social Services (MoHSS) still relies on paper-based records and most health information systems do not interact with one another. This indicates interoperability issues within the health information systems used in the Namibian healthcare sector.

Although Namibia has several e-health systems implemented (discussed in section 5.4.3.1), other components of *Digital Health* are still lacking. For example, there is no documented literature on the implementation of mobile technologies in the provision of healthcare delivery services as is the case with other developing countries (West, 2015; Maiga & Namagembe, 2014; Jennings et al., 2013).

USAID (2012) conducted a comprehensive review of the 61 health information systems used in Namibian government hospitals. The information, however, cannot be viewed comprehensively as patient health records are stored in different mediums, including electronic and paper health records. The next section presents a discussion of *Digital Health* in Namibia.

5.4.3 Digital health in Namibia

The various implementations of *Digital Health* are explained in the subsequent sections.

5.2.3.1. E-health and health information systems

Namibia has a National Health Information System (NHIS) which was developed in 1990. The NHIS supports information gathering for appropriate decision making (Health Metrics Networks, 2005).

USAID (2012) reports that e-health systems, such as the District Health Information System (DHIS) which allows for the electronic capturing of patient health information and so eradicate the manual process, have been developed in Namibian government hospitals. There is also an Electronic Patient Management System (EPMS) which specifically stores patient information (USAID, 2012). In 2011, MoHSS implemented the Integrated Healthcare Information Management System (IHCIMS) (Smit, 2011). The IHCIMS was developed to computerise patient health information and so eliminate paper based health records (Smit, 2011). The IHCIMS, a web-based HIS, was intended for use in 34 state hospitals in Namibia with no intention of sharing health information with private hospitals (Smit, 2011). USAID (2012) reports that the IHCIMS is currently being used in Windhoek Central Hospital. USAID (2012) also reports that there is a Pharmacy Management Information System (PMIS) which addresses the management of medications.

5.2.3.2. Telemedicine

A telemedicine centre was set up at the MoHSS, but is used to connect to other countries such as Nigeria, Congo, Mauritius, Egypt and Senegal for educational purposes only (MoHSS, 2016). From the literature, no records could be found regarding the concept of Digital Health in Namibia.

5.4.4 Innovation in Namibia

Namibia established the National Commission for Research, Science and Technology (NCRST) policy in 1999 (Government of Namibia, 1999). The aim of the policy was to facilitate research and innovation within the Namibian context (Government of Namibia, 1999). In a bid to facilitate research and innovation in the Namibian context, the Ministry of Information and Communication technology was created in 2005 (Matengu, 2011). The United Nations Educational, Scientific and Cultural Organisation (UNESCO) (2016, p. 14) explains that “Namibia has a comprehensive policy on science, technology and innovation.” Matengu (2011) also explains that the level at which innovation has taken place in Namibia can serve as a lesson to other countries.

Other forms of innovative actions in Namibia include the Harambee Prosperity Plan which aims to “target bottlenecks, remove implementation challenges and accelerate development in clearly defined priority areas, with greater urgency” (Namibia, 2016, p. 5). UNESCO (2016) states that the Harambee Prosperity Plan was created after President Geingob came into power in order to foster the implementation of the Namibia Vision 2030.

Innovation has also been practiced within the healthcare sector in a bid to reduce private medical aids, which aided the reduction in expenditure in treating HIV patients (Schellekens et al., 2009).

Having examined *Digital Health* implementations and innovation within the Namibian context, we can conclude that it is feasible to implement *Digital Health Innovation*

Ecosystems. No literature could be found regarding digital ecosystem development in Namibia. Therefore, this concept could not be discussed.

The next section presents the results of the feedback from KPs in Namibia, which was used to contextualise the initial *Namibian Digital Health Innovation Ecosystem*.

5.3. DEFINING AN EXPERT

Glaser & Chi (1988) describe an expert as an individual with information that can be utilised at any given opportunity. Maclellan & Soden (2003, p. 110) further define experts as individuals who “are able to think more effectively about problems.” This implies that for an individual to be considered an *expert*, he/she must have adequate knowledge regarding the subject matter at hand to enable him/her to make relevant decisions. Due to the multi-disciplinary nature of the study, professionals that have acquired adequate knowledge on the concepts of *Digital Health, Innovation* and *Digital Ecosystems* were included. For this study, participants within the Namibian context who took part in the study are referred to as knowledgeable professionals (KPs). Two approaches were utilised to gain useful feedback on *Digital Health, Innovation* and *Digital Ecosystems* within the Namibian context. The first approach employed the Delphi method, while the second made use of interviews. The use of the Delphi method is explained in the next section.

5.4. DELPHI METHOD

The Delphi method was described in Chapter 2 (section 2.4.3).

5.4.1. Panel formation overview

The number of participants needed in a Delphi study varies in the literature. For example, Hogarth (1978) suggests that 6 to 12 participants are enough, Clayton (2007) indicates that 5 to 10 are enough, if participants from various fields are utilised, while Malone et al. (2005) suggest that less than 10 participants are needed. Taking into consideration the discussions from the literature on the selection of participants in a study that utilises the Delphi technique, 10 KPs with *Digital Health* knowledge and experience in Namibia were selected. Ten KPs were selected based on their heterogeneous backgrounds. Participants needed to include both healthcare and IT practitioners who had worked in one, or more, domains of *Digital Health*. Six KPs in innovation were selected because KPs in innovation have more or less the same background. Six KPs in computer networking were selected and they seemed to have the same background. It thus seemed appropriate to select between 5 and 10 participants (Hogarth, 1978). The next section presents a description of KPs within the *Digital Health* domain.

5.4.2. Description of selected Namibian knowledgeable professionals (KPs) in Digital Health

The selected KPs were professionals who had worked in the *Digital Health* domain for a specific period (not less than 4 years). Ten KPs on specific areas of *Digital Health* were purposefully selected to identify components of *Digital Health* relevant within the Namibian context. A brief description of the professionals who were purposively selected to participate in the evaluation of important components of *Digital Health* components within the Namibian context is provided in Table 5-3:

Table 5-3: Biographic information of knowledge professionals in Digital Health domain.

Knowledgeable professionals in specific *Digital Health* domain	**Occupation of knowledgeable professionals in *Digital Health***	**Domain**	**Age range**	**Gender**	**Country**	**Expertise level in *Digital Health***	**Highest level of education**	**Work setting**	**Years of experience in *Digital Health* domain**
KP1	Medical doctor	E-health	46-60	Male	Namibia	Intermediate	Bachelor degree	Private hospital	7-10 years
KP2	Medical doctor	E-health, health information systems, wireless	46-60	Male	Namibia	Expert	Bachelor degree	Private hospital	More than 10 years
KP3	Lecturer	E-health, m-health research	46-60	Female	Namibia	Intermediate	Masters degree	University	4-6 years
KP4	Medical doctor	Health information systems	36-45	Male	Namibia	Intermediate	Bachelor degree	Public hospital	7-10 years
KP5	Systems analyst	E-health, health information systems	25-35	Male	Namibia	Intermediate	Bachelor degree	Public hospital	4-6 years
KP6	Systems analyst	E-health, health information systems	36-45	Female	Namibia	Expert	Bachelor degree	Public hospital	7-10 years

Knowledgeable professionals in specific *Digital Health* domain	Occupation of knowledgeable professionals in *Digital Health*	Domain	Age range	Gender	Country	Expertise level in *Digital Health*	Highest level of education	Work setting	Years of experience in *Digital Health* domain
KP7	Analyst programmer	E-health, health information systems	25-35	Male	Namibia	Intermediate	Bachelor degree	Public hospital	4-6 years
KP8	Medical doctor	E-health	25-35	Male	Namibia	Beginner	Bachelor degree	Public hospital	4-6 years
KP9	Senior systems analyst	E-health, health information systems	25-35	Male	Namibia	Intermediate	Bachelor degree	Public hospital	7-10 years
KP10	Medical doctor	E-health	25-35	Male	Namibia	Beginner	Bachelor degree	Public hospital	4-6 years

The table below summarises the different aspects of the biographical information of the Namibian KPs, as illustrated in Table 5.3 above.

Table 5-4: Gender of the Namibian KPs in Digital Health.

Gender	Number of experts	Percentage (%)
Male	2	20
Female	8	80
Total	10	100

Two (20%) females participated in the evaluation of *Digital Health* components, while 8 (80%) males (majority) were involved. Table 5-5 depicts the age range of the Namibian KPs.

Table 5-5: Age range of Namibian KPs.

Age range	Number of experts	Percentage (%)
25-35	5	50
36-45	2	20
46-60	3	30
Total	10	100

Five (50%) KPs who participated in evaluating the components of *Digital Health* are in the age range 26 to 35. Two (20%) Namibian KPs fall in the age range 36 to 45. Three (30%) Namibian KPs resort in the age range 46 to 60. This indicates that experts within the age range 25 to 35 years are more prevalent in this category when compared to other age ranges.

Table 5-6 provides the occupation of the Namibian KPs:

Table 5-6: Occupations of the Namibian KPs.

Occupation	Number of experts	Percentage (%)
Medical doctor	5	50
Lecturer	1	10
Systems analyst	2	20
Senior systems analyst	1	10
Analyst programmer	1	10
Total	10	100

Five (50%) medical doctors participated in evaluating the components of *Digital Health*. One (10%) lecturer, 2 (20%) systems analyst, 1 (10%) senior systems analyst and 1 (10%) analyst programmer were selected. This shows that experts from different backgrounds and occupations participated.

Table 5-7: Years of experience of Namibian KPs.

Years of experience	Number of experts	Percentage (%)
4-6 years	5	50
7-10 years	4	40
More than 10 years	1	10
Total	10	100

Five (50%) Namibian KPs who participated in this study had 4 to 6 years' experience in a *Digital Health* domain. Four (40%) of Namibian KPs had 7 to 10 years' experience in a *Digital Health* domain. One (10%) KP had more than 10 years' experience in a *Digital Health* domain. This shows that KPs who participated in evaluating the *Digital Health* components in the study possessed various levels of experience.

Most (8; 80%) of the Namibian KPs who participated in this study ranked their knowledge level on a specific domain as *intermediate*. The education levels of the Namibian KPs are depicted in Table 5-8.

Table 5-8: Education levels of the Namibian KPs.

Education	Number of experts	Percentage (%)
Bachelor degree	9	90
Masters degree	1	10
Total	10	100

Nine (90%) Namibian KPs who participated had a Bachelor degree and 1 (10%) had a Masters degree. This reveals that KPs with different qualifications participated in this study. Table 5-9 indicates the work setting of the Namibian KPs:

Table 5-9: Work setting of the Namibian KPs.

Place of work	**Number of experts**	**Percentage (%)**
Private hospital	2	20
Public hospital	7	70
University	1	10
Total	10	100

Two (20%) KPs in *Digital Health* who participated in this study work in private hospitals, 7 (70%) in public hospitals and 1 (10%) at a university. This indicates that KPs in *Digital Health* who participated in this study work in different environments.

5.4.3. Description of selected KPs in innovation within the Namibian context

The selected KPs were individuals who had worked in any area of innovation within a specific period. Six KPs in innovation were purposively selected to identify components of innovation, relevant to the Namibian context. A brief description of the professionals who were purposively selected to participate in the evaluation of important components of the concept, *Innovation,* is provided in Table 5-10.

Table 5-10: Namibian KPs selected to evaluate Innovation components.

Knowledgeable professionals in innovation	**Occupation of knowledgeable professionals in innovation**	**Domain**	**Age range**	**Gender**	**Country**	**Expertise level in *Digital Health* domain**	**Highest level of education**	**Work setting**	**Years of experience in *Digital Health* domain**
KP11	Associate Professor	Innovation research	46-60	Male	Namibia	Intermediate	Doctorate degree	University	4-6 years
KP12	Lecturer	Innovation research	26-35	Male	Namibia	Intermediate	Masters degree	University	1-3 years
KP13	Lecturer	Innovation research	36-45	Male	Namibia	Intermediate	Masters degree	University	1-3 years

Knowledgeable professionals in innovation	Occupation of knowledgeable professionals in innovation	Domain	Age range	Gender	Country	Expertise level in *Digital Health* domain	Highest level of education	Work setting	Years of experience in *Digital Health* domain
KP14	Lecturer	Innovation research	26-35	Female	Namibia	Intermediate	Masters degree	University	1-3 years
KP15	Lecturer	Innovation research	46-60	Female	Namibia	Intermediate	Masters degree	University	4-6 years
KP16	Lecturer	Innovation research	36-45	Female	Namibia	Intermediate	Masters degree	University	4-6 years

5.4.4. Summary of biographical information of KPs: Innovation

This section summarises the different aspects of the biographical information of experts.

5.4.4.1. Gender

Three (50%) males and 3 (50%) females participated in the study to evaluate Innovation components.

5.4.4.2. Age range of Namibian KPs in innovation

Three (33.3%) Namibian KPs who participated in evaluating the components of innovation were in the age range 26 to 35, 2 (33.3%) were in the age range 36 to 45 and 2 (33.3%) were in the age range 46 to 60. This indicates that KPs of different ages participated in evaluating the components of innovation.

5.4.4.3. Occupation of Namibian KPs in innovation

One (16.6%) associate professor and 5 (83.3%) lecturers participated in evaluating the components of innovation.

5.4.4.4. Years of experience of KPs in innovation

Three (50%) Namibian KPs who participated in ranking the components of innovation had 1 to 3 years' experience in innovation research, 3 (50%) had 4 to 6 years' experience in innovation research. This shows that the KPs who participated in evaluating the innovation components in the study possessed various levels of experience.

5.4.4.5. Level of expertise of Namibian KPs in innovation

Six (100%) Namibian KPs who participated in evaluating the components of innovation indicated their level of expertise as intermediate.

5.4.4.6. Education of KPs in innovation

Five (83.3%) KPs with Masters degrees and 1 (16.6%) KP with a Doctorate degree evaluated the components of innovation. This reveals that KPs with different qualifications participated in the evaluation of innovation components.

5.4.4.7. Work setting of Namibian KPs in innovation

All 6 (100%) Namibian KPs in innovation who participated in this study work at a university.

5.4.5. Description of selected KPs in digital ecosystems within the Namibian context

Taking into considerations that digital ecosystems have not been implemented within the Namibian context, KPs in the field of computer networking, network design and analysis, as Chang & West (2006) suggest that digital ecosystems evolved from similar backgrounds, were sought to determine relevant components of digital ecosystems within the Namibian context. KPs suitable for evaluating components of digital ecosystems needed to be professionals who had worked in any area of computer networking, network design and analysis within a specific period. Selected KPs in digital ecosystems were professionals who had worked in any area of computing networking, or network design, within a specific period. Six KPs in specific areas of computer networking were purposefully selected to evaluate components of digital ecosystems, as relevant to the Namibian context. A brief description of the professionals who were purposively selected to participate in evaluating important components of innovation components within the Namibian context is provided in Table 5-11.

Table 5-11: Namibian KPs selected to evaluate *Digital Ecosystems* components

Knowledgeable professionals in computer in specific digital ecosystems	**Occupation of knowledgeable professionals in *Digital Health***	**Domain**	**Age range**	**Gender**	**Country**	**Expertise level in *Digital Health* domain**	**Highest level of education**	**Work setting**	**Years of experience in *Digital Health* domain**
KP17	Systems engineer	Computer networks,	26-35	Male	Namibia	Intermediate	Bachelor degree	Software organisation	4-6 years
KP18	Systems engineer	Computer networking,	26-35	Male	Namibia	Intermediate	Bachelor degree	Software organisation	4-6 years
KP19	Senior systems administrator	Computer networks	36-45	Male	Namibia	Expert	Masters degree	Banking environment	More than 10 years
KP20	Systems administrator	Computer networks,	26-35	Male	Namibia	Intermediate	Bachelor degree	Public hospital	4-6 years
KP21	Systems administrator	Computer networks,	26-35	Male	Namibia	Intermediate	Bachelor degree	Public hospital	4-6 years
KP22	Systems administrator	Computer networks	36-45	Male	Namibia	Intermediate	Bachelor degree	Public hospital	4-6 years

5.4.6. Summary of biographical information of Namibian KPs: Digital ecosystems

This section summarises the different aspects of the biographical information of experts.

5.4.6.1. Gender of KPs in digital ecosystems

All 6 (100%) were males who participated in evaluating the components of digital ecosystems.

5.4.6.2. Age range of Namibian KPs in digital ecosystems

Four (66.6%) Namibian KPs who participated in evaluating the components of digital ecosystems were in the age range 26 to 35, 2 (33.3%) KPs were in the age range 36 to 45. This indicates that KPs from different age ranges participated in evaluating the components of digital ecosystems.

5.4.6.3. Occupation of KPs in digital ecosystems

Two (33.3%) systems engineers, 1 (16.6%) senior systems administrator and 3 (50%) lecturers participated in evaluating the components of digital ecosystems.

5.4.6.4. Years of experience of Namibian KPs in innovation

Three (50%) Namibian KPs who participated in ranking the components of digital ecosystems had 1 to 3 years of experience in innovation research and 3 (50%) had 4 to 6 years' experience. This shows that KPs who participated in evaluating the innovation components in the study possessed various years of experience.

5.4.6.5. Level of expertise of Namibian KPs in digital ecosystems

Five (83.3%) Namibian KPs who participated in evaluating the components of digital ecosystems graded their level of expertise as intermediate, while 1 (16.6%) had expert experience.

5.4.6.6. Education of Namibian KPs in digital ecosystems

Five (83.3%) Bachelor degree holders evaluated the components of digital ecosystems and 1 (16.6%) has a Masters degree. This reveals that KPs with different qualifications participated in evaluation of digital ecosystems components.

5.4.6.7. Work setting of Namibian KPs in innovation

Three (50%) Namibian KPs who evaluated the components of digital ecosystems worked in public hospitals. Two (33.3%) worked in software organisations and 1 (16.6%) worked in a banking environments where innovative processes are applied.

The next section addresses the development of the questionnaire.

5.5. DEVELOPMENT OF THE QUESTIONNAIRE FOR COMPONENTS ON DIGITAL HEALTH

While some of the literature sources concur that the first round of Delphi studies should be open ended questions (Keeney, Hasson, & McKenna, 2001; Yousuf, 2007), Hsu & Sanford (2007) posit that closed ended questions can be used if the questions were generated from the literature. Since the components to be evaluated and ranked by the KPs were identified from the literature identified in Chapters 3 and 4, the first set of questions were closed ended questions using a five-point Likert scale type of question with 1 indicating not important and 5 very. The questions are staggered as indicated below:

- Not Important
- Less Important
- Moderately Important
- Important
- Very Important

The second section allowed for open ended questions. Participants could offer their input at free will.

The next section explains the rounds taken which led to the consensus of KP judgement on important components of *Digital Health, Innovation* and *Digital Ecosystems* within the Namibian context.

5.5.1. Results on the Digital Health components from Round 1

The questionnaire on *Digital Health* was developed for Round 1, as indicated in Appendix A. The questionnaires investigated KPs' biographical information as well as their experiences. The first questionnaire for *Digital Health* requested participants to rank 29 components of *Digital Health* and indicate any relevant component not listed.

The Namibian KPs, labelled KP1 to KP10, were analysed quantitatively. The frequency and percentage of the ranking of the Namibian KPs on Digital Health are presented in the table below:

Table 5-12: Ranking the importance of the Namibian KPs on Digital Health.

Digital health component	**Not Important**		**Less Important**		**Moderately Important**		**Important**		**Very Important**		**Total**	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
e-health							2	20	8	20	10	100
m-health							2	20	8	80	10	100

Digital health component	Not Important		Less Important		Moderately Important		Important		Very Important		Total	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Telemedicine/telehealth/telecare							1	10	9	90	10	100
Health 2.0/medicine 2.0							3	30	7	70	10	100
Wireless health/wireless sensors					1	10	4	40	5	50	10	100
Internet							1	10	9	90	10	100
Genomics /personalised medicine			1	10	6	60			3	30	10	100
Mobile connectivity and bandwidth									10	100	10	100
Social networking/social media/ health and medical platforms			1	10			5	50	4	40	10	100
Computing power and data universe					5	50	4	40	1	10	10	100
Information systems							2	20	8	80	10	100
Imaging					8	80	1	10	1	10	10	100
Self-tracking (the quantified self)							1	10	9	90	10	100
Wearable computing					1	10	3	30	6	60	10	100
Health information technology							3	30	7	70	10	100
Big data							4	40	6	60	10	100
Cloud computing							4	40	6	60	10	100
Public health surveillance					3	30	3	30	4	40	10	100
Health promotion strategies					4	40	2	20	4	40	10	100
Electronic medical records					1	10			9	90	10	100
Electronic health records					1	10			9	90	10	100
Gamification					6	60	1	10	3	30	10	100
Interoperability									10	100	10	100
Health and wellness apps							1	10	9	90	10	100
Health analytics					1	10	4	40	5	50	10	100
Digitised health systems					4	40	3	30	3	30	10	100
Privacy and security							1	10	9	90	10	100
Health data exchange			7	70			2	20	1	10	10	100
E-prescription					1	10	2	20	7	70	10	100

The closed ended questions were also analysed using SPSS version 21 to measure central tendency (mean) and dispersion level (standard deviation) (SD) which is presented in Table 5-13 below.

Table 5-13: SPSS results on central tendency and dispersion levels.

Digital health components Round 1	Mean	SD
e-health	4.8	0.42
m-health	4.8	0.42
Telemedicine/telehealth/telecare	4.9	0.31
Health 2.0/medicine 2.0	4.7	0.48
Wireless health/wireless sensors	4.4	0.69
Internet	4.9	0.31
Genomics/personalised medicine	3.5	1.08

Mobile connectivity and bandwidth	5	0
Social networking/social media/ health and medical platforms	4.2	0.91
Computing power and data universe	3.6	0.69
Information systems	4.8	0.42
Imaging	3.3	0.67
Self-tracking (the quantified self)	4.9	0.31
Wearable computing	4.5	0.70
Health information technology	4.7	0.48
Big data	4.6	0.51
Cloud computing	4.6	0.51
Public health surveillance	4.1	0.87
Health promotion strategies	4	0.94
Electronic medical records	4.8	0.63
Electronic health records	4.8	0.63
Gamification	3.7	0.94
Interoperability	5	0
Health and wellness apps	4.9	0.31
Health analytics	4.4	0.69
Digitised health systems	3.9	0.87
Privacy and security	4.9	0.31
Health data exchange	2.5	1.30
E-prescription	4.6	0.51

Jirwe et al. (2009) and Mcilfatrick and Keeney (2003) agree that on a five-point Likert scale, *consensus reaching 1 to 2* means that experts totally disagree, *consensus reaching 3* represents a nonaligned judgement, while *consensus reaching 4 to 5* means that experts “agree”. The same principle was applied in this study. As shown in Table 5.13, (n=23) components met the 4 to 5 range and were considered relevant to the Namibian context, (n=1) component (health data exchange) met the 1 to 2 range which means that KPs in *Digital Health* totally disagreed and it is thus considered irrelevant to the Namibian context. With (n=5) components, consensus had not been reached amongst the selected KPs regarding *Digital Health* because the central tendency fell between 3 and 4. These five components are listed below:

- Genomics/personalised medicine
- Computing power and data universe
- Imaging
- Gamification
- Digitised health systems

There were no responses recorded to the open-ended questions. The KPs in *Digital Health* expressed the view that the list of *Digital Health* components was complete and that nothing should be added.

5.5.2. Results on the Digital Health components from Round 2

Based on the results of Round 1, a second questionnaire was developed. The questionnaire included all components for which consensus had not been reached in Round 1. The results of the first round were presented anonymously to the participants and they were then asked to view the rankings and comments of other KPs, as well as their own rankings and comments. The selected KPs in *Digital Health* were asked to reconsider their ranking of the (n=5) components as consensus had not been reached in the first round.

A total of 10 responses were received during Round 2. The closed ended questions were analysed quantitatively, the frequency and percentage are presented in Table 5.14.

Table 5-14: Results on components of Digital Health from Round 2.

Digital health component	**Not Important**		**Less Important**		**Moderately Important**		**Important**		**Very Important**		**Total**	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Genomics/personalised medicine					3	30	3	30	4	40	10	100
Computing power and data universe							6	60	4	40	10	100
Imaging							6	60	4	40	10	100
Gamification			2	20	3	30	5	50			10	100
Digitised health systems					3	30	3	30	4	40	10	100

The closed ended questions were also analysed using SPSS version 21 to measure central tendency (mean) and dispersion level (standard deviation) (SD). The results are presented in Table 5-15 below.

Table 5-15: SPSS results to measure central tendency and dispersion levels.

Digital health components Round 1	**Mean**	**SD**
Genomics/personalised medicine	4.1	0.87
Computing power and data universe	4.4	0.51
Imaging	4.4	0.51
Gamification	3.3	0.82
Digitised health systems	4.1	0.87

As illustrated in Table 5.15, (n=4) components met the 4 to 5 range and were considered relevant to the Namibian context. Only (n=1) component had not reached consensus among selected KPs in *Digital Health* as the central tendency fell between 3 and 4. The component is listed below:

- Gamification

No responses were recorded to the open-ended questions. The KPs in *Digital Health* stated that the list of *Digital Health* components was complete and that nothing should be added.

The next section explains the findings of the study in Round 3.

5.5.3. Results on the Digital Health components from Round 3

Based on the results of Round 2, a third questionnaire was developed. This questionnaire included those components for which consensus had not been reached in Round 2. The results of the first round were presented anonymously to the participants and they were then asked to view the rankings and comments of other KPs, and in the light of this reconsider their original ranking of the (n=1) component. This was done in an effort to reach consensus.

A total of 10 responses were received in Round 3. Eighty percent indicated that gamification is very important.

The closed ended questions were also analysed using SPSS version 21 to measure central tendency (mean) and dispersion level (standard deviation) (SD). This indicated that the mean for gamification was 4.8 and the SD was 0.42.

No responses were recorded to the open-ended questions. The KPs in *Digital Health* noted that the list of *Digital Health* components was complete and that nothing should be added.

The components considered relevant and important to the Namibian context are listed below:

- E-health
- M-health
- Telemedicine/telehealth/telecare
- Health 2.0/medicine 2.0
- Wireless health/wireless sensors
- Internet
- Genomics/personalised medicine
- Mobile connectivity and bandwidth
- Social networking/social media/health and medical platforms
- Computing power and data universe
- Information systems
- Imaging
- Self-tracking (the quantified self)
- Wearable computing
- Health information technology

- Big data
- Cloud computing
- Public health surveillance
- Health promotion strategies
- Electronic medical records
- Electronic health records
- Gamification
- Interoperability
- Health and wellness apps
- Health analytics
- Digitised health systems
- Privacy and security
- E-prescription

The next section explains the findings of the Delphi method applied to identify, evaluate and rank the components of innovation, relevant to the Namibian context.

5.6. DEVELOPMENT OF THE QUESTIONNAIRE FOR COMPONENTS ON INNOVATION

The questionnaire on innovation was developed for Round 1, as indicated in the Appendix. The questionnaires included questions regarding the KPs' biographical information and work experience. The first questionnaire consisted of closed-ended questions, which requested the participants to rank 27 innovation components, as well as an open-ended question which required participants to add any relevant component/s which had not been listed.

5.6.1. Results on the ranking of the components of Innovation Round 1

The Namibian KPs in the innovation domain were labelled KP11 to KP16. A total of 6 responses were received in Round 1. The closed ended questions were analysed quantitatively, the frequency and percentage are presented in Table 5-16.

Table 5-16: Ranking of Innovation components.

Innovation components	**Not Important**		**Less Important**		**Moderately Important**		**Important**		**Very Important**		**Total**	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Process innovation							2	33.3	4	66.6	6	99.9
Product innovation					2	33.3	3	50	1	16.6	6	99.9
Structure innovation					4	66.6	1	16.6	1	16.6	6	99.9
Closed innovation	3	50	1	16.6	1	16.6	1	16.6			6	99.8

Innovation components	Not Important		Less Important		Moderately Important		Important		Very Important		Total	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Open innovation					3	50	2	33.3	1	16.6	6	99.9
Open innovation 2.0			1	16.6	1	16.6			4	66.6	6	99.8
Innovation networks ecosystems							3	50	3	50	6	100
Triple Helix systems			3	50			2	33.3	1	16.6	6	99.9
Quadruple Helix systems					3	50	2	33.3	1	16.6	6	99.9
User innovation							4	66.6	2	33.3	6	99.9
Intellectual property rights									6	100	6	100
Role Players							4	66.6	2	33.3	6	99.9
Capital							2	33.3	4	66.6	6	99.9
Infrastructure					3	50	1	16.6	2	33.3	6	99.9
Regulations							4	66.6	2	33.3	6	99.9
Knowledge							3	50	3	50	6	100
Ideas							3	50	3	50	6	100
Interface					3	50	2	33.3	1	16.6	6	99.9
Culture					3	50	2	33.3	1	16.6	6	99.9
Architectural principles			3	50	3	50					6	100
Collaboration									6	100	6	100
Organisation and marketing innovation					2	33.3	2	33.3	2	33.3	6	99.9
Technology innovation							2	33.3	4	66.6	6	99.9
Healthcare innovation									6	100	6	100
Teaching			1	16.6			5	83.3			6	99.9
Influence of government ownership			3	50	3	50					6	100
Innovation spaces and living labs					2	33.3	1	16.6	3	50	6	99.9

The closed ended questions were also analysed using SPSS version 21 to measure central tendency (mean) and dispersion level (standard deviation) (SD). These values are presented in Table 5-17.

Table 5-17: SPSS results to measure the central tendency and dispersion levels for innovation components.

Innovation components Round 1	Mean	SD
Process innovation	4.66	0.51
Product innovation	3.83	0.75
Structure innovation	3.5	0.83
Closed innovation	2	1.26
Open innovation	3.66	0.81
Open innovation 2.0	4.16	1.32
Innovation networks ecosystems	4.33	0.81

Innovation components Round 1	**Mean**	**SD**
Triple Helix systems	3.16	1.32
Quadruple Helix systems	3.66	0.81
User innovation	4.33	0.51
Intellectual property rights	5	0
Role Players	4.33	0.51
Capital	4.66	0.51
Infrastructure	3.83	0.98
Regulations	4.33	0.51
Knowledge	4.5	0.54
Ideas	4.5	0.54
Interface	3.66	0.81
Culture	3.66	0.81
Architectural principles	2.5	0.54
Collaboration	5	0
Organisational and marketing innovation	4	0.89
Technology innovation	4.66	0.51
Healthcare innovation	5	0
Teaching	3.66	0.81
Influence of government ownership	2.5	0.54
Innovation spaces and living labs	4.16	0.98

A total of (n=3) components (closed innovation, architectural principles and influence of government ownership) were regarded as irrelevant as the central tendency fell in the range 2 and 3. These components were removed. A total of (n=15) components met the 4 to 5 range and were considered relevant to the Namibian context. For (n=9) components consensus had not been reached among selected KPs in innovation because the central tendency fell between 3 and 4. The 9 components are listed below:

- Product innovation
- Structure innovation
- Open innovation
- Triple Helix systems
- Quadruple Helix systems
- Infrastructure
- Interface
- Culture
- Teaching

From the open-ended question, *research and development* was added as a component of innovation, which was added to the list to be evaluated in the second round.

5.6.2. Results on the ranking of the components of Innovation Round 2

Based on the results of Round 1, a second questionnaire was developed. The questionnaire included all components for which consensus had not been reached in Round 1 (n=9) and the component added in Round 1 (n=1). A total of (n=15) components for which consensus had been reached was presented to the 6 KPs. The results of the first round were presented anonymously to the participants and they were asked to review their rankings and comments in the light of other KPs' ranking and comments. The selected innovation KPs were thus asked to reconsider ranking the (n=9) as well as the new component added from Round 1 (n=1).

A total of 6 responses were received during Round 2. The closed ended questions were analysed quantitatively. Frequency and percentages are presented in Table 5-18.

Table 5-18: Responses from Round 2 on Innovation components.

Innovation components	**Not Important**		**Less Important**		**Moderately Important**		**Important**		**Very Important**		**Total**	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Product innovation					5	83.3			1	16.6	6	99.9
Structure innovation							5	83.3	1	16.6	6	99.9
Open innovation			1	16.6	3	50	1	16.6	1	16.6	6	99.8
Triple Helix systems					4	66.6	2	33.3			6	99.9
Quadruple Helix systems					1	16.6	4	66.6	1	16.6	6	99.8
Infrastructure					2	33.3	4	66.6			6	99.9
Interface							4	66.6	2	33.3	6	99.9
Culture					2	33.3	4	66.6			6	99.9
Teaching							4	66.6	2	33.3	6	99.9
Research and development							1	16.6	5	83.3	6	99.9

The closed ended questions were also analysed using SPSS version 21 to measure central tendency (mean) and dispersion level (standard deviation) (SD). The results are presented in Table 5-19.

Table 5-19: SPSS Round 2 results to measure central tendency and dispersion levels.

Innovation components Round 2	**Mean**	**SD**
Product innovation	3.33	0.81
Structure innovation	4.16	0.40
Open innovation	3.33	1.03
Triple Helix systems	3.5	0.54
Quadruple Helix systems	4	0.63
Infrastructure	3.66	0.51
Interface	4.33	0.51
Culture	3.66	0,51

Innovation components Round 2	Mean	SD
Teaching	4.33	0.51
Research and development	4.83	0.40

As illustrated in Table 5.18, (n=5) components met the 4 to 5 range and were considered relevant to the Namibian context. For a total of (n=5) components consensus had not been reached because the central tendency fell between 3 and 4. The components are listed below:

- Product innovation
- Open innovation
- Triple Helix systems
- Infrastructure
- Culture

No responses were recorded in the open-ended questions. The innovation KPs stated that the list of *Digital Health* components was complete and that nothing should be added.

The next section explains the findings of Round 3.

5.6.3. Results on the ranking of the components of Innovation Round 3

Based on the results of Round 2, a third questionnaire was developed. This questionnaire included components for which consensus had not been reached in Round 2, (n=5). The results of the first round were presented anonymously to the participants and they were asked to view the rankings and comments of other KPs and to then reconsider ranking the (n=5) components again. This was done in an effort to reach consensus in the third round.

A total of 6 responses were received in Round 3. The closed ended questions were analysed quantitatively, the frequency and percentage are presented in Table 5-20.

Table 5-20: Results for Round 3 on Innovation components.

Digital health component	**Not Important**		**Less Important**		**Moderately Important**		**Important**		**Very Important**		**Total**	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Product innovation							3	50	3	50	6	100
Open innovation							4	66.6	2	33.3	6	99.9
Triple Helix systems	3	50	2	33.3	1	16.6					6	99.9
Infrastructure					1	16.6	1	16.6	4	66.6	6	99.8
Culture	1	16.6	3	50	2	33.3					6	99.9

The closed ended questions were also analysed using SPSS version 21 to measure central tendency (mean) and dispersion level (standard deviation) (SD). The results are presented in Table 5-21.

Table 5-21: SPSS results for Round 3 to measure central tendency and dispersion levels.

Innovation components Round 1	**Mean**	**SD**
Product innovation	4.5	0.54
Open innovation	4.33	0.51
Triple Helix systems	1.66	0.81
Infrastructure	4.5	0.83
Culture	2.1	0.75

As illustrated in Table 5.20, (n=3) components met the 4 to 5 range and were considered relevant to the Namibian context. Only (n=1) component met the 1 to 2 range and (n=1) component met the 2 to 3 range. These were removed as they were considered *irrelevant* to the Namibian context.

No responses were recorded to the open-ended questions. The selected KPs stated that they considered the list of *Digital Health* components complete.

The next section explains the findings of the Delphi method which was applied to identify, evaluate and rank the components of digital ecosystems relevant to the Namibian context.

5.7. DEVELOPMENT OF THE QUESTIONNAIRE FOR COMPONENTS ON DIGITAL ECOSYSTEMS

The questionnaire on digital ecosystems was developed for Round 1 (see Appendix G). The questionnaires asked for KPs' biographical information as well as their work experience. The first questionnaire for digital ecosystems consisted of closed-ended questions. This questionnaire requested participants to rank the components of digital ecosystems. An open-ended question, which required participants to add any relevant component not on the list, was also included.

5.7.1. Results of the ranking of the components of Digital Ecosystems Round 1

Namibian KPs from the computer networks domain were labelled KP17 to KP22. A total of 7 responses were received during Round 1. The closed ended questions were analysed quantitatively. The frequency and percentage are presented in Table 5-22.

Table 5-22: Ranking the Digital Ecosystems by Namibian KPs.

Innovation components	Not Important		Less Important		Moderately Important		Important		Very Important		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Agents	2	33.3	4	66.6							6	99.9
Species	2	33.3	2	33.3	1	16.6	1	16.6			6	99.9
Biological species							4	66.6	2	33.3	6	99.9
Economic species					3	50	3	50			6	100
Digital species							4	66.6	2	33.3	6	99.9
Mobile clients							5	83.3	1	16.6	6	99.9
Digital environment							5	83	1	16.6	6	99.9
Interoperability									6	100	6	100
Security									6	100	6	100
Trust									6	100		
Ecosystem-oriented architecture							4	66.6	2	33.3	6	99.9
Self-organisation							4	66.6	2	33.3	6	99.9
Semantic web					1	16.6	3	50	2	33.3	6	99.9
Digital content							1	16.6	5	83.3	6	99.9
Community					2	33.3	2	33.3	2	33.3	6	99.9
Technology							5	83.3	1	16.3	6	99.9
Practice			1	16.6	3	50	2	33.3			6	99.9
Implementation							3	50	3	50	6	100
Challenges					3	50	2	33.3	1	16.6	6	99.9

The closed ended questions were also analysed using SPSS version 21 to measure central tendency (mean) and dispersion level (standard deviation) (SD). These results are presented Table 5-23.

Table 5-23: SPSS results for Round 1 to measure central tendency and dispersion levels for components on Digital Ecosystems.

Digital ecosystems components Round 1	Mean	SD
Agents	1.66	0.51
Species	2.16	1.16
Biological species	4.33	0.51

Economic species	3.5	0.54
Digital species	4.33	0.51
Mobile clients	4.16	0.40
Digital environment	4.16	0.40
Interoperability	5	0
Security	5	0
Trust	5	0
Ecosystem-oriented architecture	4.33	0.51
Self-organisation	4.33	0.51
Semantic web	4.16	0.75
Digital content	4.83	0.40
Community	4	0.89
Technology	4.16	0.40
Practice	3.16	0.75
Implementation	4.5	0.54
Challenges	3.66	0.81

There were (n=2) components (agents and species) were regarded as irrelevant as the central tendency fell in the range of 1 and 2 and 2 and 3. These components were removed. Some (n=15) components met the 4 to 5 range and were considered relevant to the Namibian context. For other (n=3) components, consensus had not been reached because the central tendency fell between 3 and 4. These 3 components are:

- Economic species
- Practice
- Challenges

From the open-ended question, cloud computing, which had not previously been on the list, was added as a component of innovation. Thus, cloud computing is on the list of components to be evaluated in the Round 2. Certain questions were also rephrased to enhance their clarity.

5.7.2. Results on the ranking of the components of Digital Ecosystems Round 2

Based on the results of Round 1, a second questionnaire was developed. The questionnaire included all components about which consensus had not been reached in round 1 (n=3), as well as the additional component added in Round 1 (n=1). A total of (n=15) components, for which consensus had been reached, were presented to the 6 selected KPs in computer networks. The results of the first round were presented anonymously to the participants and they were asked to review their rankings and comments in the light of other KPs ranking and comments. They were asked to reconsider the ranking of the (n=3) components, including the component that was reworded as well as well as the new component added from round 1 (n=1).

A total of 6 responses were received during Round 2. The closed ended questions were analysed quantitatively and the frequency and percentage are presented Table 5-24.

Table 5-24: Results on the components on Digital Ecosystems for Round 2.

Digital ecosystems components	**Not Important**		**Less Important**		**Moderately Important**		**Important**		**Very Important**		**Total**	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Economic species							6				6	100
Practice							3	50	3	50	6	100
Measures for addressing challenges									6	100	6	100
Cloud computing							1	16.6	5	83.3	6	99.9

The closed ended questions were also analysed using SPSS version 21 to measure central tendency (mean) and dispersion level (standard deviation) (SD). The results are presented in Table 5-25.

Table 5-25: SPSS results to measure central tendency and dispersion levels for Round 2.

Digital ecosystems components Round 2	**Mean**	**SD**
Economic species	4	0
Practice	4.5	0.54
Measures for addressing challenges	5	0
Cloud computing	4.83	0.40

As illustrated in Table 5.24, (n=4) components met the 4 to 5 range and were considered relevant to the Namibian context.

No input was provided in the open-ended questions. The selected KPs indicated that they thought the list of digital ecosystems components complete.

Twenty-eight components of *Digital Health* are considered relevant to the Namibian context, as indicated by KPs within the Namibian context. These components are:

- E-health
- M-health
- Telemedicine/telehealth/telecare
- Health 2.0/medicine
- Wireless health/wireless sensors

- Internet
- Genomics/personalised medicine
- Mobile connectivity and bandwidth
- Social networking/social media/health and medical platforms
- Computing power and data universe
- Information systems
- Imaging
- Self-tracking (the quantified self)
- Wearable computing/sensors and wearables
- Health information technology
- Big data
- Cloud computing
- Public health surveillance
- Health promotion strategies
- Electronic medical records
- Electronic health records
- Gamification
- Interoperability
- Health and wellness apps
- Health analytics
- Digitised health systems
- Privacy and security
- E-prescription

The following twenty-two components were considered relevant to the Namibian context:

- Process innovation
- Product innovation
- Structure innovation
- Open innovation
- Open innovation 2.0
- Innovation network ecosystems
- Quadruple Helix systems
- User innovation
- Intellectual property rights
- Role Players
- Capital
- Infrastructure

- Regulations
- Knowledge
- Ideas
- Interface
- Collaboration
- Organisational and marketing innovation
- Technology innovation
- Healthcare innovation
- Teaching
- Innovation spaces and living labs

Seventeen components of digital ecosystems were considered relevant to the Namibian context. They are:

- Biological species
- Economic species
- Digital species
- Mobile clients
- Digital environment
- Interoperability
- Security
- Trust
- Ecosystem-oriented architecture
- Self-organisation
- Semantic web
- Digital content
- Community
- Technology
- Practice
- Implementation

The next section explains the results of applying the Delphi method to identifying, evaluating and ranking the components of digital ecosystems, relevant to the Namibian context.

5.8. FINDINGS FROM THE INTERVIEWS

After the completion of the Delphi rounds for *Digital Health, Innovation* and *Digital Ecosystems*, 8 KPs were purposefully selected to take part in the interviews. Four KPs were from the *Digital Health* domain, 2 were from the innovation domain and 2 KPs were from the digital ecosystems domain.

Four KPs in *Digital Health* were also asked to explain what should happen first for *Digital Health* to work in Namibia. KP1 stated "…funding is an essential factor to consider if we are looking at fully implementing *Digital Health* in Namibia…." KP4 indicated that "first of all, if *Digital Health* is supposed to work in Namibia, digitalised health records should fully replace paper records."

Even though some hospitals have computerised systems in place, it cannot be denied that some hospitals and clinics still rely on paper records. The first step will be to completely digitalise health records if we are looking at *Digital Health* in Namibia. KP3 explained that "there is a lot that needs to be done for *Digital Health* to be implemented in Namibia, but the most important is make the people become aware of the benefits of *Digital Health* and its relevance to healthcare and patients…." KP6 stated added that "training is one key point that needs to be established. The people involved in *Digital Health* should be trained on how to use these technologies. Not just the healthcare providers, the patients should have an idea of what to do with this technology and how it affects them." KP6 added "I think the first step for *Digital Health* to work is readiness and willingness to use *Digital Health* technologies in the process. Are the people involved ready to use the technology? Are they willing to learn and incorporate it into their day to day activities? If they are willing, then yes, I believe with the right things put in place, *Digital Health* can work in Namibia."

When KPs were asked whether they would like to participate in such an ecosystem, and if so, in which capacity, the majority indicated that they would like to be part of such an ecosystem. KP13 indicated "…in the capacity of research and innovation, I would like to share my innovative ideas in this ecosystem and build knowledge that can lead to healthcare innovation. I would be willing to participate in research activities in which the findings can be shared and incorporated by professionals in the ecosystem." Information sharing was considered as an area in which experts would like to serve. KP4 stated "I can serve in the capacity of sharing relevant information with other professionals, like myself, as well as other organisations. Knowing that patients will take part in managing their health, I will be willing to give all the support I can assisted by digital technologies." KP1 commented "I would like to be able to connect with other hospitals and clinics or even pharmacies. I also see the concept of open innovation is included in the ecosystem, that means I can share ideas with other doctors and vice versa. I would also use digital technologies to provide better care to my patients." KP6 added "…providing technical support within the platform will be necessary; I think I can contribute in that regard."

KPs were asked to explain the perceived value of the ecosystem to the Namibian context. All KPs were certain that the ecosystem will be of value to the Namibian context. Information sharing was regarded as a benefit of implementing such an ecosystem within the Namibian context. KP1 commented that "…when this ecosystem is implemented, it will be a common platform for all health practitioners to share information and seek advice from professionals." KP13 believes that such an ecosystem will facilitate innovation because "users will have the opportunity to keep the intellectual property right, I like the concept of user innovation, where innovative ideas are not only left in the hands of the professionals. Users, in this case patients, can also share their ideas regarding what they want and this might bring about improved processes as well." KP3 explained that "…Namibia will have an advantage to have that kind of ecosystem, it will have an effect on service delivery for sure." KP4 stated "…this ecosystem will create better and efficient ways of providing healthcare services and improvement in the way healthcare is delivered, especially for patients." In addition, KP6 indicated "…doctors can interact, share information and even patients can be part of the ecosystem when they participate in this kind of ecosystem." KP20 explained that "there will be a difference in the way information is transferred from one point to another. I see this as a value because it will have an impact on the care of patients." KP21 noted that "it will be of value, this kind of structure is what the health sector needs, the idea of information sharing will be helpful in terms of how patients are provided with healthcare service." KP4 indicated that "I see so much potential in the implementation of a *Digital Health Innovation Ecosystem* and of benefit, especially for patients."

The transcribed data was transferred to Hyper Research 3.7.3 software, in which codes were assigned to different statements. The following codes were generated from the findings which pointed to five factors that need to be in place for *Digital Health* to work. They are:

- Funding
- Digitalisation of health records
- Awareness of the benefits of *Digital Health*
- Training for healthcare practitioners and patients on the use of digital technologies in healthcare
- Willingness and readiness to adopt *Digital Health* technologies

The next section presents the findings of the evaluation of innovation components by experts in Namibia.

The following codes were generated from the findings. The potential stakeholders, who may take part in the Namibian *Digital Health Innovation Ecosystem,* and their roles are as follows:

- **Researcher/academics**: Participate in research activities and knowledge building which will lead to healthcare innovation.

- **Medical practitioners**: Share information between other medical practitioners and organisations. Connect with other medical practitioners and organisations. Assist patients in the healthcare process through the use of digital technologies.
- **IT professionals:** Participate in providing technical support in the ecosystem.
- **Patients:** Receive healthcare services through digital technologies. Participate in sharing innovative ideas which can lead to healthcare innovation.

The following codes were generated from the interview findings and revealed the following benefits of a *Digital Health Innovation Ecosystem* within the Namibian context:

- Shared information between medical professionals and health institutions
- Facilitate innovation in healthcare
- Improved healthcare service delivery
- Improved healthcare for patients

The next section presents the reliability and validity of the Delphi results.

5.9 RELIABILITY AND VALIDITY OF DELPHI RESULTS

To maintain reliability and validity of Delphi results for each concept, *Digital Health, Innovation* and *Digital Ecosystems:*

- Results from the rounds were examined by supervisors
- Statistical calculations were checked by supervisors
- The response rate of the questionnaire was 100% for each round

The next section describes the intermediate *Namibian Digital Health Innovation Ecosystem Framework.*

5.10 DIGITAL HEALTH INNOVATION ECOSYSTEMS INTERMEDIATE FRAMEWORK

The findings from the experts in Namibia, in response to the questionnaire and interviews on *Digital Health, Innovation* and *Digital Ecosystems,* have been presented in sections 5.6, 5.7, 5.8 and 5.9. This section consolidates the findings on *Digital Health, Innovation* and *Digital Ecosystems* and presents the Namibian *Digital Health Innovation Ecosystem* intermediate framework, based on the feedback from experts in Namibia. The framework is presented in Figure 5-4. The intermediate *Namibian Digital Health Innovation Ecosystem Framework* is based on the findings from KPs who evaluated the initial framework in Namibia. The intermediate *Namibian Digital Health Innovation Ecosystem Framework* envisages the components relevant to the Namibian health context, as indicated by KPs in Namibia. These

KPs believe that adopting an ecosystem oriented approach is relevant to a *Digital Health Innovation Ecosystem Framework* for Namibia. KPs in Namibia believe that the stakeholders of a *Digital Health Innovation Ecosystem* in Namibia should consist of different professionals and health institutions, both inside and outside Namibia. In addition, these KPs affirm that the innovation should be practiced within the Namibian context of digital health innovation ecosystems.

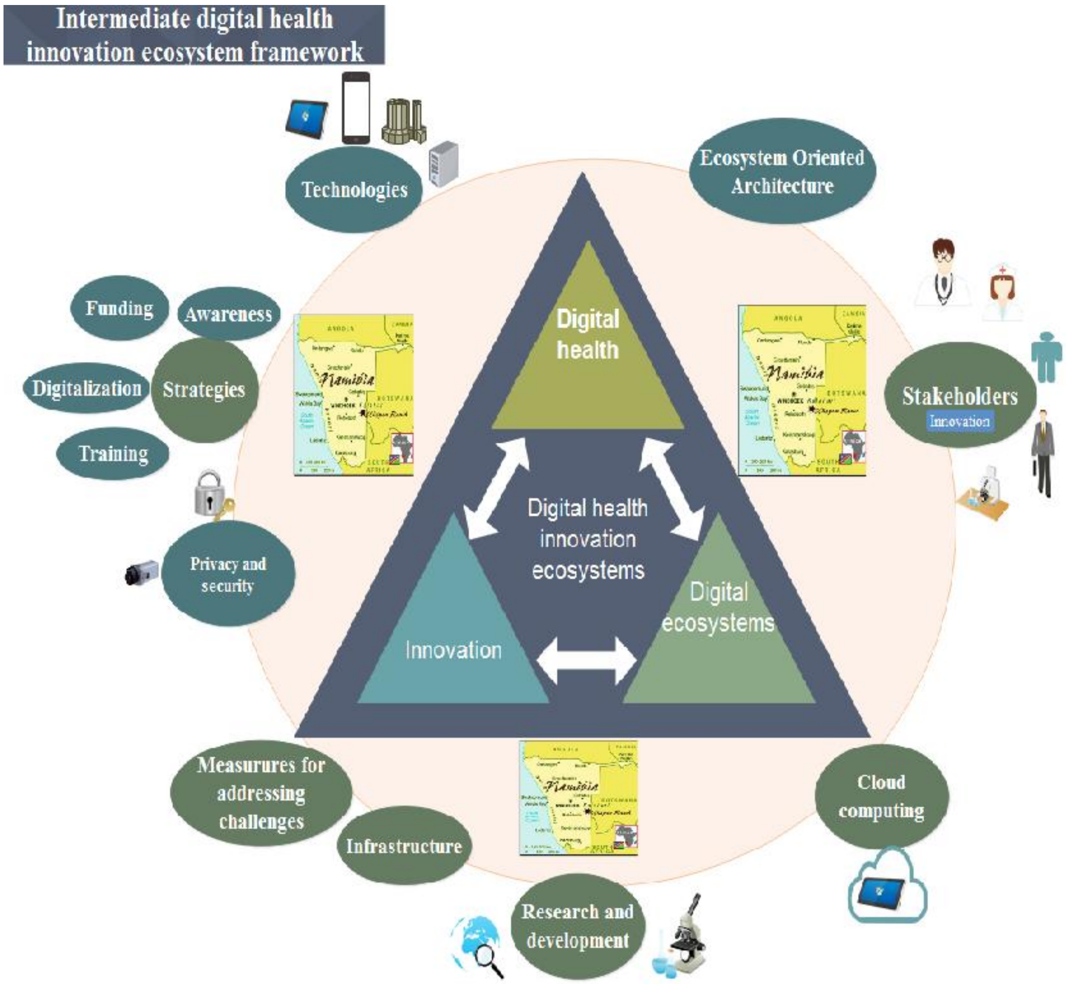


Figure 5-4: The intermediate Namibian Digital Health Innovation Ecosystem framework.

Cloud computing, where information can be shared between stakeholders, was considered relevant to the Namibian context. Research and development were also highlighted as a necessary component within the *Digital Health Innovation Ecosystem*. Incorporating research and development into the *Digital Health Innovation Ecosystem* is important to improve the knowledge base and produce innovative solutions to problems encountered by stakeholders in the digital health innovation ecosystem.

Infrastructure needs to be developed within the Namibian context and this issue should be addressed by the relevant stakeholders.

There is a tendency for challenges to manifest in an environment where different stakeholders participate. The Namibian *Digital Health Innovation Ecosystem* is no exception. Measures for addressing challenges within a *Namibian Digital Health Innovation Ecosystem* should be put into place.

Stakeholders who take part in the *Digital Health Innovation Ecosystem* should consider privacy and security as important components which need to be enforced in a Namibian digital health innovation ecosystem. Privacy and security measures could prevent loss of information as well as unlawful possession of information.

Funding was noted as an important component to establishing digital health in Namibia. Measures should be put into place to secure funding to support the *Namibian Digital Health Innovation Ecosystem*. Patients and medical practitioners need to be aware of the benefits of digital health, appreciate its use and embrace these digital health technologies. Digitalisation of health records is necessary if digital health is to be implemented. Training of both medical practitioners, and patients, is needed to appropriately use and adopt digital health technologies in the Namibian context.

KPs have indicated that technologies are important in the *Namibian Digital Health Innovation Ecosystem*. These technologies include digital health technologies (as described in Chapter 3 of this study).

The next step is to validate the *Digital Health* innovation ecosystem's intermediate framework by global experts and present the final *Digital Health* innovation ecosystems framework for Namibia.

5.11 SUMMARY

This chapter presented the development of the *Digital Health Innovation Ecosystem's* intermediate framework and the findings of its evaluation, through questionnaires and interviews. The findings refined the components of the *Digital Health Innovation Ecosystem* and presented it as relevant to the Namibian context. The intermediate framework will be validated by global experts and the final *Digital Health Innovation Ecosystem* framework for the Namibian context, will be presented in Chapter 6.

CHAPTER 6. VALIDATION OF THE INTERMEDIATE FRAMEWORK AND DEVELOPMENT OF THE FINAL FRAMEWORK

6.1. INTRODUCTION

Chapter 5 completed Phase 2 of this study which entailed developing and evaluating the initial *Digital Health Innovation Ecosystem* framework by KPs within the Namibian context as well as the development of the intermediate framework. Chapter 5's findings provided relevant information which led to the refining of the initial framework and the development of the intermediate framework. This chapter focuses on the third phase of the study, which is the validation of the intermediate framework by global experts and the development of the final *Digital Health Innovation Ecosystem Framework*. The chapter serves different purposes. Firstly, it aims to answer the third, and fourth, sub-research questions posed in section 1.4.1:

- What are the components of Digital Health, innovation and ecosystems relevant to the Namibian context as identified by knowledgeable professionals (KPs) in Namibia, and globally?
- What strategies need to be put into place for Digital Health to be established in Namibia?

Secondly, the chapter also aims to answer the following objectives of the study:

- To validate the intermediate framework (artefact) for a *Digital Health Innovation Ecosystem*.
- To present the final framework (artefact) for a *Digital Health Innovation Ecosystem.*
- To identify the perceived benefits of a *Digital Health Innovation Ecosystem* for Namibia, based on the findings of global experts.
- To identify potential stakeholders of a *Digital Health Innovation Ecosystem* for Namibia, based on the findings of global experts.
- To identify strategies to be put in place for *Digital Health* to be established in Namibia, based on the findings of global experts.

As explained in Chapter 2, this study adopts the Design Science research methodology. Figure 6.1 highlights the phase which is covered in Chapter 6 (encircled in green). As illustrated in Figure 6.1, the initial framework has been developed and evaluated by KPs within the Namibian context. The intermediate framework was also developed and validated in Chapter 5. Chapter 6 focuses on validating the intermediate framework by global experts. The findings from this chapter will lead to the development of the final *Digital Health Innovation Ecosystem*.

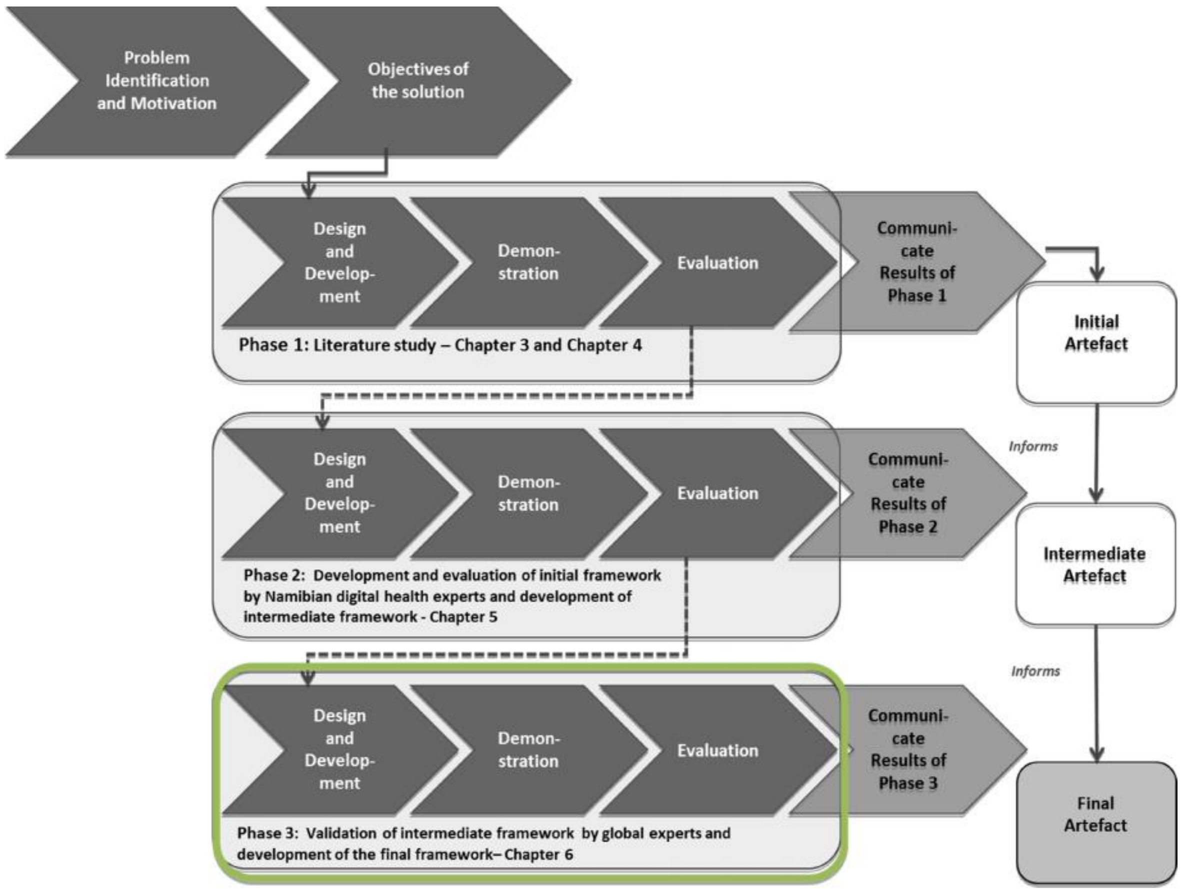


Figure 6-1: Phase 3 in DSRM process.

The next section provides an overview of chapter 6.

6.2. OVERVIEW OF CHAPTER 6

This chapter is divided into 3 sections. The first section focuses on the validation of the *Digital Health Innovation Ecosystem Intermediate Framework*, which includes a discussion on expert reviews and *how* the components of *Digital Health Innovation Ecosystems* were validated by global experts. The second section focuses on the development of the *Digital Health Innovation Ecosystem Final Framework* per section 6.4. The third section focuses on guidelines on *how* the components of *Digital Health, Innovation* and *Digital Ecosystems* can be implemented for the Namibian context, as per section 6.5.

6.3. EXPERT REVIEWS

An overview of the study was presented to experts, in the form of a letter. In order to evaluate the components of *Digital Health, Innovation* and *Digital Ecosystems*, experts in the field of *Digital Health, Innovation* and *Digital Ecosystems,* outside the context of Namibia, were sought. The definition of an expert was provided in Chapter 5 (section 5.4). These experts were selected based on their level of experience regarding the subject matter and their ability to contribute to the validation of a *Digital Health Innovation Ecosystem*.

6.3.1. Selection of experts

Hobrook et al. (2007) suggest that the number of experts needed to evaluate a process should not be less than 2. Hobrook et al. (2007) emphasise that between 2 and 5 experts are adequate for an evaluation processes. Nielson (2000) postulates that 5 users are adequate when testing the usability of a product. Ouma (2013) explains that 5 experts are adequate in finding 85% of errors in the evaluation process, as indicated in Figure 6.2.

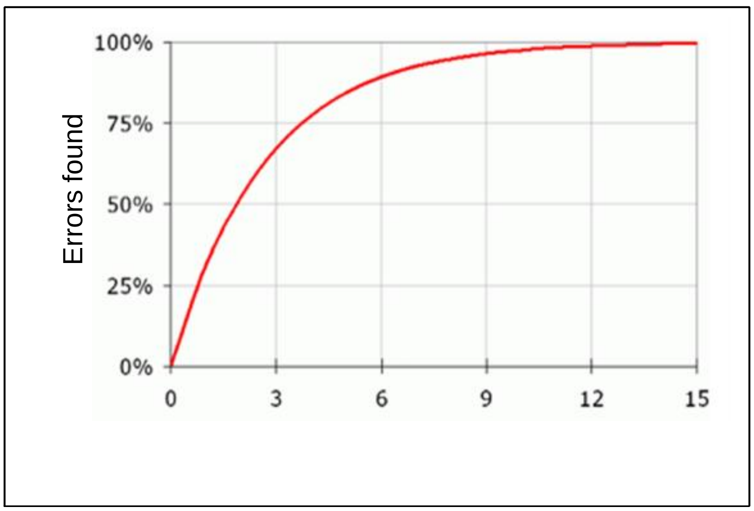


Figure 6-2: Number of experts needed to determine errors (Ouma, 2013; Nielen, 2000).

Barnum et al. (2003) suggest that 3 to 4 users are needed for evaluation purposes, however it is helpful if 5 users can be contacted, in case some users do not turn up for evaluation. The same approach was applied in this study. Initially, an email request for participation was sent to 15 experts (5 for *Digital Health*, 5 for innovation and 5 for digital ecosystems). Five *Digital Health experts*, 4 innovation experts and 3 digital ecosystems experts responded. For the purpose of the study, 12 experts (5 *Digital Health* experts, 4 innovation experts and 3 digital ecosystems experts) participated in the validation of the components of *Digital Health, Innovation* and *Digital Ecosystems*. Taking into consideration that *Digital Health, Innovation* and *Digital Ecosystems* consists of concepts taken from 3 domains, and as suggested by Hobrook (2007) and Nielson (2000), few experts were considered ideal for validating the components from each domain.

6.3.2. Questionnaire development

Web-based questionnaires (see Appendices E, F and G) were distributed to selected global experts. An introduction to the study was provided to the participants (see Appendices E, F and G). The questionnaire consisted of both open-ended and closed-ended questions. The experts were asked to rank the components of *Digital Health, Innovation* and *Digital Ecosystems,* based on their order of importance:

- Not Important
- Less Important
- Moderately Important
- Important
- Very important

6.3.3. Biographical information of experts: Digital health

Table 6.1 provides the biographical information of *Digital Health* experts who participated in the study.

Table 6-1: Biographic information of *Digital Health* experts.

Experts	Occupation	Gender	Age range	Country	Field of expertise	Expertise level	Highest level of education	Work setting	Years of experience
E1	Deputy Professor/ Research Fellow	Female	Over 60 years	Germany	Digital health	Intermediate	Doctorate degree	University	4-6 years
E2	Lecturer	Female	36-45 years	Portugal	Digital health	Novice	Doctorate degree	University	1-3 years
E3	Project manager	Male	46-60 years	Ireland	Digital health	Expert	Masters degree	University	4-6 years
E4	Lecturer	Male	36-45 years	Ireland	Digital health	Intermediate	Masters degree	University	4-6 years
E5	Lecturer	Male	26-35 years	Nigeria	Digital health	Intermediate	Doctorate degree	University	4-6 years

As presented in Table 6.1, 3 experts hold a Doctorate, while 2 experts have Masters degrees. Experts who participated in this study’s experience in the field ranged from 1 to 3 years and from 4 to 6 years. One expert can be regarded as on an expert level (based on expertise levels of Table 6.1) *Digital Health*, 4 of the experts are considered intermediate experts in *Digital Health*, while 1 expert is considered a novice in *Digital Health*. Despite one expert being a novice, she was still selected based on her acquired knowledge of the *Digital Health* domain and the number of publications published within the *Digital Health* domain. Furthermore, these experts had the capacity of providing relevant information regarding the components of *Digital Health* as relevant to the Namibian context. Experts were based in different countries namely Germany, Portugal, Finland, Ireland and Nigeria. Two female and 3 male experts, all in the field of *Digital Health,* participated in the study. One expert was a project manager, 3 experts were lecturers and 1 expert was a deputy professor and research fellow. All experts work at a University. One expert was over 60 years old, 2 experts were aged between 36 and 45 years, 1 expert was aged between 46 and 60 years and 1 expert was between 26 and 35 years old.

6.3.4. Findings from the closed-ended questions: Digital Health

This section provides findings that the experts provided based on the different components of *Digital Health*.

6.3.4.1. E-health

The experts were asked to rank e-health as a component of *Digital Health* based on its importance in the Namibian context. Three experts indicated that e-health is a Very Important component of *Digital Health* within the Namibian context, 1 expert indicated that e-health is an Important component of *Digital Health* within the Namibian context, while 1 expert indicated that e-health is Moderately Important within the Namibian context. The findings validate e-health as a relevant component of *Digital Health* within the Namibian context as most of the experts believe that e-health is relatively important within the Namibian context. The concept is thus retained.

6.3.4.2. M-health

The experts were asked to rank m-health as a component of *Digital Health* based its importance in the Namibian context. Two experts indicated that m-health is a Very Important component of *Digital Health* within the Namibian context, 2 experts indicated that m-health is an Important component of *Digital Health* within the Namibian context, while 1 expert indicated that m-health is Moderately Important within the Namibian context. The findings validate m-health as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that m-health is relatively important within the Namibian context. The concept is thus retained.

6.3.4.3. Telemedicine/telehealth/telecare

The experts were asked to rank telemedicine/telehealth/telecare as a component of *Digital Health* based on its importance in the Namibian context. Three experts indicated that telemedicine/telehealth/telecare is a Very Important component of *Digital Health* within the Namibian context and 2 experts indicated that telemedicine/telehealth/telecare is an Important component of *Digital Health* within the Namibian context. The findings validate telemedicine/telehealth/telecare as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that telemedicine/telehealth/telecare is relatively important within the Namibian context. The concept is thus retained.

6.3.4.4. Health 2.0/medicine 2.0

The experts were asked to rank health 2.0/medicine 2.0 as a component of *Digital Health* based on its importance in the Namibian context. Three experts indicated that health 2.0/medicine 2.0 is a Very Important component of *Digital Health* within the Namibian context, 2 experts indicated that health 2.0/medicine 2.0 is an Important component of *Digital Health* within the Namibian context. The findings validate health 2.0/medicine 2.0 as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that health 2.0/medicine 2.0 is relatively important within the Namibian context. The concept is thus retained.

6.3.4.5. Wireless health/wireless sensors

The experts were asked to rank wireless health/wireless sensors as a component of *Digital Health* based its importance in the Namibian context. One expert indicated that wireless health/wireless sensors is a Very Important component of *Digital Health* within the Namibian context, 2 experts indicated that wireless health/wireless sensors is an Important component of *Digital Health* within the Namibian context. Two experts indicated that wireless health/wireless sensors are Moderately Important within the Namibian context. The findings validate wireless health/wireless sensors as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that wireless health/wireless sensors are relatively important within the Namibian context. The components were thus retained.

6.3.4.6. Internet

The experts were asked to rank Internet as a component of *Digital Health* based on its importance in the Namibian context. One expert indicated that the Internet is a Very Important component of *Digital Health* within the Namibian context, 1 expert indicated that the Internet is an Important component of *Digital Health* within the Namibian context. The findings validate the Internet as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that Internet is relatively important within the Namibian context. The component is thus retained.

6.3.4.7. Genomics/personalised medicine

The experts were asked to rank genomics/personalised medicine as a component of *Digital Health* based on its importance in the Namibian context. Three experts indicated that genomics/personalised medicine is a Very Important component of *Digital Health* within the Namibian context, 2 experts indicated that genomics/personalised medicine is an Important component of *Digital Health* within the Namibian context. The findings validate genomics/personalised medicine as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that genomics/personalised medicine is relatively important within the Namibian context. The component is thus retained.

6.3.4.8. Mobile connectivity and bandwidth

The experts were asked to rank mobile connectivity and bandwidth as a component of *Digital Health* based on its order of importance within the Namibian context. Four experts indicated that mobile connectivity and bandwidth is a Very Important component of *Digital Health* within the Namibian context, 1 expert indicated that mobile connectivity and bandwidth is an Important component of *Digital Health* within the Namibian context. The findings validate mobile connectivity and bandwidth as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that Internet is relatively important. The component was thus retained.

6.3.4.9. Social networking/social media/health and medical platforms

The experts were asked to rank social networking/social media/health and medical platforms as a component of *Digital Health* based on its order of importance in the Namibian context. Three experts indicated that social networking/social media/health and medical platforms are a Very Important component of *Digital Health* within the Namibian context, 1 expert indicated that social networking/social media/health and medical platforms is an Important component of *Digital Health* within the Namibian context. The findings validate social networking/social media/health and medical platforms as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that social networking/social media/health and medical platforms is relatively important within the Namibian context. The component is thus retained.

6.3.4.10. Computing power and data universe

The experts were asked to rank computing power and data universe as a component of *Digital Health* based on its importance in the Namibian context. Two experts indicated that computing power and data universe is a Very Important component of *Digital Health* within the Namibian context, 2 experts indicated that computing power and data universe is an Important component of *Digital Health* within the Namibian context. One expert indicated that computing power and data universe is Moderately Important within the Namibian context. The findings validate computing power and data universe as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that computing power and data universe is relatively important within the Namibian context. The component is thus retained.

6.3.4.11. Information systems

The experts were asked to rank information systems as a component of *Digital Health* based on its importance to the Namibian context. All experts indicated that information systems are a Very Important component of *Digital Health* within the Namibian context. The findings validate information systems as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that information systems are relatively important within the Namibian context. The component is thus retained.

6.3.4.12. Imaging

The experts were asked to rank imaging as a component of *Digital Health* based on its importance in the Namibian context. Two experts indicated that imaging is a Very Important component of *Digital Health* the Namibian context, 2 experts indicated that imaging is an Important component of *Digital Health* within the Namibian context. One expert indicated that imaging is a Moderately Important component of *Digital Health* within the Namibian context. The findings validate imaging as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that imaging is relatively important within the Namibian context. The component is thus retained.

6.3.4.13. Self-tracking (the quantified self)

The experts were asked to rank self-tracking (the quantified self) as a component of *Digital Health* based on its importance in the Namibian context. Two experts indicated that self-tracking (the quantifies self) is a Very Important component of *Digital Health* in the Namibian context, 2 experts indicated that self-tracking (the quantified self) is an Important component of *Digital Health* within the Namibian context. One expert indicated that self-tracking (the quantified self) is a Moderately Important component of *Digital Health* within the Namibian context. The findings validate self-tracking (the quantified self) as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that self-tracking (the quantified self) is relatively important within the Namibian context. The component is thus retained.

6.3.4.14. Wearable computing/sensors and wearables

The experts were asked to rank wearable computing/sensors and wearables as a component of *Digital Health* based their importance in the Namibian context. Three experts indicated that wearable computing/sensors and wearables is a Very Important component of *Digital Health* the Namibian context, 2 experts indicated that wearable computing/sensors and wearables is an Important component of *Digital Health* within the Namibian context. The findings validate wearable computing/sensors and wearables as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that wearable computing/sensors and wearables is relatively important within the Namibian context. The component is thus retained.

6.3.4.15. Health information technology

The experts were asked to rank health information technology as a component of *Digital Health* based its importance in the Namibian context. Four experts indicated that health information technology is a Very Important component of *Digital Health* the Namibian context, 1 expert indicated that health information technology is an Important component of *Digital Health* within the Namibian context. The findings validate health information technology as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that health information technology is relatively important within the Namibian context. The component is thus retained.

6.3.4.16. Big data

The experts were asked to rank big data as a component of *Digital Health* based on its importance in the Namibian context. Two experts indicated that big data is a Very Important component of *Digital Health* in the Namibian context, 2 experts indicated that big data is an Important component of *Digital Health* within the Namibian context. One expert indicated that big data is a Moderately Important component of *Digital Health* within the Namibian context. The findings validate big data as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that big data is relatively important within the Namibian context. The component is thus retained.

6.3.4.17. Cloud computing

The experts were asked to rank cloud computing as a component of *Digital Health* based on its importance in the Namibian context. Four experts indicated that cloud computing is a Very Important component of *Digital Health* in the Namibian context, 1 expert indicated that cloud computing is a Moderately Important component of *Digital Health* within the Namibian context. The findings validate cloud computing as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that cloud computing is relatively important within the Namibian context. The component is thus retained.

6.3.4.18. Public health surveillance

The experts were asked to rank public health surveillance as a component of *Digital Health* based on its importance in the Namibian context. Two experts indicated that public health surveillance is a Very Important component of *Digital Health* in the Namibian context, 1 expert indicated that public health surveillance is an Important component of *Digital Health* within the Namibian context. Two experts indicated that public health surveillance is a Moderately Important component of *Digital Health* within the Namibian context. The findings validate public health surveillance as a relevant component of *Digital Health* within the Namibian context, as most experts believe that public health surveillance is relatively important within the Namibian context. The component is thus retained.

6.3.4.19. Health promotion strategies

The experts were asked to rank health promotion strategies as a component of *Digital Health* based on its importance in the Namibian context. Three experts indicated that health promotion strategies are a Very Important component of *Digital Health* the Namibian context, 1 expert indicated that health promotion strategies is an Important component of *Digital Health* within the Namibian context. One expert indicated that health promotion strategies are a Moderately Important component of *Digital Health* within the Namibian context. The findings validate health promotion strategies as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that health promotion strategies are relatively important within the Namibian context. The component is thus retained.

6.3.4.20. EMRs

The experts were asked to rank EMRs as a component of *Digital Health* based on its importance in the Namibian context. Three experts indicated that EMRs is a Very Important component of *Digital Health* in the Namibian context, 2 experts indicated that EMRs is an Important component of *Digital Health* within the Namibian context. The findings validate EMRs as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that EMRs is relatively important within the Namibian context. The component is thus retained.

6.3.4.21. EHRs

The experts were asked to rank EHRs as a component of *Digital Health* based on their importance in the Namibian context. Two experts indicated that EHRs is a Very Important component of *Digital Health* the Namibian context, 3 experts indicated that EHRs is an

Important component of *Digital Health* within the Namibian context. The findings validate EHRs as a relevant component of *Digital Health* within the Namibian context, as most experts believe that EHRs is relatively important within the Namibian context. The component is thus retained.

6.3.4.22. Gamification

The experts were asked to rank health gamification as a component of *Digital Health* based on its order of importance in the Namibian context. Three experts indicated that gamification is a Very Important component of *Digital Health* in the Namibian context, 2 experts indicated that gamification is a Moderately Important component of *Digital Health* within the Namibian context. The findings validate gamification as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that gamification is relatively important within the Namibian context. The component is thus retained.

6.3.4.23. Interoperability

The experts were asked to rank interoperability as a component of *Digital Health* based on its order of importance in the Namibian context. All experts indicated that interoperability is a Very Important component of *Digital Health* in the Namibian context. The findings validate interoperability as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that interoperability is relatively important within the Namibian context. The component is thus retained.

6.3.4.24. Health and wellness applications

The experts were asked to rank health and wellness apps as a component of *Digital Health* based on its importance in the Namibian context. Two experts indicated that health and wellness apps is a Very Important component of *Digital Health* within the Namibian context, 1 expert indicated that health and wellness apps is an Important component of *Digital Health* within the Namibian context. One expert indicated that health and wellness apps is a Moderately Important component of *Digital Health* within the Namibian context. The findings validate health and wellness apps as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that health and wellness apps is relatively important within the Namibian context. The component is thus retained.

6.3.4.25. Health analytics

The experts were asked to rank health analytics as a component of *Digital Health* based on their importance in the Namibian context. Two experts indicated that health analytics is a Very Important component of *Digital Health* within the Namibian context, 2 experts indicated that health analytics is an Important component of *Digital Health* within the Namibian context. One expert indicated that health analytics is a Moderately Important component of *Digital Health* within the Namibian context. The findings validate health analytics as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that health analytics is relatively important within the Namibian context. The component is thus retained.

6.3.4.26. Digitised health systems

The experts were asked to rank digitised health systems as a component of *Digital Health* based on its order of importance in the Namibian context. Three experts indicated that digitised health systems is a Very Important component of *Digital Health* within the Namibian context, 1 expert indicated that digitised health systems is an Important component of *Digital Health* within the Namibian context. The findings validate digitised health systems as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that digitised health systems is relatively important within the Namibian context. The component is thus retained.

6.3.4.27. Privacy and security

The experts were asked to rank privacy and security as a component of *Digital Health* based on its importance in the Namibian context. All experts indicated that privacy and security is a Very Important component of *Digital Health* the Namibian context. The findings validate privacy and security as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that privacy and security is relatively important within the Namibian context. The component is thus retained.

6.3.4.28. E-prescription

The experts were asked to rank e-prescription as a component of *Digital Health* based on its importance in the Namibian context. Three experts indicated that e-prescription is a Very Important component of *Digital Health* in the Namibian context, 1 expert indicated that e-prescription is an Important component of *Digital Health* within the Namibian context. One expert indicated that e-prescription is a Moderately Important component of *Digital Health* within the Namibian context. The findings validate health e-prescription as a relevant component of *Digital Health* within the Namibian context, as most of the experts believe that e-prescription is relatively important within the Namibian context. The component is thus retained.

In summary, 28 out of 29 components of *Digital Health* presented to the experts were considered relevant and was thus retained:

- E-health

- M-health
- Telemedicine/telehealth/telecare
- Health 2.0/medicine 2.0
- Wireless health/wireless sensors
- Internet
- Genomics/personalised medicine
- Mobile connectivity and bandwidth
- Social networking/social media/health and medical platforms
- Computing power and data universe
- Information systems
- Imaging
- Self-tracking (the quantified self)
- Wearable computing/sensors and wearables
- Health information technology
- Big data
- Cloud computing
- Public health surveillance
- Health promotion strategies
- Electronic medical records
- Electronic health records
- Gamification
- Interoperability
- Health and wellness apps
- Health analytics
- Digitised health systems
- Privacy and security
- E-prescription

6.3.5. Findings from the Digital Health questions

This section presents the findings from the open-ended questions in the *Digital Health* questionnaire.

- Experts were asked to indicate whether the list of components included any irrelevant components which should be removed.

All experts believed that all components presented were relevant and that none should be removed.

In summary, no component of *Digital Health* presented to *Digital Health* experts was removed.

- Experts were asked to indicate whether any components should be added to the list.

Based on the response from the open-ended questions it was found that open source technologies could be a part of the Namibian digital health innovation ecosystem. As one of the experts put it:

”open source technology should be added to the list”

It was also indicated that user experience would be relevant concept for this context:

”user experience should be added… some form of patient-centredness, as through UX, should be included”

Personalised health management and health coaching is an important component of the Digital Health Innovation Ecosystem as one expert explained:

“personalised health management (in preventive scope) and health coaching services should be added to the list”

It was also found that the component information systems should be rephrased to health information systems as one expet put it:

“health information systems specifically refers to the management of health information”

In summary, components of *Digital Health* that need to be added to list of *Digital Health* components relevant to the Namibian context, as indicated by some experts, include:

- **Open source technology**: According to Lochhaas and Moore (2010), open source software (OSS) is a type of software acquisition which comes at no extra cost and software codes can be easily customised to meet the needs of the user. Wilson (2009) emphasises that one of the challenges of implementing HISs is cost issues. However, when the cost of implementing HISs is drastically reduced, it becomes easier for health institutions to implement. Open source EMRs, EHRs and HISs can be incorporated into the Namibian *Digital Health Innovation Ecosystem* to save costs.
- **Personalised health management (in preventive scope):** This refers to management of patients’ health through the use of smart technologies (Lymberis, 2005) in a bid to prevent illnesses.

- **Health coaching services**: Jordan (2013, p. 76) explains that "health coaching is a rapidly growing nonclinical health profession that offers an accessible, client centred, holistic approach to changing attitudes, behaviour, and lifestyles habits of individuals for improved health and well-being." Health coaching is "the practice of health education and health promotion within a coaching context, to enhance the well-being of individuals and to facilitate the achievement of their health-related goals" (Palmer, 2004, p. 189). Health coaching can be provided in the Namibian *Digital Health Innovation Ecosystem* to support healthcare services to patients.
- **User eXperience and patient-centredness**: User eXperience is defined as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service" (ISO, 9241-210). Patient-centred care involves a consideration of those essentials required by a patient when providing healthcare delivery services. One of the *Digital Health* global experts suggested that user eXperience and patient-centeredness should be present in a *Digital Health* innovation ecosystem. User eXperience should be incorporated in every system which makes up the Namibian *Digital Health* innovation ecosystem. The purpose is to ensure that all systems can be used by patients, medical professionals and other stakeholders.

The components of *Digital Health* which need to be rephrased are:

- Information systems to health information systems.
- Experts were asked to comment on, what they believed should be, the first step for Digital Health to be established in Namibia.

One expert indicated that key components like e-health, m-health and telemedicine should be fully implemented firstly before Digital Health could function within the Namibian context. One expert emphasised that "the identification of IT communication channels used by the population is essential, to choose the most appropriate communication channel, or for expanding the IT infrastructure to be able to address a potentially large target group in a digital way. Equally important is to create health awareness in the patient. Therefore, I think it is essential to create a user (patient) - centred system." This suggests that appropriate communication channels should be put in place to determine *how* information can be shared and how patients should be made more aware of digital health. One expert suggested that participants in the *Digital Health Innovation Ecosystem* process should firstly be trained to acquire the necessary skills to navigate the system before *Digital Health* is established in Namibia.

In summary, the strategies which need to be put into place for *Digital Health* to succeed in Namibia are:

  - Identification of appropriate digital communication channels.
  - User (patient) centred system.
  - Learning process for participants.

- Experts were asked whether they would participate in a *Digital Health Innovation Ecosystem,* and if so, in what capacity.

Three experts indicated that they would like to take part in a *Digital Health* innovation ecosystem. One expert explained that participation would be in the form of research and innovation where the expert would "contribute towards developing innovative research to improve the *Digital Health* innovation ecosystem." Another expert indicated that participation would be in the form of "mathematical modelling and ICT4D for optimising the health system using the one health approach. I am especially interested in the interface to the user (patient) and how to really reach a patient to be able to create risk/health awareness." One expert explained that participation would be in the form of "bioinformatics and molecular biology towards personalised medicine."

In summary, from a global perspective, potential stakeholders of the *Digital Health Innovation Ecosystem* would be:

  - **Researchers**: To take part in research and innovation which can help improve the ecosystem. Researchers can also include mathematical modelling and ICT4D for optimising the health system using the one health approach. Researchers can also participate in the form of bioinformatics and molecular biology towards personalised medicine.

- Experts were asked to indicate whether they believed a *Digital Health Innovation Ecosystem* would be of value in the Namibian context.

All experts perceived the *Digital Health* innovation ecosystem to be of value to Namibia. One expert indicated that "as a developing country, *Digital Health* can improve healthcare processes and overall life of patients in Namibia, taking into consideration that *Digital Health Innovation Ecosystems* will enable connections between different people, it will improve connection with experts in the medical field as experts will be part of the ecosystem." One expert explained "Yes, definitely. I think especially the implementation of such a structured concept can help to optimise the health system. Furthermore, to use the digital devices and communication channels the population uses, can lead to a huge impact." One expert indicated that a *Digital Health Innovation Ecosystem* would help save resources and provide efficient and effective health services. One expert added "Yes, a *Digital Health Innovation Ecosystem* mind-set is the way of the future as it is meant to be open, collaborative and inclusive. Governments alone in many parts of the world would not be able to cope with the rise of chronic diseases, and the need to improve the quality and efficiency of healthcare delivery. These are challenges which every government is currently facing and as such Namibia would need digital innovative ecosystem that will involve academic, non-profit, and commercial organisations to be able to cope with the spread of these diseases." One expert added "for sure there can be value if the system can be operated from a fresh (non-legacy) ground on and builds on interoperability within the country and outside the country's own borders."

In summary, the perceived value of *Digital Health Innovation Ecosystems* in the Namibian context, as indicated by global *Digital Health* experts, are:

- Efficient and effective healthcare delivery services to patients.
- Minimise resources used in the healthcare process.
- Support the Namibian government in the provision of better healthcare through collaboration of academics, non-profit and commercial organisations.

6.3.6. Biographical information of experts: Innovation

This section provides the biographical information of innovation experts who participated in the study, presented in the table below

Table 6-2: Biographic information of innovation experts.

Experts	Occupation	Gender	Age range	Country	Field of expertise	Expertise level	Highest level of education	Work setting	Years of experience
E1	Deputy Professor/ Research Fellow	Female	Over 60 years	Germany	Innovation	Intermediate	Doctorate degree	University	4-6 years
E2	Researcher	Male	36-45 years	Nigeria	Innovation	Expert	Doctorate degree	Research institution	More than 10 years
E3	Professor and consultant	Male	Over 60 years	Taiwan	Innovation	Expert	Doctorate degree	University	More than 10 years
E5	Researcher	Male	36-45 years	United Kingdom	Innovation	Intermediate	Doctorate degree	University	4-6 years

As presented in Table 6.2, all experts have Doctorate degrees. Experts who participated in this study had experience ranging from 4 to 6 years and more than 10 years. Two of the experts are considered intermediate in *Digital Health*, while 2 of the experts are considered experts in innovation. Experts were based in different countries namely Germany, Nigeria, Taiwan and the United Kingdom. One female expert and 3 male experts in the field of innovation participated in the study. One of the experts is a deputy professor, 1 of the experts is a professor, 2 of the experts are researchers. Three experts work in a University, while 1 expert works in a research institution. Two of the experts are over 60 years old. Two of the experts are between 35 to 45 years.

6.3.7. Findings from the experts on Innovation components

This section provides the findings from expert reviews on the components relevant to Innovation.

6.3.7.1. Process innovation

The experts were asked to rank process innovation as a component of innovation based on the its importance in the Namibian context. Three experts indicated that process innovation is a Very Important component of innovation within the Namibian context, 1 expert indicated that process innovation is an Important component of innovation within the Namibian context. The findings validate process innovation as a relevant component of *Digital Health* within the Namibian context as most of the experts believe that process innovation is relatively important within the Namibian context. The component is thus retained.

6.3.7.2. Product innovation

The experts were asked to rank product innovation as a component of innovation based on its importance in the Namibian context. One expert indicated that product innovation is a Very Important component of innovation within the Namibian context. One expert indicated that product innovation is Less Important within the Namibian context, 2 experts indicated that product innovation is Not Important within the Namibian context. The findings did not validate product innovation as a relevant component of *Digital Health* within the Namibian context as most of the experts did not agree that product innovation is relatively important within the Namibian context. The component was thus removed.

6.3.7.3. Structure innovation

The experts were asked to rank structure innovation as a component of innovation based on its importance in the Namibian context. Three experts indicated that structure innovation is a Very Important component of innovation within the Namibian context. One expert indicated that structure innovation is Important within the Namibian context. The findings validated structure innovation as a relevant component of innovation within the Namibian context as most of the experts agreed that structure innovation is relatively important within the Namibian context. The component is thus retained.

6.3.7.4. Open innovation

The experts were asked to rank open innovation as a component of innovation based on its importance in the Namibian context. Three experts indicated that open innovation is a Very Important component of innovation within the Namibian context. One expert indicated that open innovation is Less Important within the Namibian context. The findings validated open innovation as a relevant component of innovation within the Namibian context as most of the experts agreed that open innovation is relatively important within the Namibian context. The component is thus retained.

6.3.7.5. Open innovation 2.0

The experts were asked to rank open innovation 2.0 as a component of innovation based on the order of importance to the Namibian context. All experts indicated that open innovation 2.0 is a Very Important component of innovation within the Namibian context. The findings validated open innovation 2.0 as a relevant component of innovation within the Namibian context as most of the experts agreed that open innovation 2.0 is relatively important within the Namibian context. The component is thus retained.

6.3.7.6. Innovation networks ecosystems

The experts were asked to rank innovation networks ecosystems as a component of innovation based on its importance in the Namibian context. All experts indicated that innovation networks ecosystems are a Very Important component of innovation within the Namibian context. The findings validated innovation networks ecosystems as a relevant component of innovation within the Namibian context as most of the experts agreed that innovation networks ecosystems is relatively important within the Namibian context. The component is thus retained.

6.3.7.7. Quadruple Helix systems

The experts were asked to rank innovation Quadruple Helix systems as a component of innovation based on its importance in the Namibian context. Three experts indicated that Quadruple Helix systems is an Important component of innovation within the Namibian context, 1 expert indicated that Quadruple Helix systems is Less Important within the Namibian context. The findings validated Quadruple Helix systems as a relevant component of innovation within the Namibian context as most of the experts agreed that Quadruple Helix systems (government, industry, academia and community) are relatively important within the Namibian context. The component was thus retained.

6.3.7.8. User innovation

The experts were asked to rank user innovation as a component of innovation based on the order of its importance in the Namibian context. Three experts indicated that user innovation is a Very Important component of innovation within the Namibian context. One expert indicated that user innovation is an Important component of innovation within the Namibian context. The findings validate user innovation as a relevant component of user innovation within the Namibian context, as most of the experts believe that user innovation is relatively important within the Namibian context. The component is thus retained.

6.3.7.9. Intellectual property rights

The experts were asked to rank intellectual property rights as a component of innovation based on its importance in the Namibian context. Two experts indicated that intellectual property rights is an Important component of innovation within the Namibian context. One expert indicated that intellectual property rights are Less Important component of innovation within the Namibian context. The findings validate intellectual property rights as a relevant component of innovation within the Namibian context, as most of the experts believe that intellectual property rights is relatively important within the Namibian context. The component is thus retained.

6.3.7.10. Role players

The experts were asked to rank role players as a component of innovation based on its order of importance in the Namibian context. All experts indicated that role players is a Very Important component of innovation within the Namibian context. The findings validate role players as a relevant component of innovation within the Namibian context. The component is thus retained.

6.3.7.11. Capital

The experts were asked to rank capital as a component of innovation based on the order of its importance in the Namibian context. Two experts indicated that capital is an Important component of innovation within the Namibian context. Two experts indicated that capital is a Moderately Important component of innovation within the Namibian context. The findings validate capital as a relevant component of innovation within the Namibian context, as most of the experts believe that capital is relatively important within the Namibian context. The component is thus retained.

6.3.7.12. Infrastructure

The experts were asked to rank infrastructure as a component of innovation based on its importance in the Namibian context. All experts indicated infrastructure as a Very Important component of innovation within the Namibian context. The findings validate infrastructure as a relevant component of innovation within the Namibian context, as most of the experts believe that infrastructure is relatively important within the Namibian context. The component was thus retained.

6.3.7.13. Regulations

The experts were asked to rank regulations as a component of innovation based on its importance in the Namibian context. All experts indicated that regulations is a Very Important component of innovation within the Namibian context. The findings validate regulations as a relevant component of innovation within the Namibian context, as most of the experts believe that regulations are relatively important within the Namibian context. The component is thus retained.

6.3.7.14. Knowledge

The experts were asked to rank knowledge as a component of innovation based on its importance in the Namibian context. One expert indicated that knowledge is a Very Important component of innovation within the Namibian context. The findings validate knowledge as a relevant component of innovation within the Namibian context, as most of the experts believe that knowledge is relatively important within the Namibian context. The component is thus retained.

6.3.7.15. Ideas

The experts were asked to rank ideas as a component of innovation based on its importance in the Namibian context. Two experts indicated that ideas is a Very Important component of innovation within the Namibian context. Two experts indicated that ideas is an Important component of innovation within the Namibian context. The findings validate ideas as a relevant component of innovation within the Namibian context, as most of the experts believe that ideas is relatively important within the Namibian context. The component is thus retained.

6.3.7.16. Interface

The experts were asked to rank interface as a component of innovation based on its importance in the Namibian context. The findings validate interface as a relevant component of innovation within the Namibian context, as most of the experts believe that interface is relatively important within the Namibian context. The component is thus retained.

6.3.7.17. Collaboration

The experts were asked to rank collaboration as a component of innovation based on its importance in the Namibian context. All experts indicated that collaboration is a Very Important component of innovation within the Namibian context. The findings validate collaboration as a relevant component of innovation within the Namibian context, as most of the experts believe that collaboration is relatively important within the Namibian context. The component is thus retained.

6.3.7.18. **Organisational** and **markting innovation**

The experts were asked to rank organisational and marketing innovation as a component of innovation based on its importance in the Namibian context. All experts indicated that organisational and marketing innovation is a Very Important concept of innovation within the Namibian context. The findings validate organisational and marketing innovation as a relevant component of innovation within the Namibian context, as most of the experts believe that organisational and marketing innovation is relatively important within the Namibian context. The component is thus retained.

6.3.7.19. Technology innovation

The experts were asked to rank technology innovation as a component of innovation based on its importance in the Namibian context. One expert indicated that technology innovation is a Very Important component of innovation within the Namibian context. Three experts indicated that technology innovation is an Important component of innovation within the Namibian context. The findings validate technology innovation as a relevant component of innovation within the Namibian context, as most of the experts believe that technology innovation is relatively important within the Namibian context. The component is thus retained.

6.3.7.20. Healthcare innovation

The experts were asked to rank healthcare innovation as a component of innovation based on its importance in the Namibian context. One expert indicated that healthcare innovation is a Very Important component of innovation within the Namibian context. Three experts indicated that healthcare innovation is an Important component of innovation within the Namibian context. The findings validate healthcare innovation as a relevant component of innovation within the Namibian context, as most of the experts believe that healthcare innovation is relatively important within the Namibian context. The component is thus retained.

6.3.7.21. Teaching

The experts were asked to rank teaching as a component of innovation based on its importance in the Namibian context. All experts indicated that teaching is a Very Important component of innovation within the Namibian context. The findings validate teaching as a relevant component of innovation within the Namibian context, as most of the experts believe that teaching is relatively important within the Namibian context. The component is thus retained.

6.3.7.22. Innovation spaces and living labs

The experts were asked to rank innovation spaces and living labs as a component of innovation based on its importance in the Namibian context. One expert indicated that innovation spaces and living labs is a Very Important component of innovation within the Namibian context. Three experts indicated that innovation spaces and living labs is an Important component of innovation within the Namibian context. The findings validate innovation spaces and living labs as a relevant component of innovation within the Namibian context, as most of the experts believe that innovation spaces and living labs is relatively important within the Namibian context. The component is thus retained.

6.3.7.23. Research and development

The experts were asked to rank research and development as a component of innovation based on its importance in the Namibian context. Three experts indicated that research and development is an Important component of innovation within the Namibian context, while one expert indicated that research and development is a Moderately Important component of innovation within the Namibian context. The findings validate research and development as a relevant component of innovation within the Namibian context, as most of the experts believe that research and development is relatively important within the Namibian context. The component is thus retained.

In summary, of the 23 components of innovation presented, innovation experts revealed that 22 components of innovation should be retained which include:

- Process innovation
- Structure innovation
- Open innovation
- Open innovation 2.0
- Innovation networks ecosystems
- Quadruple Helix systems
- User innovation
- Intellectual property rights
- Role players

- Capital
- Infrastructure
- Regulations
- Knowledge
- Ideas
- Interface
- Collaboration
- Organisational and marketing innovation
- Technology innovation
- Healthcare innovation
- Teaching
- Innovation spaces and living labs
- Research and development

One component was regarded as not important enough to the Namibian context to be included namely:

- Product innovation

6.3.7.24. Findings from the open-ended questions

This section presents the findings from the opened-ended questions in the innovation questionnaire.

- Experts were asked to indicate whether there were any irrelevant components which should be removed from the list.

One expert specified that product innovation is not a relevant component of innovation for a *Digital Health Innovation Ecosystem* as products do not need to be produced in a *Digital Health Innovation Ecosystem* and hence the component is irrelevant. One expert indicated that *Interface* is not clear and should be rephrased. *Interface* was therefore rephrased to *channel between role players*.

In summary, the following changes were made:

  - o *Interface* was changed to *channel between role players.*

- Experts were asked to indicate whether there was any component of innovation which needed to be added to the list.

One expert indicated that "the entrepreneur; the firm" should be added as components of innovation, relevant to the Namibian context.

In summary, components of innovation that need to be added to list of innovation components relevant to the Namibian context, as indicated by some experts, include

- The entrepreneur and the firm.

- Experts were asked to indicate whether they would like to be part of a *Digital Health Innovation Ecosystem* and, if so, in what capacity.

Two experts indicated that they would like to take part in a *Digital Health* innovation ecosystem. Two experts explained that participation would be in the form of a consultant.

In summary, from a global perspective, potential stakeholders of the *Digital Health Innovation Ecosystem* would be

- **Consultants**: These are innovation experts who are ready to exchange ideas with other role players in the *Digital Health* innovation ecosystem.

- Experts were asked to indicate whether they believed that a *Digital Health Innovation Ecosystem* would be of value in the Namibian context.

All experts perceived the *Digital Health Innovation Ecosystems* to be of value in the Namibian context. One expert indicated that "Telemedicine, virtual learning for health professionals, patient interaction via smartphone, access to global expert network for answering professionals' questions, are all important components to add to *Digital Health*."

In summary, the perceived value of *Digital Health* innovation ecosystems in the Namibian context, as indicated by innovation experts, are:

- Telemedicine.
- Virtual learning for health professionals.
- Patients being able to interact in the ecosystem, through mobile devices.
- Global expert network for answering professional's questions.

6.3.8. Biographical information of experts: Digital ecosystems

This section provides the biographical information of digital ecosystems experts who participated in the study, presented in Table 6-3:

Table 6-3: Biographic information of digital ecosystems experts.

Experts	Occupation	Gender	Age	Country	Field of	Expertise	Highest	Work	Years of

			range		**expertise**	**level**	**level of education**	**setting**	**experience**
E1	Professor	Female	46-60 years	Australia	Digital ecosystems	Intermediate	Doctorate degree	University	4-6 years
E2	Deputy Professor/ research fellow	Female	Over 60 years	Germany	Digital ecosystems	Intermediate	Doctorate degree	University	4-6 years
E3	Professor	Male	46-60 years	Italy	Digital ecosystems	Intermediate	Doctorate degree	University	4-6 years

As presented in Table 6.3, all experts hold a Doctorate degree. Experts who participated in this study had 4 to 6 years' experience. All experts are considered as intermediate regarding their expertise level in digital ecosystems. Experts were based in different countries including Australia, Germany and Italy. Two female experts in the field of digital ecosystems participated in the study, while one male expert in the field of digital ecosystems participated in the study. One of the experts is a deputy professor and research fellow, 2 of the experts are professors. All experts work at a University. One of the experts is over 60 years. Two of the experts are between 46 and 60 years old.

6.3.9. Findings from the experts on Digital Ecosystems

This section provides from findings from the feedback of the experts on Digital Ecosystem components.

6.3.9.1. Biological species

The experts were asked to rank biological species as a component of digital ecosystems based on its importance in the Namibian context. Three experts indicated that biological species is a Very Important component of digital ecosystems within the Namibian context. The findings validate biological species as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that biological species is relatively important within the Namibian context. The component was thus retained.

6.3.9.2. Economic species

The experts were asked to rank economic species as a component of digital ecosystems based on its importance in the Namibian context. Three experts indicated that economic species is a Very Important component of digital ecosystems within the Namibian context. The findings validate economic species as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that economic species is relatively important within the Namibian context. The component is thus retained.

6.3.9.3. Digital species

The experts were asked to rank digital species as a component of digital ecosystems based on its importance in the Namibian context. Three experts indicated that digital species is a Very Important component of digital ecosystems within the Namibian context. The findings validate digital species as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that digital species is relatively important within the Namibian context. The component is thus retained.

6.3.9.4. Mobile clients

The experts were asked to rank mobile clients as a component of digital ecosystems based on its importance in the Namibian context. Two experts indicated that mobile clients is a Very Important component of digital ecosystems within the Namibian context and 1 expert indicated the mobile clients is an Important component of digital ecosystems within the Namibian context. The findings validate mobile clients as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that mobile clients is relatively important within the Namibian context. The component is thus retained.

6.3.9.5. Digital environment

The experts were asked to rank digital environment as a component of digital ecosystems based on its importance in the Namibian context. Two experts indicated that digital environment is a Very Important component of digital ecosystems within the Namibian context and 1 expert indicated the digital environment is an Important component of digital ecosystems within the Namibian context. The findings validate digital environment as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that digital environment is relatively important within the Namibian context. The component is thus retained.

6.3.9.6. Interoperability

The experts were asked to rank interoperability as a component of digital ecosystems based on its importance in the Namibian context. One expert indicated that interoperability is a Very Important component of digital ecosystems within the Namibian context and 2 experts indicated that interoperability is an Important component of digital ecosystems within the Namibian context. The findings validate interoperability as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that interoperability is relatively important within the Namibian context. The component is thus retained.

6.3.9.7. Security

The experts were asked to rank security as a component of digital ecosystems based on its importance in the Namibian context. Two experts indicated that security is a Very Important component of digital ecosystems within the Namibian context and 1 expert indicated that security is an Important component of digital ecosystems within the Namibian context. The findings validate security as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that security is relatively important within the Namibian context. The component is thus retained.

6.3.9.8. Trust

The experts were asked to rank trust as a component of digital ecosystems based on its importance in the Namibian context. One expert indicated that trust is a Very Important component of digital ecosystems within the Namibian context and 2 experts indicated that trust is an Important component of digital ecosystems within the Namibian context. The findings validate trust as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that trust is relatively important within the Namibian context. The component is thus retained.

6.3.9.9. Ecosystem-oriented architecture

The experts were asked to rank ecosystem-oriented architecture as a component of digital ecosystems based on its importance in the Namibian context. One expert indicated that ecosystem-oriented architecture is a Very Important component of digital ecosystems within the Namibian context and 2 experts indicated that ecosystem-oriented architecture is an Important component of digital ecosystems within the Namibian context. The findings validate ecosystem-oriented architecture as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that ecosystem-oriented architecture is relatively important within the Namibian context. The component is thus retained.

6.3.9.10. Self-organisation

The experts were asked to rank self-organisation as a component of digital ecosystems based on its importance in the Namibian context. One expert indicated that self-organisation is a Moderately Important component of digital ecosystems within the Namibian context and 2 experts indicated that self-organisation is an Important component of digital ecosystems within the Namibian context. The findings validate self-organisation as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that self-organisation is relatively important within the Namibian context. The component is thus retained.

6.3.9.11. Semantic web

The experts were asked to rank sematic web as a component of digital ecosystems based on its importance in the Namibian context. One expert indicated that sematic web is a Very Important component of digital ecosystems within the Namibian context and 2 experts indicated that semantic web is an Important component of digital ecosystems within the Namibian context. The findings validate semantic web as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that semantic web is relatively important within the Namibian context. The component is thus retained.

6.3.9.12. Digital content

The experts were asked to rank digital content as a component of digital ecosystems based on its importance in the Namibian context. One expert indicated that digital content is a Very Important component of digital ecosystems within the Namibian context and 2 experts indicated that digital content is an Important component of digital ecosystems within the Namibian context. The findings validate digital content as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that digital content is relatively important within the Namibian context. The component is thus retained.

6.3.9.13. Community

The experts were asked to rank community as a component of digital ecosystems based on its importance in the Namibian context. One expert indicated that community is a Very Important component of digital ecosystems within the Namibian context and 2 experts indicated that community is an Important component of digital ecosystems within the Namibian context. The findings validate community as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that community is relatively important within the Namibian context. The component is thus retained.

6.3.9.14. Technology

The experts were asked to rank technology as a component of digital ecosystems based on its importance in the Namibian context. Two experts indicated that technology is a Very Important component of digital ecosystems within the Namibian context and 1 expert indicated that technology is an Important component of digital ecosystems within the Namibian context. The findings validate technology as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that technology is relatively important within the Namibian context. The component is thus retained.

6.3.9.15. Practice

The experts were asked to rank practice as a component of digital ecosystems based on its importance in the Namibian context. One expert indicated that practice is a Very Important component of digital ecosystems within the Namibian context and 2 experts indicated that practice is an Important component of digital ecosystems within the Namibian context. The findings validate practice as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that practice is relatively important within the Namibian context. The component is thus retained.

6.3.9.16. Implementation

The experts were asked to rank implementation as a component of digital ecosystems based on its importance in the Namibian context. All experts indicated that implementation is a Very Important component of digital ecosystems within the Namibian context. The findings validate implementation as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that implementation is relatively important within the Namibian context. The component is thus retained.

6.3.9.17. Measures for addressing challenges

The experts were asked to rank measures for addressing challenges as a component of digital ecosystems based on its importance in the Namibian context. All experts indicated that measures for addressing challenges is an Important component of digital ecosystems within the Namibian context. The findings validate measures for addressing challenges as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that measures for addressing challenges is relatively important within the Namibian context. The component is thus retained.

6.3.9.18. Cloud computing

The experts were asked to rank cloud computing as a component of digital ecosystems based on its importance in the Namibian context. Two experts indicated that cloud computing is a Very Important component of digital ecosystems within the Namibian context and 1 expert indicated that cloud computing is an Important component of digital ecosystems within the Namibian context. The findings validate cloud computing as a relevant component of digital ecosystems within the Namibian context as most of the experts believe that cloud computing is relatively important within the Namibian context. The component is thus retained.

In summary, from 18 components of digital ecosystems presented, digital ecosystems experts revealed that 18 components should be retained which include:

- Biological species

- Economic species
- Digital species
- Mobile clients
- Digital environment
- Interoperability
- Security
- Trust
- Ecosystem-oriented architecture
- Self-organisation
- Semantic web
- Digital content
- Community
- Technology
- Practice
- Implementation
- Measures for addressing challenges
- Cloud computing

6.3.9.19. Findings from the open-ended questions

This section presents the findings from the opened-ended questions in the digital ecosystems questionnaire.

- Experts were asked to indicate whether there were any irrelevant components which should be removed from the list.

All experts indicated that there were no irrelevant components of digital ecosystems which needed to be removed.

- Experts were asked to indicate whether any component of innovation had to be added to the list of components presented.

One expert indicated that “stakeholders” should be added as a component of digital ecosystems relevant to the Namibian context.

In summary, components of digital ecosystems that need to be added to the list of digital ecosystems components relevant to the Namibian context, as indicated by some experts, include:

  - Stakeholders.

- Experts were asked to indicate whether they would like to be part of a *Digital Health Innovation Ecosystem* and, if so, in what capacity.

No responses were provided.

- Experts were asked to indicate whether they believed that a *Digital Health Innovation Ecosystem* would be of value in the Namibian context.

One expert indicated that the value of a *Digital Health Innovation Ecosystem* is that "it can help with planning, development of infrastructure and there will be an improved utilisation of resources."

In summary, the perceived value of *Digital Health Innovation Ecosystems* in the Namibian context, as indicated by digital ecosystems experts, are:

- Improved planning.
- Development of infrastructure.
- Utilisation of resources.

Having provided the results of the validation of *Digital Health, Innovation* and *Digital Ecosystems* components by global experts, the final framework for *Digital Health* innovation ecosystems is provided in the next section.

6.4. FINAL FRAMEWORK FOR DIGITAL HEALTH INNOVATION ECOYSTEMS

The final framework, incorporating the findings from the global experts, is presented in Figure 6-3.

Evaluation is an integral part of the Design Science Research Process model (Peffers et al., 2008). It should "observe and measure how well an artefact supports a solution to the problem and involves comparing the solution to actual observed results from use of the artefact in the demonstration" (Peffers et al., 2008, p. 13). However, it has been stated that little guidance exists in the literature with respect to the evaluation of artefacts (Herselman & Botha, 2015; Prat et al., 2014; Shresta et al., 2014), and that methods and objectives of evaluation are fragmented and unclear (Prat et al., 2014).

Authors such as Prat et al. (2014) and Venable et al. (2016) have proposed evaluation design frameworks (see Table 6.4) to address this gap in the Design Science Research literature.

Table 6-4: Frameworks for evaluation.

Author	Approach to evaluation	Proposed method
Prat et al. (2014): "Artefact evaluation in information systems design research: a holistic view"	The artefact is a system that needs to be evaluated against the specific dimensions of a system (goal, environment, structure, activity, and evolution).	Use four different characteristics against which to define an evaluation method: Form of evaluation (quantitative, qualitative). Secondary participant (e.g. students, practitioners, researchers).

		Level of evaluation (abstract artefact, instantiation). Relativeness of evaluation (comparable artefacts or absence of artefact).
Venable et al. (2016): "FEDS: a Framework for Evaluation in Design Science Research"	FEDS includes a two-dimensional characterisation of DSR evaluation episodes (particular evaluations), with one dimension being the functional purpose of the evaluation (formative or summative) and the other dimension being the paradigm of the evaluation (artificial or naturalistic).	Follow an evaluation design process comprised of the following four steps: Explicate the goals of the evaluation. Choose the evaluation strategy/ies. Determine the properties to evaluate. Design the individual evaluation episode(s).

In general, a method of evaluation needs to suit the nature of the item that is being evaluated. Furthermore, it needs to "provide feedback for further development, and… [assure] the rigour of the research" (Venable et al., 2016, p. 1). The *why*, as well as the *how, what* and *when* to evaluate become central to the evaluation method (Lagsten, 2011; Prat et al., 2014; Venable et al., 2016), as is evident from the frameworks outlined in Table 6.4.

For the purpose of this research, both of the frameworks of Prat et al. (2014) and Venable et al. (2016), as listed in Table 6-4, were applied to describe the nature of the artefact's (a *Namibian Digital Health Innovation Ecosystem*) evaluation: FEDS was used to determine the functional purpose of the artefact (to inform the Namibian health department to consider implementing it in Namibia) and to evaluate the artefact by both experts from Namibia, as well as from a global perspective. This addressed the relevance and utility of the artefact.

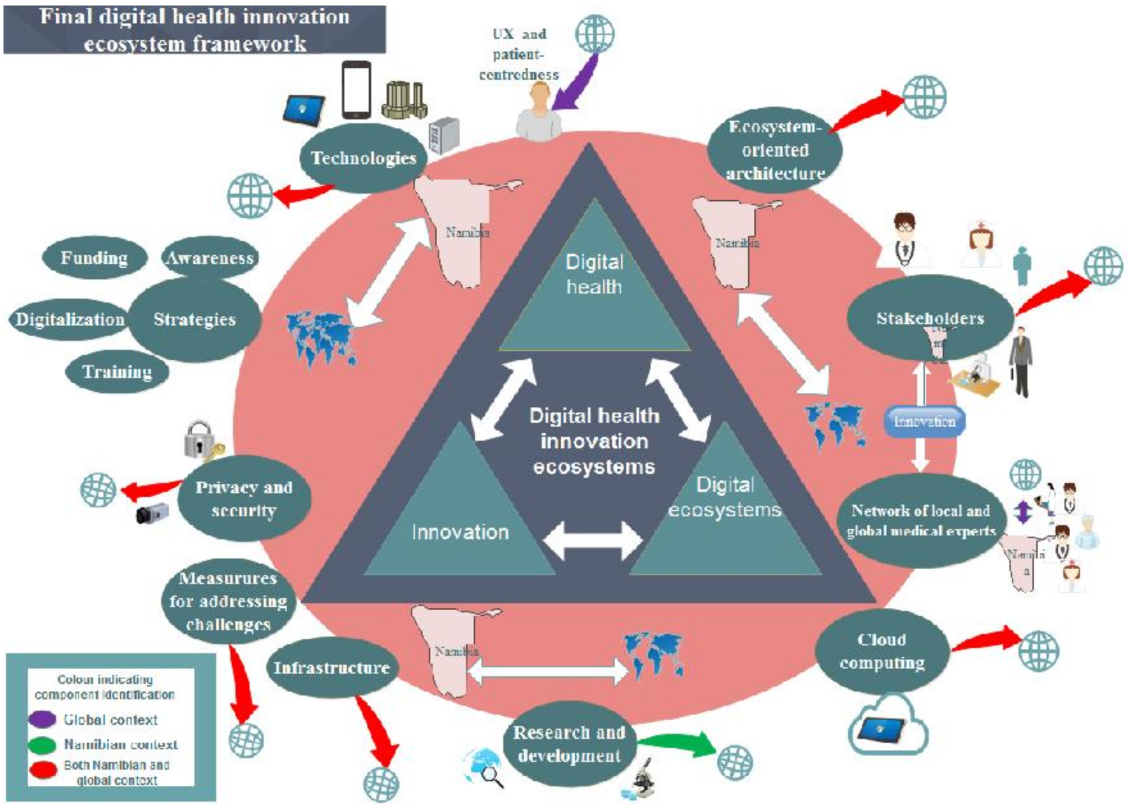


Figure 6-3: Final Namibian Digital Health Innovation Ecosystem Framework.

The final framework is a visual representation of the concepts, their components and their interrelated links, as explored in this study.

The final *Namibian Digital Health Innovation Ecosystem Framework* consists of the components *Digital Health, Innovation* and *Digital Ecosystems* which have been evaluated by Namibian KPs and validated by global experts in *Digital Health, Innovation* and *Digital Ecosystems*. The framework not only contains components of *Digital Health, Innovation* and *Digital Ecosystems* relevant to the Namibian context, but it also provides useful insights to be taken into consideration for the implementation of *Digital Health* in Namibia.

Ecosystem-oriented architecture was identified by both Namibian and global contexts as an architecture which should be deployed in a Namibian digital health innovation ecosystem. As described by Ion et al. (2008) this architecture supports the interoperability and the integration of the different processes that characterise a digital ecosystem. The final *Digital Health Innovation Ecosystem* should thus adopt an ecosystem-oriented architecture which suits both the Namibian and global context. The stakeholders (biological and economic species) in the final digital health innovation framework consist of different health, and non-health professionals, as well as health institutions. Stakeholders were identified by both Namibian KPs, and global experts, as an important component in a digital health innovation ecosystem. However, stakeholders will not work alone but collaborate with international experts and/or stakeholders. There is a network of global health experts which can assist local professionals within the Namibian context, as indicated by the innovation expert (as per section 6.3). This assistance could include interaction in response to specific needs, thus improving the quality of care provided to patients within the Namibian context. However, collaborations between local and international stakeholders, as well as the network of global health experts, will be guided by context specific policies on innovation relevant to their own countries (based on the innovation components described in this study). The ideas and knowledge shared by stakeholders, and global health experts in the *Digital Health Innovation Ecosystem,* will be guided by intellectual property rights and thus influence the free flow of information among stakeholders. The parties concerned, both locally and internationally, will be motivated to work as *collaborators,* rather than *competitors*.

Sharing of information between stakeholders in a *Digital Health Innovation Ecosystem* can be facilitated when cloud computing is deployed. As indicated by a Namibian innovation KP, research and development is relevant to a Namibian *Digital Health Innovation Ecosystem* as it facilitates innovation and development. Research and development can be a collaborative activity between local and global professionals.

As indicated in the framework, informed by both Namibian KPs and global experts, the infrastructural support (both physical and technical) needed to create and sustain the *Digital Health Innovation Ecosystem,* will be provided by Namibian stakeholders and external sources.

As indicated by both Namibian KPs and global experts, implementing a *Digital Health Innovation Ecosystem* in a developing country, like Namibia, will be challenging. However, relevant policies and adequate planning should go a long way in addressing potential challenges in a timeous manner. Global stakeholders can assist Namibian role-players with human and/or capital resources as well as infrastructural and/or knowledge-based support.

Privacy and security is a component which both Namibian KPs, and global experts, deem important to the Namibian digital health innovation ecosystem. Privacy and security concerns affect both the Namibian and global health experts participating in activities within the digital health innovation ecosystem. Information shared and applications deployed in the *Digital Health Innovation Ecosystem* need to be protected. If not properly addressed, privacy and security issues may deter stakeholders, and global health experts, from freely taking part in the *Digital Health Innovation Ecosystem.* Policies regarding the enforcing of security measures within the *Digital Health Innovation Ecosystem* should be put into place and strictly implemented.

As indicated, by both Namibian KPs and global experts, a strategy for training patients regarding the use of digital health technologies is paramount.

Technologies, which will be used by medical practitioners and patients, form a relevant part of the expert evaluated digital health innovation ecosystem. These systems need to be managed by IT professionals. The digital health technologies, as used in the *Digital Health Innovation Ecosystem,* can also be used by global health practitioners to provide support to the Namibian medical practitioners. Technological support can also be provided by global professionals.

UX and patient-centredness, as pointed out by a global digital health expert (see section 6.3.5.), is to be incorporated into those systems which will be used by patients. The implementation of these components will facilitate patients' learning and adoption process.

In conclusion, it is evident that the mere transfer of European solutions, methodologies and models to the Namibian context is not feasible. The experience and knowledge of co-creating with users and of industry identifying the beneficiaries of digital health systems, or the adaptation of the cost structure of solutions, would probably be the traditional focus areas when considering the value of European examples for South Africa. Failure to appreciate the local context and/or user needs is a mistake typically made when solutions are transferred from Europe to Africa. Learning from other countries' experiences, at system level, requires stakeholders to pay attention to how the emerging Namibian digital health system has adapted to, integrated and coordinated with the Namibian National Innovation System.

6.5. GUIDELINES, WITH APPROACHES, TOWARDS IMPLEMENTING THE NAMIBIAN DIGITAL HEALTH INNOVATION ECOSYSTEM

The six guidelines, with approaches, towards implementing a digital health innovation ecosystem in developing countries, were listed in Chapter 4, section 4.7. However, said guidelines will be adapted to explain the specific guidelines to implement a digital health innovation ecosystem in the Namibian context. The guidelines are described below:

6.5.1. Guideline 1: Identification of stakeholders and their role in the ecosystem

Identifying stakeholders in the digital health innovation ecosystem is the first step towards implementing this ecosystem in Namibia. Namibian stakeholders include: patients, healthcare practitioners (doctors, nurses, pharmacists and other healthcare practitioners from both public and private hospitals in Namibia), public and private hospitals and public and private clinics, researchers and academics from Universities and University of

Technology, research centres and Information technology experts with experience in health information systems. These stakeholders can be located in any of the 14 regions in Namibia.

Every stakeholder (i.e. patients, healthcare practitioners, health institutions, researchers and IT professionals from within the Namibian context) will play a role within the ecosystem in the domain of their expertise. Healthcare practitioners will perform healthcare delivery related activities using digital health technologies, such as telemedicine, and so interact with patients in the digital health innovation ecosystem. Using telemedicine, healthcare professionals can consult with patients who reside in a distant location. Other digital health components, as specified in this study, can also be used by healthcare practitioners and patients to deliver and manage healthcare. Health institutions can provide support by sharing information with other health institutions to reach agreement, via the correct communication channels, regarding the use of healthcare resources for the delivery of healthcare services. Researchers and academics can conduct research which will lead to innovation and new ideas which can promote innovation in the delivery of healthcare services. IT professionals taking part in the digital health innovation ecosystem can provide technical support of the various technologies deployed.

Chang & West (2006) suggest that *species* in a digital ecosystem should be self-organised. This implies that participants should be free to make their own decisions. Therefore, the decision *to join* the digital health innovation ecosystem or *to withdraw* from it, ultimately lies with every stakeholder. To implement this process, the use of certain platforms such as social media, social networks, health and medical platforms can be developed and then, stakeholders can join and withdraw, at will.

6.5.2. Guideline 2: Connecting international through local

Global stakeholders should also be allowed to join in the establishment of a Namibian digital health innovation ecosystem. Global stakeholders include healthcare practitioners (doctors, nurses and other healthcare practitioners), health institutions, researchers, academics and consultants outside the Namibian context. These stakeholders can impart ideas, knowledge and skills beneficial to the stakeholders in the Namibian context. In this manner, ideas and knowledge are shared between local and global entities. The incorporation of innovation processes will ensure that shared ideas and knowledge is beneficial to all stakeholders.

Implementing platforms (such as social networks, social media presence and health and medical platforms) is a possible way to connect local and international participants. The Namibian government should draw up policies which govern intellectual property rights and other possible benefits which may arise from the sharing of information within the Namibian digital health innovation ecosystem.

These benefits can be applied to patients, medical practitioners, researchers, health institutions, consultants or any entity represented in the ecosystem. For instance, if a private health organisation, from either a Namibian or global context, shares an idea with other stakeholders in the digital ecosystem, then that private health organisation owns the intellectual property to said shared ideas. If the ideas turn out to be beneficial, the private health organisation is to be rewarded. The same principle can be applied to all stakeholders participating in the ecosystem.

6.5.3. Guideline 3: Organising Requirements

The Namibian context can take up components (identified in this study) which can be explored in the digital health innovation ecosystem. Due to resource constraints, the implementation of *all digital health components at the same time* (especially components related to technology) may prove to be difficult. However, one component can be explored whilst other components are being added. For example, m-health can be explored and adopted by Healthcare practitioners to provide healthcare services to patients in the digital health innovation ecosystem. Components of innovation and digital ecosystems can also be incorporated. For example, implementing open innovation where ideas are shared not only in a single organisation or context, but within the Namibian context and in the global context and intellectual property rights, in which ownership of ideas and knowledge remains with the producer.

All components needed within the Namibian context have been identified in this study. The Namibian government can thus adopt each component at the correct stage of development.

6.5.4. Guideline 4: Defining the operational environment

Since this platform interconnects patients, individuals, medical professionals, researchers and consultants, both locally and internationally, the operational environment can be deployed in a cloud computing environment, as indicated by KPs in Namibia. The technologies will be deployed on this platform. Seeing that the stakeholders are from different environments, the need arises for a single environment wherein technologies can be accessed. The adoption of the appropriate cloud computing model is essential as applications such as EMRs, EHRs and HISs will need to be deployed in this cloud. For example, if a doctor in Namibia needs a second opinion from a global expert regarding a patient’s diagnosis, the global expert can access the specific patient’s information in the EMR, which is deployed in the cloud. However, issues such as privacy and security need to be addressed to maintain the confidentiality of the relevant information.

6.5.5. Guideline 5: Align the existing healthcare applications with the new digital health applications

At this point in time public and private health institutions have their own systems. New digital health applications, developed to service the digital health innovation ecosystem, will need to interact with existing systems. Interoperability can be achieved when new digital applications are developed in such a way that patient health information (stored in existing Namibian health institution systems) can be accessed. Information does not need to be duplicated, hence continuing the work flows. Interoperability can be achieved through the introduction of e-health interoperability standards for e-health systems. The governing body of health institutions in Namibia, in conjunction with global experts in interoperability standards, can select which e-health interoperability standards to deploy.

6.5.6. Guideline 6: Review, monitoring and ethics

The government of Namibia should devise polices to ensure that activities taking place within the digital health innovation ecosystem are reviewed and monitored. These policies, as determined by the Namibian government, should include: assessing the productivity and benefits of activities carried out and identifying the challenges encountered in the ecosystem. The period at which the review and monitoring should occur can be either annually, or biannually. Those individuals, or organisation/s, responsible for carrying out the review and monitoring should also be identified in the policy.

As a means of controlling access to information and how information is shared within the digital health innovation ecosystem, ethical guidelines should be defined.

6.6. SUMMARY

This chapter provided the results of the validation of the intermediate Namibian *Digital Health, Innovation* and *Digital Ecosystem* by global experts. The chapter also presented the strategies which need to be put into place for *Digital Health* to be established in Namibia, the perceived benefits of *Digital Health* to the Namibian context and the potential stakeholders of the Namibian *Digital Health Innovation Ecosystem,* as presented by global experts. The final *Digital Health Innovation Ecosystem Framework* is presented.

CHAPTER 7. CONCLUSION, REFLECTION AND RECOMMENDATIONS

7.1. INTRODUCTION

Chapter 6 completed Phase 3 of this study which entailed validating the intermediate *Digital Health Innovation Ecosystems Framework* by global experts and the development of the final framework. The findings from Chapter 6 provided relevant information towards refining the intermediate framework and the development of the final framework. Chapter 6 also provided guidelines for implementing a *Digital Health Innovation Ecosystem* in the Namibian context. This chapter summarises and concludes the research project.

The next section provides an overview of Chapter 7.

7.2. OVERVIEW OF CHAPTER 7

The research overview is presented in section 7.3. Reflections on the research questions and research objectives are provided in section 7.4. A summary of the research methodology is presented in section 7.5. Evaluation of the research study is presented in section 7.6. The contribution made by the study is explained in section 7.7. Limitations of the study are presented in section 7.8 and future research is elaborated on in section 7.9. Personal reflections are explained in section 7.10. Lesson learnt are shared in section 7.11 and section 7.12 concludes the chapter.

7.3. RESEARCH OVERVIEW

This thesis consists of seven chapters. Chapter 1 provided an overview of the research, highlighting the research problem, research questions and research objectives. Chapter 2 explained the research processes which were used in carrying out the study.

Chapter 3 provided a systematic literature review on *Digital Health* innovation ecosystems. Chapter 4 provided a scoping review of *Digital Health* innovation ecosystems in developed, and developing, countries and guidelines for implementing a *Digital Health* innovation ecosystem. The findings from Chapters 3 and 4 led to the development of the initial framework which was compiled in Chapter 5. The initial framework was evaluated by KPs in Namibia and the intermediate framework was compiled in Chapter 5.

Chapter 6 presented the findings from the validation of the intermediate framework and the final framework was presented. The guidelines on how the components of *Digital Health, Innovation* and *Digital Ecosystems* of the final *Digital Health Innovation Ecosystem Framework* can be contextualised for Namibia was also discussed.

7.4. REFLECTIONS ON THE RESEARCH QUESTIONS AND RESEARCH OBJECTIVES

This study aimed to investigate the components of a *Digital Health Innovation Ecosystem Framework* for the Namibian context, which led to the formulation of the main research question: ***What are the components that constitute a framework for a Digital Health Innovation Ecosystem in Namibia?*** The research question was answered in Chapter 6 with the development of the final *Digital Health Innovation Ecosystem Framework*.

The main research question was answered through several sub-research questions and objectives which were listed in Chapter 1 (sections 1.2.2 and 1.2.3).

The first sub-research question is presented below:

- What are the components of *Digital Health, Innovation* and *Digital Ecosystems*?

The first sub-research question aided the following research objective:

- To review the components that constitute *Digital Health*, *innovation* and *digital ecosystems.*

The first sub-research question, and related objective, were answered through the systematic literature review conducted in Chapter 3. From the systematic literature review, the components of *Digital Health*, *Innovation, Digital Ecosystems* were revealed.

The second sub-research question is presented below:

- What does the existing literature communicate about *Digital Health*, *Innovation* and *Digital Ecosystems* in developed and developing countries?

The second sub-research question aided the following research objective:

- To review the evidence from literature of how *Digital Health, Innovation* and *Digital Ecosystems* operate and exist in developed and developing countries.

The second sub-research question, and related objective, were answered in the scoping review conducted in Chapter 4. From the scoping review, the evidence of *Digital Health*, innovation and digital ecosystems in developed, and developing, countries was presented which revealed the components of *Digital Health, Innovation* and *Digital Ecosystems* in developed and developing countries. The initial *Digital Health Innovation Ecosystem Framework* was also provided at the end of Chapter 4.

The third sub-research question is presented below:

- What are the components of *Digital Health, Innovation* and *Ecosystems* relevant to the Namibian context, as identified by KPs in Namibia and globally?

The third sub-research question aided the following research objectives:

- To provide an initial framework (artefact) for a *Digital Health Innovation Ecosystem*.
- To evaluate the initial framework (artefact) for a *Digital Health Innovation Ecosystem* in Namibia by KPs in Namibia.
- To provide the intermediate framework (artefact) for a *Digital Health Innovation Ecosystem* in Namibia.
- To validate the intermediate framework (artefact) for a *Digital Health Innovation Ecosystem* through expert reviews globally.
- To develop the final framework (artefact) for a *Digital Health Innovation Ecosystem* in Namibia, based on the findings from expert reviews globally.

The third sub-research question, and related objectives, were answered Chapter 5. The initial framework was compiled from the findings in Chapters 3 and 4. The initial framework for a *Digital Health Innovation Ecosystem* in Namibia was evaluated by KPs in Namibia which led to the development of the intermediate framework presented in Chapter 5. The components of *Digital Health, Innovation* and *Digital Ecosystems,* as relevant to the Namibian context and identified by KPs in Namibia, were presented in Chapter 5.

The intermediate framework was compiled from the findings discussed in Chapter 5. The intermediate framework for a *Digital Health Innovation Ecosystem* in Namibia was validated by global experts, which led to the development of the final framework presented in Chapter 6. The components of *Digital Health, Innovation* and *Digital Ecosystems,* relevant to the Namibian context and identified by global experts, were presented in Chapter 6.

The fourth sub-research question is presented below:

- What strategies need to be put in place for *Digital Health* to be established in Namibia?

The fourth sub-research question aided the following research objectives:

- Identify strategies to be put into place for *Digital Health* to be established in Namibia based on the findings from experts globally.
- Identify strategies to be put into place for *Digital Health* to be established in Namibia based on the findings from KPs in Namibia.

- Propose guidelines for implementing a *Digital Health Innovation Ecosystem* in developing countries.

The fourth sub-research question, and related objectives, were answered in Chapters 5 and 6. Interviews were conducted with KPs to determine strategies which needed to be put into place for *Digital Health* to be established in Namibia. The findings were presented in Chapter 5. Questionnaires were administered to global experts to determine the strategies which needed to be put into place for *Digital Health* to be established in Namibia. These findings were presented in Chapter 6. The guidelines for implementing a *Digital Health Innovation Ecosystem* in developing countries was proposed in Chapter 4 and guidelines for implementing a *Digital Health Innovation Ecosystem,* within the Namibian context, are also provided at the end of Chapter 6.

7.5. ADOPTION OF DSR GUIDELINES IN THIS STUDY

Although interpretivism and positivism were applied to different phases of the research, pragmatism formed the overall research philosophy of the study. Design science was the chosen methodology to develop the framework. The study provided guidelines of design science research as proposed by Hevner et al. (2004). The adoption of the guidelines in this study is presented below:

1. *Design as an Artefact:* The study identified the components that constitute *Digital Health* innovation ecosystems for the Namibian context. The final artefact is a framework which lists: the components of a *Namibian Digital Health Innovation Ecosystem,* as well as the perceived benefits and the potential stakeholders of *Digital Health* innovation ecosystems for the Namibian context, both locally and internationally. The strategies to be put in place for *Digital Health* to be established in Namibia, were also provided.
2. *Problem Relevance:* The problem identified in this study refers to the lack of information sharing amongst healthcare practitioners, healthcare institutions and patients in the Namibian context. This is as a result of organisational policies and competitiveness amongst healthcare practitioners and health institutions in Namibia.
3. *Design Evaluation:* The framework was refined at different stages, starting at the extensive literature reviews, the evaluation of *Digital Health*, *Innovation Ecosystems* by KPs within the Namibian context through the Delphi study and the validation of the components of *Digital Health, Innovation* and *Digital Ecosystems* by global experts through expert reviews. The final framework incorporated all the changes suggested in each phase.

4. *Research Contributions:* The framework is expected to provide useful insights into the implementation of a *Digital Health Innovation Ecosystem* within the Namibian context.
5. *Research Rigour:* To maintain rigour, different approaches were applied in the study. Firstly, the literature was used to identify components of the concepts: *Digital Health, Innovation* and *Digital Ecosystems*. In order to make the components relevant to the Namibian context, primary data was gathered from the Namibian context through questionnaires and interviews. Questionnaires were also used to gather data from global experts and validate the framework.
6. *Design as a Search:* Some of the research questions were answered using literature reviews to identify relevant components of *Digital Health, Innovation* and *Digital Ecosystems*.
7. *Communication of Research:* The findings of the study have been published in the form of conference papers and book chapters.

Web-based questionnaires, interviews and expert reviews were used as the primary data collection methods, while literature reviews were used as the secondary data collection method.

7.6. EVALUATION OF THE RESEARCH STUDY

The evaluation of a research study is important to determine the trustworthiness of the study. The adoption of the design science guidelines in this study was presented in section 7.5. Evaluation measures of an interpretive study are provided by Oates (2006). These measures were adopted in this study as the evaluation measures also followed an interpretivist approach in different phases of the study and is and presented below:

1. *Credibility:* Multiple data collection methods were applied in this study to ensure creditability.
2. *Dependability:* To ensure dependability of the findings, the multiple data sources were employed through published academic papers, Delphi method and expert reviews. Notes were also taken during the interviews.
3. *Trustworthiness:* To ensure trustworthiness of the findings, KPs in the field of *Digital Health*, innovation and networking within the Namibian context were selected to evaluate the components of *Digital Health, Innovation* and *Digital Ecosystems.* These KPs also provide useful information on which strategies to put into place for *Digital Health* to be established, the perceived benefits of *Digital Health Innovation Ecosystem* in the Namibian context and the potential stakeholders of a *Digital Health Innovation Ecosystem* for Namibia. To validate the findings presented by KPs in Namibia, global experts in the field of *Digital Health, Innovation* and *Digital*

Ecosystems were selected. The global experts also provided useful information on which strategies to put into place for *Digital Health* to be established, the perceived benefits of *Digital Health* innovation ecosystems in the Namibian context and the potential stakeholders of a *Digital Health Innovation Ecosystem* for Namibia. Thus, the findings of the study can be considered trustworthy.

4. *Confirmability:* Questionnaires and interviews were used to confirm the findings from the literature. The feedback from KPs in Namibia and global experts provided useful information which led to the development of the final *Digital Health Innovation Ecosystem Framework.*
5. *Transferability:* This study can be considered transferrable as the findings of the study can be adopted in a similar context.

Design Science evaluation techniques were also applied to evaluate the final framework (section 6.4). Credibility was achieved through the study's adherence to 5 evaluation criteria, as proposed by Oates (2006).

7.7. RESEARCH CONTRIBUTION

The study aimed at developing a framework for a *Namibian Digital Health Innovation Ecosystem*. Design science research was applied in the evaluation and validation of the framework, at different phases. Each phase contributed towards answering the research questions, as posed in section 1.4.1. Both practical and theoretical contributions were made which are described in the following sections.

7.7.1. Practical contribution

The novelty of this research is the compilation of a *Digital Health Innovation Ecosystem Framework* for the Namibian context. The framework consists of components of *Digital Health, Innovation* and *Digital Ecosystems*, strategies to be put into place for *Digital Health* to be established in Namibia, perceived benefits of *Digital Health* innovation ecosystems in the Namibian context and potential stakeholders of a *Digital Health Innovation Ecosystem*. The findings consisted of input from both Namibian and global experts, which can be adopted in evaluating the components of *Digital Health Innovation Ecosystems* in different contexts.

In Namibia, there is no study which identifies the components that constitute a *Namibian Digital Health Innovation Ecosystem Framework,* specifically developed for the Namibian context. Thus, the final *Namibian Digital Health Innovation Ecosystem Framework* provides relevant information regarding the components that constitute a *Digital Health Innovation Ecosystem Framework* for the Namibian context.

The findings of the study could provide useful information to decision makers in the Namibian healthcare sector on the important components to consider when implementing a *Digital Health Innovation Ecosystem*.

The study also provides guidelines to, with approaches for, implementing a *Digital Health Innovation Ecosystem* in developing countries. These guidelines can be applied in different contexts, as well as Namibia.

7.7.2. Theoretical contribution

Locke and Golden-Biddle (1997) believe any research grounded in academic knowledge constitutes a theoretical contribution. The findings of the study were grounded in findings of academic literature, which were accepted and evaluated through academic knowledge, hence contributing to the theoretic knowledge store. Furthermore, the study provided empirical findings, based on the evaluation by KPs in Namibia and the validation of experts globally, hence contributing theoretically.

7.8. LIMITATIONS OF THE STUDY

Despite the study meeting its objectives, there were limitations to the study which need to be noted. This study is limited to identifying components of a *Digital Health Innovation Ecosystem Framework* relevant to the Namibian context. Although guidelines for implementing a *Digital Health Innovation Ecosystem* for the Namibian context were provided, guidelines for implementing *individual* components of the final *Digital Health Innovation Ecosystem* were not provided.

As a result of *Digital Ecosystems* not having been implemented in the Namibian context, KPs who evaluated the components of *Digital Ecosystems* within the Namibian context had a networking background which is similar to a digital ecosystems background (Chang & West, 2006). The concept of *Digital Ecosystems,* and the components identified in this study were, however, explained to the KPs in networking before questionnaires were administered and interviews conducted. This was done to ensure that they were familiar with the terms and they could provide useful information on the subject. The researcher also ensured that only participants who felt comfortable with *Digital Ecosystems,* and who were very knowledgeable in the field of the networking, took part in the study.

The scope of this research is extensive and complex as it involves three already mature domains namely Innovation, Health and Ecosystems. It is acknowledged that not all aspects, constructs, models and components of these domains can be addressed in a single study; however, this body of research endeavours to address these domains from a Digital Health perspective. Although the researcher has tried to limit bias by applying specific types of literature (like systematic literature and scoping reviews, as evident from Chapters 3 and 4), other less accentuated perspectives might be considered more important, depending on *who* is investigating the issues at hand. This study thus presents a high-level overview of what *Digital Health, Innovation* and *Digital Ecosystems* can offer within ecosystem thinking for a developing country like Namibia.

The typical overburdened and understaffed health systems that are presented within developing countries share typical multimorbidities and a historic pathway that obstruct digitisation. The abyss between ideal digital innovations and the real life wicked problems experienced within health systems requires a business interphase. Therefore, the e-health model for developing countries suggested by Drury (2005) can be included as part of a realisation of the implementation of digital health innovation ecosystems in developing countries.

These limitations are thus acknowledged. The following suggestions are made for possible future research.

7.9. FUTURE RESEARCH

A possible area for further study could be the provision of guidelines on how individual components of the *Digital Health Innovation Ecosystem Framework* could be implemented. It would also be interesting to examine implementing the final *Digital Health Innovation Ecosystem Framework* in Namibia, using the guidelines provided in this study. Due to the dearth of digital ecosystems within the Namibian context, future work should be focused on how digital ecosystems can be *introduced* to the Namibian context.

7.10. PERSONAL REFLECTION

This study was born out of a necessity to address the knowledge void regarding the absence of: guidelines which can improve the way healthcare services in Namibia are delivered and administered to patients, the coordination of healthcare services between health institutions and relevant stakeholder irrespective of their affiliation. The *Digital Health Innovation Ecosystem Framework* was thus conceptualised as a potential tool to help in the improvement of healthcare processes within the Namibian context.

7.11. LESSONS LEARNT

From the findings of the study, it is apparent that health institutions in Namibia mostly focus on e-health and health information systems. Other forms of *Digital Health* should be implemented within the Namibian context to improve healthcare delivery services.

From the findings of the study, it is apparent that the concept of "Digital Health" is relatively new within the Namibian context, as such, it is important to have Digital Health educational and training workshops for both patients and healthcare professionals with emphasis on the the value of Digital Health.

Another lesson learnt from this study is that funding needs to be made available for *Digital Health* to be established in Namibia and infrastructure development is crucial to allow for Internet access.

Both medical practitioners and patients should be willing to adapt the use of *Digital Health* technology and so participate in a *Digital Health* innovation ecosystem.

7.12. SUMMARY AND FINAL RECOMMENDATIONS

This chapter provides a summary of the findings of the study and concludes the thesis. Limitations and future research have been presented. A personal reflection on the topic and lessons learnt have been discussed.

It is essential to address innovation commercialisation in Namibia. This entails that documents should be developed and refined to conceptualise regulations, price constraints, limited access to markets and the overall value of commercial markets. The cultural change required, especially in some academic and government institutions, as well as in business, will be enormous if the true potential of Open Innovation is embraced. Regulation comes after innovation and in innovation the focus must be on technology, sustainability and the user to streamline a digital ecosystem. Users must feel, or experience trust, they must change their behaviour, and they must feel that they can control their own access to a system. Their uptake and use are essential for an ecosystem to work, or to be regarded as a sustainable solution. Technology should include components of interoperability, standards, integration of infrastructure, privacy components, big data and a focus on analytics, storage and control of access. For sustainability to work, the value of a system must be shared across groups where there are partnerships, capacity building, training, leadership and governance, and where measurement can refine the true value.

For digital health to contribute towards improved health equality in the Namibian context, the specific challenges of implementing e-Health solutions need to be addressed. Reaching out to, engaging with and empowering low-income populations in urban and rural areas to deliver novel digital health services require highly targeted measures, which will require careful consideration of relatively idiosyncratic conditions. Simple transfer of off-the-shelf technology or solutions will not work, but lead to high failure rates. Success will require local (Namibian) development of innovative solutions that are sensitive to (local) economic, social, cultural and organisational factors, and that are adapted to augment the broader Namibian capabilities in digital health.

It is recommended to consider the Wikiversity approach as a logical next step to support open innovations in digital health domain. Pragmatism was mentioned as the guiding principle of the study, so deriving Open Educational Resources for Wikiversity from the scientific findings is in line with objective of the study.

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APPENDICES

Appendix A

Dear Participant,

The aim of this study is to determine the components that constitute a digital health innovation ecosystem hence contributing towards the development of a framework for a Namibian Digital Health Innovation Ecosystem Framework.

A systematic literature review was conducted to explore the concepts, digital health, innovation and digital ecosystems to identify the components that constitute a digital health innovation ecosystem.

As a result, an initial framework for a digital health innovation ecosystem was developed. However, the components of the digital health can only be useful within the Namibian context once it has been evaluated by knowledgeable professionals like you.

The purpose of this questionnaire is for you to identify and rank relevant components of digital health within the Namibian context. Please note that your contribution is vital to the completion of this study as the findings will help accurately determine which identified digital health component is relevant and useful to the Namibian context to appropriately develop an intermediate framework for a Namibian Digital Health Innovation Ecosystem.

Are you male or female? *

- Male
- Female

What is your age range? *

- 18-25
- 26-35
- 36-45
- 46-60
- Over 60 years

What is your occupation? *

Have you worked on e-health, m-health, or digital health related projects? *

- Yes
- No

If you answered yes to the previous question, how many years of experience do you have in that domain? *

- 1-3 years
- 4-6 years
- 7-10 years
- More than 10 years

In what country do you work? *

Describe your expertise level if you have worked on e-health, m-health, or digital health related projects *

- Expert
- Intermediate
- Beginner

What is your highest level of education? *

- Bachelor
- Masters
- Doctorate
- Other:

Describe your work environment

- University
- Hospital
- Clinic
- Health organisation

Please rank "e-health" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important

- Very Important

Please rank "m-health" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "telemedicine/telehealth/telecare" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Health 2.0 / medicine 2.0" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "wireless health/ wireless sensors" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "internet" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important

- Very Important

Please rank "Genomics / personalized medicine" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "health data exchange" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "mobile connectivity and bandwidth" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "social networking/social media/health and medical platforms" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "computing power and data universe" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important

- Very Important

Please rank "information systems" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "imaging" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "self-tracking (the quantified self)" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "wearable computing / sensors and wearables" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "health information technology" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important

- Very Important

Please rank "Big data" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Cloud computing" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "public health surveillance" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Health promotion strategies" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Electronic medical records" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important

- Very Important

Please rank "Electronic health records" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Gamification" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Interoperability" as a component of digital health relevant to the Namibian context fro 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Health and wellness apps" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Health analytics" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important

- ◯ Very Important

Please rank "Digitized health systems" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "Privacy and security" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Are there any relevant components of digital health which have not been added to the list?

- ◯ Yes
- ◯ No

If your answer to the previous question is yes, what are those components? Please explain why they should be added.

Appendix B

Dear participant

The aim of this study is to determine the components that constitute a digital health innovation ecosystem hence contributing towards the development of a framework for a Namibian Digital Health Innovation Ecosystem.

A systematic literature review was conducted to explore the terms, digital health, innovation and digital ecosystems to identify the components that constitute a digital health innovation ecosystem.

As a result, an initial framework for a digital health innovation ecosystem was developed. However, the components of the digital health can only be useful within the Namibian context once it has been evaluated by knowledgeable professionals like you.

The purpose of this questionnaire is for you to identify and rank relevant components of innovation within the Namibian context.

Please note that your contribution is vital to the completion of this study as the findings will help accurately determine which identified innovation component is relevant and useful to the Namibian context to appropriately develop a framework for a Namibian Digital Health Innovation Ecosystem.

Are you male or female? *

- Male
- Female

What is your age range? *

- 18-25
- 26-35
- 36-45
- 46-60
- Over 60 years

What is your occupation? *

Have you worked on innovation related projects? *

- Yes
- No

If you answered yes to the previous question, how many years of experience do you have in that domain?

- 1-3 years
- 4-6 years
- 7-10 years

- More than 10 years

In what country do you work? *

Describe your expertise level if you have worked on innovation related projects

- Expert
- Intermediate
- Beginner

What is your highest level of education? *

- Bachelor
- Masters
- Doctorate
- Other:

Describe your work environment *

- University
- Hospital
- Clinic
- Health organisation
- Other:

Please rank "process innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "product innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "structure innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "open innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "information technology" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "closed innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "open innovation 2.0" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "innovation network ecosystems" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Triple Helix system" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important
-

Please rank "Quadruple Helix system" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "User innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Intellectual property rights" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Actors" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Capital" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Infrastructure" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Regulations" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Knowledge" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Ideas" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important

- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Interface" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Culture" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Architectural principles" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Collaboration" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Organisational and marketing innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important

- Moderately Important
- Important
- Very Important

Please rank "Technology innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Healthcare innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Teaching" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Influence of government ownership" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Innovation spaces and living labs" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important

- ◯ Important
- ◯ Very Important

Are there any relevant components which have not been added to the list identified above?

- ◯ Yes
- ◯ No

If your answer to the previous question is yes, what are those components?

APPENDIX C

Dear Participants

The aim of this study is to determine the components that constitute a digital health innovation ecosystem hence contributing towards the development of a framework for a Namibian Digital Health Innovation Ecosystem.

A systematic literature review was conducted to explore the terms, digital health, innovation and digital ecosystems to identify the components that constitute a digital health innovation ecosystem.

As a result, an initial framework for a digital health innovation ecosystem was developed. However, the components of the digital ecosystems can only be useful within the Namibian context once it has been evaluated by knowledgeable experts like you.

The purpose of this questionnaire is for you to identify and rank relevant components of digital ecosystems that you feel is relevant to the Namibian context.

Please note that your contribution is vital to the completion of this study as the findings will help accurately determine which identified digital ecosystems component is relevant and useful to the Namibian context to appropriately develop a framework for a Namibian Digital Health Innovation Ecosystem

Are you male or female? *

- ◯ Male
- ◯ Female

What is your age range? *

- ◯ 18-25
- ◯ 26-35
- ◯ 36-45
- ◯ 46-60

- Over 60 years

What is your occupation? *

Have you worked on digital ecosystems related projects? *

- Yes
- No

if you answered yes to the previous question, how many years of experience do you have in that domain?

- 1-3 years
- 4-6 years
- 7-10 years
- More than 10 years

In what country do you work? *

Describe your expertise level if you have worked on digital ecosystems related projects

- Expert
- Intermediate
- Beginner

What is your highest level of education? *

- Bachelor
- Masters
- Doctorate
- Other:

Describe your work environment *

- University
- Hospital
- Clinic
- Health organisation
- Other:

Please rank "Agents" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important

- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Species" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Biological species" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Economic species" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Digital species" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "mobile clients" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important

- A Bit Important
- Moderately Important
- Important
- Very Important
-

Please rank "digital environment" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "interoperability" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "security" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "trust" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "ecosystem-oriented architecture" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important

- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "self-organisation" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "semantic web" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "digital content" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "community" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "technology" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important

- Moderately Important
- Important
- Very Important

Please rank "practice" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "implementation" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "challenges" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Are there any relevant components which have not been added to the list identified above?

- Yes
- No

If your answer to the previous question is yes, what are those components? Please explain why the component(s) should be added

Appendix D

Interview questions

Are there any irrelevant components of digital health, innovation and digital ecosystems you feel should be removed from this list?

If yes, please explain which component(s) should be removed and why

Identify what should happen first for Digital Health in Namibia to work effectively and why? – For digital health experts only

Would you like to be part of a digital health innovation ecosystem? if so how and in what capacity?

Do you think a digital health innovation ecosystem can have value for Namibia? – if so how?

Appendix E

Dear Participant,

The aim of this study is to determine the components that constitute a digital health innovation ecosystem hence contributing towards the development of a framework for a Namibian Digital Health Innovation Ecosystem.

A systematic literature review was conducted to explore the terms, digital health, innovation and digital ecosystems to identify the components that constitute a digital health innovation ecosystem.

As a result, an initial framework for a digital health innovation ecosystem was developed and evaluated by digital health, innovation and digital ecosystems experts in Namibia. However, the components of the digital health can only be useful within the Namibian context once it has been validated by digital health experts like you.

The purpose of this questionnaire is for you to identify and rank relevant components of digital health within the Namibian context.

Please note that your contribution is vital to the completion of this study as the findings will help accurately determine which identified digital health component is relevant and useful to the Namibian context to appropriately develop a framework for a Namibian Digital Health Innovation Ecosystem.

Are you male or female? *

- Male
- Female

What is your age range? *

- 18-25
- 26-35
- 36-45
- 46-60
- Over 60 years

What is your occupation? *

Have you worked on e-health, m-health, or digital health related projects? *

- Yes
- No

If you answered yes to the previous question, how many years of experience do you have in that domain? *

- 1-3 years
- 4-6 years
- 7-10 years
- More than 10 years

In what country do you work? *

Describe your expertise level if you have worked on e-health, m-health, or digital health related projects *

- Expert
- Intermediate
- Beginner

What is your highest level of education? *

- Bachelor
- Masters
- Doctorate
- Other:

Describe your work environment

- ◯ University
- ◯ Hospital
- ◯ Clinic
- ◯ Health organisation

I've invited you to fill in a form:

1

Please rank "e-health" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "m-health" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "telemedicine/telehealth/telecare" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "Health 2.0 / medicine 2.0" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important

- Very Important

Please rank "wireless health/ wireless sensors" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "internet" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Genomics / personalized medicine" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "mobile connectivity and bandwidth" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "social networking/social media/health and medical platforms" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important

- Very Important

Please rank "computing power and data universe" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "information systems" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "imaging" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "self-tracking (the quantified self)" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "wearable computing / sensors and wearables" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important

- Very Important

Please rank "health information technology" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Big data" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Cloud computing" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "public health surveillance" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Health promotion strategies" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important

- ◯ Very Important

Please rank "Electronic medical records" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "Electronic health records" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "Gamification" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "Interoperability" as a component of digital health relevant to the Namibian context fro 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important
- ◯ Very Important

Please rank "Health and wellness apps" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ◯ Not Important
- ◯ A Bit Important
- ◯ Moderately Important
- ◯ Important

- ○ Very Important

Please rank "Health analytics" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ○ Not Important
- ○ A Bit Important
- ○ Moderately Important
- ○ Important
- ○ Very Important

Please rank "Digitized health systems" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ○ Not Important
- ○ A Bit Important
- ○ Moderately Important
- ○ Important
- ○ Very Important

Please rank "Privacy and security" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ○ Not Important
- ○ A Bit Important
- ○ Moderately Important
- ○ Important
- ○ Very Important

Please rank "E-prescription" as a component of digital health relevant to the Namibian context from 1 being not important to 5 being most important

- ○ Not Important
- ○ A Bit Important
- ○ Moderately Important
- ○ Important
- ○ Very Important

Are there any irrelevant components of digital health, innovation and digital ecosystems you feel should be removed from this list?

- ○ Yes
- ○ No

If your answer to the previous question is yes, please state which component(s) should be removed and why?

Are there any relevant components which have not been added to the list identified

above?

- ◉ Yes
- ○ No

If your answer to the previous question is yes, what are those components? Please explain why they should be added.

Identify what should happen first for Digital Health in Namibia to work effectively and why?

Would you like to be part of a digital health innovation ecosystem? if so how and in what capacity?

Do you think a digital health innovation ecosystem can have value for Namibia? – if so how?

Appendix F

Dear participant

The aim of this study is to determine the components that constitute a digital health innovation ecosystem hence contributing towards the development of a framework for a Namibian Digital Health Innovation Ecosystem.

A systematic literature review was conducted to explore the terms, digital health, innovation and digital ecosystems to identify the components that constitute a digital health innovation ecosystem.

As a result, an initial framework for a digital health innovation ecosystem was developed and evaluated by digital health, innovation and digital ecosystems experts in Namibia. However, the components of the digital health can only be useful within the Namibian context once it has been validated by innovation experts like you.

The purpose of this questionnaire is for you to identify and rank relevant components of innovation within the Namibian context.

Please note that your contribution is vital to the completion of this study as the findings will help accurately determine which identified innovation component is relevant and useful to the Namibian context to appropriately develop a framework for a Namibian Digital Health Innovation Ecosystem.

Are you male or female? *

- Male
- Female

What is your age range? *

- 18-25
- 26-35
- 36-45
- 46-60
- Over 60 years

What is your occupation? *

Have you worked on innovation related projects? *

- Yes
- No

If you answered yes to the previous question, how many years of experience do you have in that domain?

- 1-3 years
- 4-6 years
- 7-10 years
- More than 10 years

In what country do you work? *

Describe your expertise level if you have worked on innovation related projects

- Expert
- Intermediate
- Beginner

What is your highest level of education? *

- Bachelor
- Masters
- Doctorate
- Other:

Describe your work environment *

- University
- Hospital
- Clinic
- Health organisation
- Other:

Please rank "process innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "product innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "structure innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "open innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "open innovation 2.0" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "innovation network ecosystems" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Quadruple Helix system" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "User innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Intellectual property rights" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important

- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Actors" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Capital" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Infrastructure" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Regulations" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Knowledge" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important

- Moderately Important
- Important
- Very Important

Please rank "Ideas" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Interface" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Collaboration" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Organisational and marketing innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Technology innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important

- Important
- Very Important

Please rank "Healthcare innovation" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Teaching" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Innovation spaces and living labs" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Research and development" as a component of innovation relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Are there any irrelevant components of innovation you feel should be removed from this list?

- Yes
- No

If your answer to the previous question is yes, please state which component(s) should be removed and why

Are there any relevant components which have not been added to the list identified above?

- Yes
- No

If your answer to the previous question is yes, what are those components?

Would you like to be part of a digital health innovation ecosystem, if so how and in what capacity?

Do you think a digital health innovation ecosystem can have value for Namibia – if so how?

APPENDIX G

Dear Participants

The aim of this study is to determine the components that constitute a digital health innovation ecosystem hence contributing towards the development of a framework for a Namibian Digital Health Innovation Ecosystem.

A systematic literature review was conducted to explore the terms, digital health, innovation and digital ecosystems to identify the components that constitute a digital health innovation ecosystem.

As a result, an initial framework for a digital health innovation ecosystem was developed and evaluated by digital health, innovation and digital ecosystems experts in Namibia. However, the components of the digital ecosystems can only be useful within the Namibian context once it has been validated by digital ecosystems experts like you.

Please note that your contribution is vital to the completion of this study as the findings will help accurately determine which identified digital ecosystems component is relevant and useful to the Namibian context to appropriately develop a framework for a Namibian Digital Health Innovation Ecosystem

Are you male or female? *

- Male
- Female

What is your age range? *

- 18-25
- 26-35
- 36-45
- 46-60
- Over 60 years

What is your occupation? *

Have you worked on digital ecosystems related projects? *

- Yes
- No

if you answered yes to the previous question, how many years of experience do you have in that domain?

- 1-3 years
- 4-6 years
- 7-10 years
- More than 10 years

In what country do you work? *

Describe your expertise level if you have worked on digital ecosystems related projects

- Expert
- Intermediate
- Beginner

What is your highest level of education? *

- Bachelor
- Masters
- Doctorate
- Other:

Describe your work environment *

- University
- Hospital
- Clinic
- Health organisation
- Other:

Please rank "Biological species" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important

- Important
- Very Important

Please rank "Economic species" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "Digital species" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "mobile clients" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "digital environment" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "interoperability" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important

- Important
- Very Important

Please rank "security" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "trust" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "ecosystem-oriented architecture" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "self-organisation" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "semantic web" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important

- Very Important

Please rank "digital content" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "community" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "technology" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "practice" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "implementation" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "measures for addressing challenges" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Please rank "cloud computing" as a component of digital ecosystems relevant to the Namibian context from 1 being not important to 5 being most important

- Not Important
- A Bit Important
- Moderately Important
- Important
- Very Important

Are there any irrelevant components of digital ecosystems you feel should be removed from this list

- Yes
- No

If your answer to the previous question is yes, please state which component(s) should be removed and why

Are there any relevant components which have not been added to the list identified above?

- Yes
- No

If your answer to the previous question is yes, what are those components? Please explain why the component(s) should be added

Would you like to be part of such an ecosystem, if so how and in what capacity? Do you think a digital health innovation ecosystem can have value for Namibia – if so how?

APPENDIX H

UNISA university of south africa

INFORMED CONSENT FORM

My name is Gloria E. Iyawa and I am a Doctorate student in the School of Computing, College of Science, Engineering and Technology at the University of South Africa (UNISA), conducting research under supervision of Professor Marlien Herselman and Professor Adele Botha. I am inviting you to participate in the follow-up interviews. I have purposively selected knowledgeable professionals in the field of digital health, innovation and networking and you became one of the selected experts and your participation during the interview session would be greatly appreciated.

My research is titled “A Namibian Digital Health Innovation Ecosystem Framework”, and is aimed at investigating the components that constitute digital health innovation ecosystems framework for the Namibian context. The aim of this interview is to identify relevant information on digital health, innovation and digital ecosystems. The interview session is expected to take approximately one hour though you might decide to terminate it at any time and you are free to respond to questions you feel you’re free to do so.

With your permission, I will audiotape and take notes during interview which will be transcribed later for the purpose of data analysis. If you choose not to be audiotaped, I will take notes instead. If you agree to being audiotaped but feel uncomfortable at any time during the interview, I can turn off the recorder at your request, if you don’t wish to continue, you can stop the interview at any time.

I would like to assure you that this study has received approval by University of South Africa’s College of Science, Engineering and Technology ethical clearance committee.

Your participation in this study is **voluntary**; you are under no obligation to participate. You may **withdraw** at any time without prejudice or penalty. To maintain anonymity names and any information from which identities could be inferred will not be included and the transcribed data will be coded. No individual identities will be used in any reports or publications resulting from the study.

The completed study will be reported in aggregate. **Confidentiality** and **anonymity** will be maintained, and only the researcher will have access to the study data and information. Feel free to make comments during interview sessions. There will not be any identifying names on notes taken and your names and any other identifying details will never be revealed in any publication of the results of this study. All data collected will be stored in a secure place (locked cabinet) and will be destroyed in three years. As with all research, there is a chance that confidentiality could be compromised; however, we are taking precautions to minimize this risk.

If you would like to know the results of this research or you have any questions about the research, please feel free to contact Professor Marlien Herselman on +27128413081, or Professor Adele Botha on +27128413265 or myself, (Gloria E. Iyawa) on +264814545413 or my email address gloria.iyawa@gmail.com. Should you have any comments or concerns resulting from your participation in this study, please contact Prof Ernest Mnkandla (mnkane@unisa.ac.za) or call him on +27 11 670 9059.

Thanking you in advance for your cooperation. Your help is greatly appreciated.

Declaration:

I have read this letter of consent and voluntarily consent to participate in this study.

Name: ______________________________

Signature: ____________________ Date: ____________________

Witness (Signature): ____________________ Date: ____________________

Researcher: ____________________ Date: ____________________

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

UNISA | college of science, engineering and technology

Dear Ms Gloria Ejehiohen Iyawa (50862979)

Date: 2015-08-26

Application number: 090/GEI/2015/CSET_SOC

REQUEST FOR ETHICAL CLEARANCE: (Towards Developing an Online Healthcare Framework for Integrating Patient Health Information in Developing Countries: A Namibian Context)

The College of Science, Engineering and Technology's (CSET) Research and Ethics Committee has considered the relevant parts of the studies relating to the abovementioned research project and research methodology and is pleased to inform you that ethical clearance is granted for your research study as set out in your proposal and application for ethical clearance.

Therefore, involved parties may also consider ethics approval as granted. However, the permission granted must not be misconstrued as constituting an instruction from the CSET Executive or the CSET CRIC that sampled interviewees (if applicable) are compelled to take part in the research project. All interviewees retain their individual right to decide whether to participate or not.

We trust that the research will be undertaken in a manner that is respectful of the rights and integrity of those who volunteer to participate, as stipulated in the UNISA Research Ethics policy. The policy can be found at the following URL:
http://cm.unisa.ac.za/contents/departments/res_policies/docs/ResearchEthicsPolicy_apprvCounc_21Sept07.pdf

Please note that the ethical clearance is granted for the duration of this project and if you subsequently do a follow-up study that requires the use of a different research instrument, you will have to submit an addendum to this application, explaining the purpose of the follow-up study and attach the new instrument along with a comprehensive information document and consent form.

Yours sincerely

Prof Ernest Mnkandla
Chair: College of Science, Engineering and Technology Ethics Sub-Committee

Prof IOG Moche
Executive Dean: College of Science, Engineering and Technology

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