POSSIBLE FUTURES OF HEALTH TECHNOLOGIES FOR SOUTH AFRICA TOWARDS 2035

by

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Research proposal submitted in partial fulfilment requirements for the degree of Master in Business Administration (MBA) in the Faculty of Business and Economics Management (Graduate School of Business) at the Nelson Mandela University.

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Supervisor: Professor Christian Adendorff

Degree of confidentiality: A

DECLARATION

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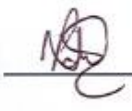
SIGNATURE: 

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I would like to express my sincere appreciation to everyone who contributed toward the completion of this study. In particular, I would like to thank:

- The Creator, who made it all possible;
- My husband, who made this journey all the more interesting by coming along for the ride and for his consistent support and encouragement;
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- My MBA group members and classmates for the memories and camaraderie, and last but not least,
- Professor Christian Adendorff, for his guidance through the completion of this treatise and for his exceptional insight and inspiring wisdom

ABSTRACT

Purpose – The purpose of this treatise is to develop four alternative scenarios for Possible Futures of Health Technologies for South Africa towards 2035. A desired future in the form of a future vision will be presented as well as recommendations made to the relevant decision-making stakeholders for implementation.

Approach – This study employs a futures studies methodology known as the Six Pillars used in mapping the present and future, further deepening and broadening the future through the development of scenarios, and lastly, transforming the future by tapering it down to the preferred vision. The four scenarios in this study are informed by current affairs, a qualitative study with industry experts as well as global views and research. The scenarios are as follows: 'Health Technology Hub', which is the 'best case' scenario, to which the country aspires; 'Medicating Backwards', the 'worst case' scenario, in which everything turns negative; 'Frozen Revolution', in which no change occurs, making it 'business as usual' and 'Trans-humans', the outlier future based on a disruptive or emerging issue.

Practical implications – The way the world works is changing rapidly due to disruptive technologies. Demographic shifts such as the high birth rate in Africa will bring about opportunities for the economy. Health technologies, for this study, is regarded as the application of knowledge and skills in the form of devices, medicines, vaccines, procedures and systems as well as the convergence of digital technologies with health to improve the efficiency of healthcare delivery, solve health issues, offer personalised medicines and improve the quality of lives. Technologies such as artificial intelligence (AI), virtual reality (VR), Internet of Things (IoT), 3D printing, robotics, nanotechnology are seen as the next disruptors. Healthcare in Africa is under pressure to transform, and future trends that stem from the Fourth Industrial Revolution will need to provide innovative, affordable, accessible, good quality, efficient and sustainable solutions. Along with these technologies comes the factors such as the fear of the impact on jobs, inequality, privacy, security and healthcare in South Africa.

The outcomes of the extensive analysis of futures studies in this study provide credibility to the argument that current planning for the future of health technologies in South Africa needs intense modifications. The development of insightful plausible futures is essential to the planning process and is seen to be an effective strategic tool employed by businesses. It is the responsibility of private and public sectors to ascertain which path is preferred and what decisions need to be made to ensure that vision is realised and that SA progresses toward economic growth and sustainable development. The 'Future Vision of Health Technologies in South Africa Towards 2035' is attainable if all stakeholders agree to work collaboratively, communicate transparently, educate the people of the land, regulate appropriately, build trust, increase innovation, include communities and share the purpose.

Keywords – Futures studies, health technologies, South Africa, Six Pillars, scenarios, vision, strategic, sustainable

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SUPERVISOR(S) — **DATE** 7 May 2018

HEAD OF DEPARTMENT — **DATE** 08 August 2018

STUDENT(S) — **DATE** 04 April 2018

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4 December 2018

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Editor's letter

I hereby state that I have proofread and edited the above mentioned student's thesis in its entirety, excluding the Appendices. I have not attended to formatting the text. Neither have I worked on the Table of Contents, List of Figures and List of Tables.

I have made a number of suggestions regarding the content of the text and also of the cited references and the References section. I have left it up to the student to accept or reject my suggestions and to make the final necessary changes by herself.

Yours faithfully,

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1 CHAPTER ONE: RESEARCH P ROPOSAL

1.1. INTRODUCTION

Russian economist, Nikolai Kondratieff in the 1930's, suggested that long-term behavior moves in a long wave-like manner which we now refer to as "K-waves" that run on a cycle of about 60 years (Kondratieff, 1979; Wilenius & Casti, 2015). Each wave is moved by a dominant technology which results in changes both economically and society of the technology from the previous wave (Kondratieff, 1979). Each new wave has been linked to some major economic crisis and the sixth wave which has just started revolves around smart technologies and making human lives better (Wilenius & Casti, 2015).

EYQ (2016) discusses the way the world is changing and has changed thus far due to disruptive technologies. The key megatrends or driving forces in the healthcare sector are technology and healthcare innovation, globalisation, politics, demographic shifts, dissatisfactory and universal provision of healthcare (Deloitte, Iraiyatulsit, & Van der Laan, 2016; Ernst & Young Global, 2017). The information technology (IT) revolution has allowed for the creation of new industries, customer empowerment and has made sharing of knowledge popular. Discontinuity comes from the inability to predict based on the past with all the disruptive technologies that are coming into play (Deloitte et al., 2016). Demographic shifts such as the high birth rate in Africa will bring about opportunities for the economy while the aging population will change healthcare needs (Ernst & Young Global, 2017). Current policies will not work for the future of healthcare and thus needs to be revised taking into consideration public and private entities (Deloitte et al., 2016). Universal Healthcare (UHC) is a solution to the issues of healthcare globally but is it and when will it be achievable (Deloitte et al., 2016)?

The World Health Organisation (WHO) defines health technologies as "the application of organised knowledge and skills in the form of devices, medicines, vaccines, procedures and systems developed to solve a health problem and improve quality of lives" (Blythe et al., 2018). For the purposes of this study, included in that definition of health technologies is digital health which refers to the convergence of digital

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LIST OF ACRONYMS AND ABBREVIATIONS

3D	Three-dimensional
AI	Artificial Intelligence
AIDS	Acquired Immune Deficiency Syndrome
AR	Augmented reality
BRICS	Brazil, Russia, India, China, South Africa
CIFS	Copenhagen Institute for Future Studies
CLA	Causal Layered Analysis
CSIR	Council for Scientific and Industrial Research
EHR	Electronic Health Record
EIA	Emerging Issues Analysis
ES	Environmental Scanning
FDA	Food and Drug Administration
FTA	Future-oriented technology Analysis
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
HIV	Human Immunodeficiency Virus
HPRS	Health Patient Registration System
IBER	Integrated Burn Electronic Record and Registry
ICT	Information and Communications Technology
IoT	Internet of Things
IP	Intellectual Property
IR	Industrial Revolution
IT	Information Technology
M&A	Mergers and Acquisitions
NACI	National Advisory Council on Innovation
NDoH	National Department of Health
NHI	National Health Insurance
NGO	Non-Governmental Organisation
NDP	National Development Plan

OECD	Organisation for Economic Cooperation and Economic Development
PLC	Programmable Logic Controller
PPPs	Public Private Partnerships
PWC	Price Waterhouse Cooper
R&D	Research and Development
RFID	Radio-Frequency Identification
SA	South Africa
SDGs	Sustainable Development Goals
SKA	Square Kilometre Array
STEM	Science, Technology, Engineering and Mathematics
Tn	Trillion
VR	Virtual Reality
WEF	World Economic Forum
WHO	World Health Organisation
UHC	Universal Healthcare
UN	United Nations
UNDP	United Nations Development Programme
US	United States

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1 CHAPTER ONE: RESEARCH PROPOSAL

1.1. INTRODUCTION

Russian economist, Nikolai Kondratieff in the 1930's, suggested that long-term behaviour moves in a long wave-like manner which we now refer to as "K-waves" that run on a cycle of about 60 years (Kondratieff, 1979; Wilenius & Casti, 2015). Each wave is moved by a dominant technology which results in changes, both economically and socially, of the technology from the previous wave (Kondratieff, 1979). Each new wave has been linked to some major economic crisis and the sixth wave, which has just started, revolves around smart technologies and making human lives better (Wilenius & Casti, 2015).

Schreiber (2016) discusses the way the world is changing and has changed thus far due to disruptive technologies. The key megatrends or driving forces in the healthcare sector are: technology and healthcare innovation, globalisation, politics, demographic shifts, discontinuity and universal provision of healthcare (Deloitte, Inayatullah, Van der Laan, 2016; Ernst & Young Global, 2017). The information technology (IT) revolution has allowed for the creation of new industries along with customer empowerment and has made sharing of knowledge popular. Discontinuity comes from the inability to predict based on past events due to all the disruptive technologies that are coming into play (Deloitte et al., 2016). Demographic shifts such as the high birth rate in Africa will bring about opportunities for the economy while the aging population will change healthcare needs (Ernst & Young Global, 2017). Current policies will not work for the future of healthcare and thus these policies need to be revised taking into consideration public and private entities (Deloitte et al., 2016). Universal Healthcare (UHC) is a possible solution to the issues of healthcare globally but is and when, will it be achievable? (Deloitte et al., 2016)

The World Health Organisation (WHO) defines health technologies as "the application of organised knowledge and skills in the form of devices, medicines,

vaccines, procedures and systems developed to solve a health problem and improve quality of lives" (Mytton; Velazquez; Banken; Mathew; Ikonen; Taylor; Painter; Jean-Baptiste; Poon & Ruelas, 2010; p1). For the purposes of this study, included in that definition of health technologies is digital health, which refers to the convergence of digital technologies with health to improve the efficiency of healthcare delivery and offer personalised medicines (Sonnier, 2018).

The vision for 2030 for South Africa (SA) included in the National Development Plan (NDP) speaks of the drastic change needed in efficiency, equity, effectiveness as well as the quality of healthcare in the country (Bodnar & Lohr, 2004). The Department of Science and Technology (DST) has implemented programmes, one of which is in Biotechnology and Health Innovation, to inspire research and innovation in those particular areas (NPC, 2010). Investing in health interventions as well as systems is vital for South Africa. Affordable solutions are available using modern medicine, and better treatments are possible and should be developed to enable SA to achieve the benefits of a healthier country (Adendorff, 2013). Antunes and Canongia (2006) list artificial intelligence (AI), virtual reality (VR), Internet of Things (IoT), three-dimensional (3D) printing, robotics, nanotechnology and the sharing economy which fall under the Fourth Industrial Revolution, as the next disruptions to industries. Looking towards the future allows for the identification of opportunities and priorities as well as stakeholder and trends relationship analyses through scanning (Antunes & Canongia, 2006).

1.2. PROBLEM STATEMENT

Healthcare in Africa is under pressure to transform, and future trends that stem from the Fourth Industrial Revolution will need to provide innovative, affordable, accessible, good quality, efficient solutions. Technological innovation within the healthcare space is being highlighted due to the increased number of people who have a longer lifespan and those affected by non-communicable diseases (IOL, 2017). Tan and Ong (2002) agree that the use of new technology in the healthcare sphere is rising and believe that the benefits of these improvements outweigh their

disadvantages. Although it might be expensive initially, if it can improve lives, prevent disability and increase productivity, it is worth the cost (Tan & Ong, 2002). The question therein is will SA take advantage of this or be left behind, and what does it need to do to produce a desired future in healthcare?

In September 2015, the United Nations (UN) and world leaders adopted the 17 Sustainable Development Goals (SDGs) with an action plan for implementation up to 2030. The goals include, among other items: Good health and well-being; Industry, innovation and infrastructure along with Sustainable cities and communities (United Nations, 2018)**.** This is in line with SA's NDP which speaks of the change needed in efficiency, equity, effectiveness as well as the quality of healthcare (Bodnar & Lohr, 2004). Under these plans, it seems that health technologies will be a major contributor to realising these goals.

Competition is continuously growing and forces adaptations and modifications to be undertaken in all industries. Innovation, science and technology are the main factors affecting competition in developing economies (Antunes & Canongia, 2006). Governments and companies are expected therefore to invest in technology training and development as well as to use scanning and foresight tools to assist in formulating strategies (Antunes & Canongia, 2006). The consensus according to Wilenius and Casti (2015), is that the Earth is facing a higher demand than ever before, and scarcity of resources is a concern into the future. When looking at the Kondratieff long wave theory, the sixth wave is meant to speak to the need for economic growth and social cohesion around intelligent systems that allows for the more effective use of resources and meaningful lives (Wilenius & Casti, 2015). According to Serrano-Cinca, Fuertes-Callén and Mar-Molinero (2005), there is agreement in that human well-being needs to be the focus for economic growth. The Global Competitive Index (GCI) 2017-2018 also shows that SA has dropped in its ranking, moving from 47th to 61st and therefore needs to put in work in order to improve in this area (Schwab, 2017). It is important to note that two of the pillars of the GCI are innovation and health (Serrano-Cinca et al., 2005).

The three areas for improvement noted in healthcare would be expanding access, managing costs and improving quality (Ernst & Young Global, 2017). One of the

main building blocks in healthcare systems is “medicines, vaccines and technology” but there seems to be a lack of recognition of this fact and inadequate support towards them (Health Systems Trust, 2013). In the report, South African Health Review 2017, the view is that if a patient is unable to get access to drugs or vaccines, this is considered a failure of the health system in its entirety. SA thus needs to invest in solutions that will prevent these types of situations from occurring.

SA is faced with the burden of many diseases. Health policies and legislation in this area however, have not been very productive. The White Paper on the National Health Insurance (NHI) was meant to provide some clarity on the changes to legislation that will be made but we have not been able to achieve this (Ridde & Morestin, 2011). The Medical Innovation Bill is still not passed by parliament and the South African Health Products Regulatory Authority (SAPHRA) is not fully functional as yet, thus producing negative implications for the progress of the country in this field. This raises the concern as to the ability of the government to implement the necessary legislation to adopt these health technologies in the applicable manner.

Technological innovations have been seen to enhance productivity, create new markets and jobs but there are many concerns around them leading to increased unemployment as the ‘machines take over’, lower wages and increased inequality as the gap between the technology owners and the workers widens (Bruckner, LaFleur, & Pitterle, 2017). Lower-skilled jobs are expected to be more affected by these smarter technologies, but there are rules to follow and regulations to be created, especially when it comes to healthcare. Labour market elasticity and worker security are needed to ensure shared success (Serrano-Cinca et al., 2005). According to statistics stated by Smith (2017), millions of South Africans, around 29% of the total, cannot afford proper food, healthcare and other essentials. On the other hand, the rich keep increasing their wealth with statistics showing average earnings of the top 200 incomes in SA enlarged from R16.6m in 2007 to R20.8m in 2015 (Smith, 2017). Caution is needed when looking at how to get the benefit from these technologies but not make the inequality issue worse.

As much as the potential of health technologies can be seen, the challenge lies in implementation in a developing country. An example is the mobile health

technologies that are available. Although they have received uptake, mainstream adoption has not occurred due to the lack of credibility and other supporting mechanisms like rebates from insurance companies and so forth (Ernst & Young Global, 2017).

Due to the strict regulations around data privacy and security in the healthcare sector, the advancement of digital health is suppressed (Ernst & Young Global, 2017). According to Van De Belt, Engelen, Berben and Schoonhoven (2010), the definition of Health 2.0 is still blurry but, more often than not, and for this study, it involves the use of improved internet and communication in the realm of healthcare. Health 2.0 requires the integration of data which will only be attained through concerted effort in terms of collaborations and appropriate platforms (Ernst & Young Global, 2017).

This study will investigate the drivers for the future of healthcare in SA as well as surrounding ideas and aspects. It will provide the current state of affairs in the country around policies, infrastructure, workforce, public-private partnerships, government's role and inequality. The study will also look at what is happening globally in terms of health technology trends and where Africa and developing or low to middle income countries stand in terms of progress and implementation of health technologies. It will also delve into complications as well as opportunities for SA in this sector into the future.

Looking at futures studies, in particular, Inayatullah's methodologies and scenario planning techniques will be used to provide insight into the health technology industry in SA. Different futures will be explored and this study will aim to provide a guide on what SA needs to do in order to get to the desired future in terms of affordable, good quality, efficient healthcare using health technologies and a sustainable way forward. Malcolm X has stated so aptly, "The future belongs to those who prepare for it today" (Sibeko, 2018).

Based on the context above, the **main research problem** for this paper is:

Globally, there is recognition of the focus that needs to be placed on health technologies and the impact that it has had and will have going forward.

However, a less developed country like South Africa faces many challenges that may hinder it from fully enjoying the benefits of such technological innovation and this may in turn have a negative effect on the goals and sustainability of the country.

1.3. RESEARCH QUESTIONS

1.3.1 PRIMARY RESEARCH QUESTION

The primary research objective to be addressed in this study is: To provide guidance to decision-makers within the healthcare space in SA by investigating the readiness of private and public sectors for health technologies in SA through possible alternative scenarios.

1.3.2 SECONDARY RESEARCH QUESTIONS

The main research problem is further supported by the secondary research questions in Table 1-1 below:

Table 1-1: Secondary Research Questions	
RQ1	What are the factors that need to be considered in determining the readiness of South African businesses for health technologies?
RQ2	What are the potential implications and impact on the South African healthcare market as a result of technology innovation?
RQ3	What are the consequences to the South African economy of not embracing technology in healthcare?
RQ4	What impeding variables exist in the implementation of a preferable future for health technologies in South Africa?

1.4. OBJECTIVES

1.4.1 PRIMARY RESEARCH OBJECTIVE

Based on the main research question, the primary research objective is to gain insight and understanding about the readiness of the South African private and public sectors for health technologies by developing possible alternative scenarios and providing a desired vision and strategies for implementation in SA.

1.4.2 SECONDARY RESEARCH OBJECTIVES

To support the primary objective, the following secondary research objectives in Table 1-2 will be pursued:

Table 1-2: Secondary Research Objectives	
RO1	To conduct an in-depth analysis of the state of health technologies in South Africa and establish whether public and private stakeholders are aware of the potential of this field.
RO2	To consider opportunities as well as threats that will influence the vision of health technologies in South Africa by looking at specific drivers and using them to plot various alternative futures.
RO3	To conduct a survey to determine the level of awareness and interest of applicable stakeholders on the potential of health technologies.
RO4	To analyse South Africa's progress and failure with regards to health technologies.
RO5	To develop a practical set of recommendations for the implementation of health technologies in South Africa and ways to address the main inhibitors.

1.5. CONCEPTUAL RESEARCH FRAMEWORK

The conceptual framework design below in Figure 1-1 describes the extent to which the variables that influence the health technology industry are understood. It also aims to recognise the global trends and standards as well as the nature of technological development and progress in an African context. It includes the development of ideas for a better future for SA.

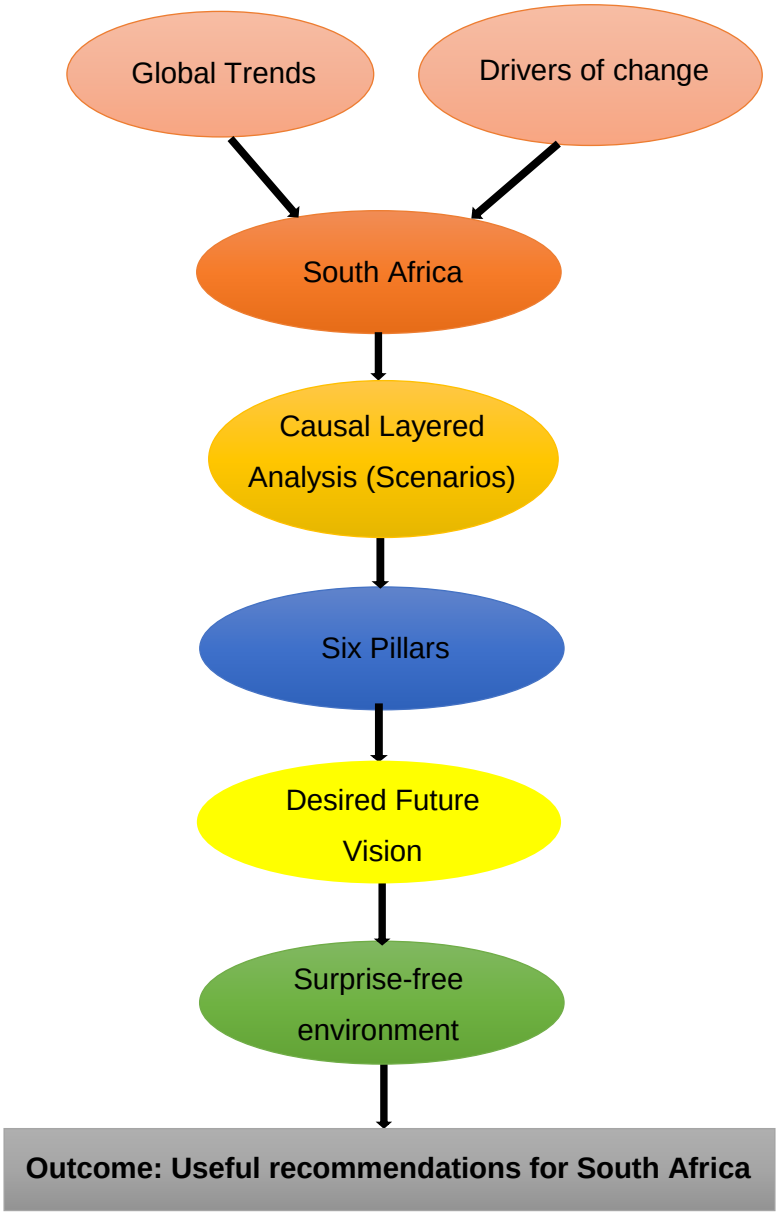

Figure 1-1: Conceptual Framework

Source: Author's own construction (2018)

1.6. RESEARCH DESIGN AND METHODOLOGY

The research method that will be used in this exploratory study is the Six Pillars methodology. Dr Inayatullah elaborates on the method in his paper explaining the different levels and concepts of the technique (Inayatullah, 2008). There are six basic concepts when it comes to futures thinking, those being: “used future, disowned future, alternative futures, alignment, models of social change and uses of the future” (Inayatullah, 2008).

The next level is emergence which refers to a deeper level of thinking and allows for paradigm shifts (Inayatullah, 2008). The final levels are about culture and systems change within an organisation (Inayatullah, 2008). Figure 1-2 below is a diagrammatic representation of the Six Pillars process and the different mechanisms within each level that can be undertaken in order to achieve a successful outcome.

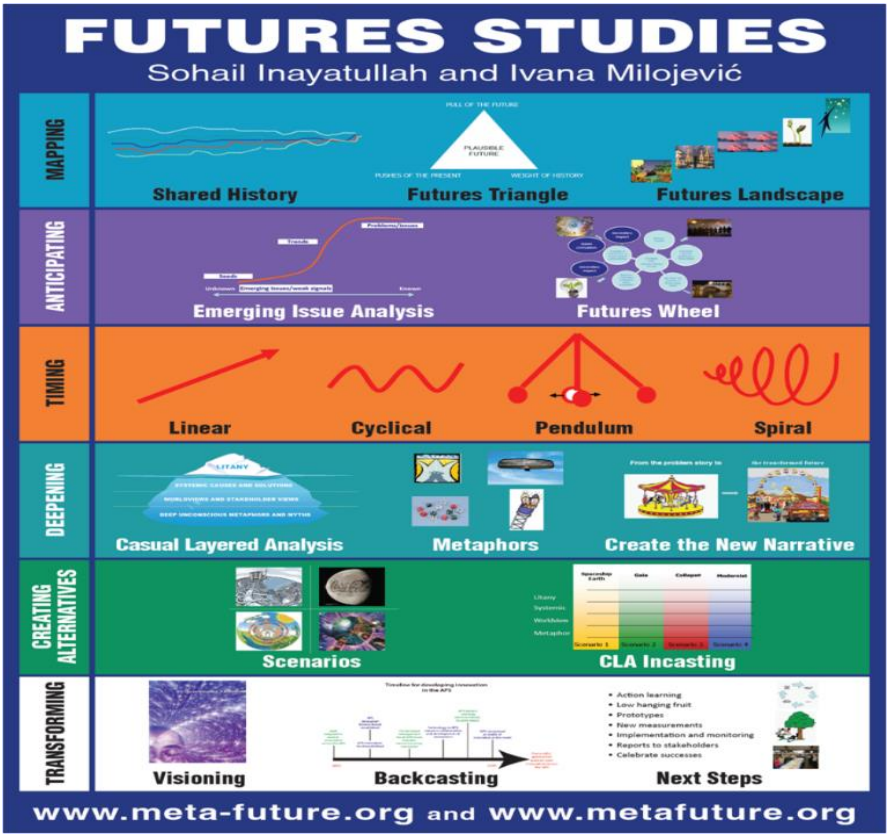

Figure 1-2: Outline of Futures Studies Methodologies

Source: Milojević and Inayatullah (2015)

Within the deepening layer, Causal Layered Analysis (CLA) will be used. CLA is an emerging qualitative methodology adopted in the discipline of planning as an approach to deconstruct complex social issues (Bishop & Dzidic, 2014). A connection lies between the layers and each layer explores a different way of understanding issues (Bishop & Dzidic, 2014). According to Bishop and Dzidic (2014), an analysis within the layers needs to be undertaken with structured questions to allow for alternative futures to be proposed which will require revisioning.

The CLA method has four levels of analysis:

The 'litany' level - the official public description of the issues,

The 'social causes or systems' level - in which some underlying systemic causes are revealed,

The 'world-view or paradigm' level - the analysis is concerned with challenging the deeper assumptions behind the issues, and

The 'myth/metaphor' level - the perspective is rational and the method attempts to separate the irrational (Inayatullah, 1998a).

Scenario planning, which is an inclusive methodology, will be used to improve understanding and cultivate insight into the consequences of the issues and driving forces influencing health technologies.

Thinking about the future and creating possible scenarios is a part of human nature and can be traced over time (Irmak, 2003). Dr Sohail Inayatullah, who is an expert and pioneer in the field of futures studies, has divided it into three research dimensions namely: empirical, interpretive and critical (Inayatullah, 1990). Futures studies remains contentious due to the fact that although people have tried to map it, there is no hegemonic paradigm that defines it (Inayatullah, 1998a). Bell (1997b) states that it is not a futurist's aim to predict the future but to rather create versions of "possible, probable and preferable futures" to enable people to make informed decisions. Futures studies and Future-Oriented Technology Analysis (FTA) involve complicated dynamic systems and processes while engaging numerous

stakeholders to ensure awareness and participation in societal concerns (Kreibich, Oertel, & Wolk, 2011).

Collis and Hussey (2009) state that the research paradigm is the philosophical framework that leads the way in which the research will be conducted. The two main research paradigms are **positivism,** that has principles related to realism, and the other, which is **interpretivism** which relates to principles of idealism (Collis & Hussey, 2009). The ontological assumption of interpretivism is that social reality is subjective and socially constructed which implies multiple realities (Collis & Hussey, 2009). The paradigm that is most closely linked to the qualitative methodology of this research is interpretivism which will be applied in this study.

Saunders, Lewis and Thornhill (2009) explain that planning to explore the data received and develop theories from there that will subsequently relate to the literature is known as an inductive approach. A smaller sample is needed here, unlike with the deductive approach, as the research aims to understand why a certain issue occurs rather than make assumptions and describe what occurs (Saunders, Lewis, & Thornhill, 2009).

Qualitative research methodology involves the collection of primary data through participants' observations, in-depth interviews, document analysis and focus groups (Yilmaz, 2013). This study will take an interpretivistic approach and a qualitative process will be followed in order to gain a beneficial understanding of the issues, strategies and actions that management should follow to solve the problems.

Case studies typically combine data collection methods such as archives, interviews, questionnaires and observations and the selection of these cases is an important aspect of building theory from case studies (Eisenhardt, 1989). The nature of the research process will focus on available case studies to further understand the phenomena. An analysis of case studies, particularly from other developing countries, will be investigated to assist in providing solutions.

Additionally, a literature study will be completed through a variety of sources, which will include books, local and international journals, the internet and other local and international publications.

In-depth, semi-structured interviews will be used to collect data from participants selected from health-related fields. Structured and open-ended questions will be used for the interview, but further questions may evolve after those questions are answered. For the interview purposes, the population will be limited to stakeholders within the healthcare arena from both public and private spheres. The sample will be selected via the judgemental or purposive sampling approach. The sample selected will be based on the expertise and knowledge that these interviewees have, to provide value to the study. A small sample of people (under 10) will be used for this research project as the survey answers are meant to obtain high-level thoughts and opinions from the different sectors. Case studies will also be selected in a critical manner based on the relevance and applicability for this study.

The methodologies are further explained in Chapter Two. The Six Pillars approach will be used to perform the analysis on the data including CLA frameworks, scenario development and visioning to inform the requirements and planning needed towards the desired vision of SA in the heathcare technology field.

This research study therefore follows the path of: identifying the objectives and questions; identifying key driving forces; determining the uncertain key driving forces; selecting key local factors; developing different scenarios; identifying the possible consequences of the different scenarios in SA; testing the policies and checking for consistency; setting a vision for SA in this field; identifying indicators and change factors to enable a surprise-free outcome and thereby developing practical recommendations for SA.

1.7. THE IMPORTANCE AND BENEFITS OF THIS STUDY

SA is not faring well currently, in terms of the Global Competitiveness Index (GCI), as well as in the plans and goals it has set to achieve, especially with regards to healthcare. The point of these goals and plans is to ensure that SA sees economic growth as well as sustainability of the country. According to Australia's National Innovation and Science Agenda, "[e]xtraordinary technological change is

transforming how we live, work, communicate and pursue good ideas. We need to embrace new ideas in innovation and science, and harness new sources of growth to deliver the next age of economic prosperity…", which applies to SA and the rest of the world (Smith & Watson, 2018; p26).

Human life expectancy has increased over the years while poverty, contagious disease and illiteracy are some of the issues that have decreased (Glenn, Millennium, Florescu, Millennium, & View, 2017). It has also been noted that over 3.8 billion people around the world are now able to connect to the Internet. With only one third without a mobile phone and 50% having smart phones, the potential for faster change is enormous (Glenn et al., 2017). The benefits of incorporating technology in the health sector have been seen, and there are numerous possibilities for the future. Some solutions presented by Schreiber (2016) include:

Artificial intelligence (AI) – generally symptoms and test results determine the diagnosis based on theories and rules. The opportunity for AI lies in the ability to diagnose and possibly prescribe based on enhanced algorithms with more accuracy than humans.

Sensors – medical devices, applications on mobile phones, wearables, etc. have started using sensor technology to allow for real-time monitoring. New sensors will have reduced in size, be cheaper and more powerful.

Analytics – currently big data is collected and analysed in healthcare organisations, but the potential of combining those analytics with sensor information is huge with regards to determining drivers and medication adherence for example.

Sharing economy – sharing economic platforms, Airbnb is an example of a company who does this successfully, deploys underutilised assets and this could have use in healthcare when it comes to better usage of excess capacity.

A study undertaken by Wepner and Giesecke (2018), wherein they have developed scenarios around policy options in healthcare in Europe, has been published. Analysis of applicable trends were used to develop possible futures. They arrived at the conclusion that future needs will be different and modifications of policies in

certain aspects are required in order to accommodate and fully utilise the benefits that these changes will provide (Wepner & Giesecke, 2018). The study provides some direction around policy formation but will need to be redirected when it comes to a low-middle income country like SA and this is what this study aims to provide.

A health technology assessment (HTA) system is currently used internationally to assist in identifying and informing decision-making around health technologies. It is meant to look at the impact and effects of such technologies as well as the affordability and social aspects like access and equity (Health Systems Trust, 2013). SA has limited legislature in place currently to support HTA but this may be an opportunity for the country to develop policies aligned with the NHI (Health Systems Trust, 2013). This will be investigated to provide recommendations on what can and should be done with regards to policy formation.

Putzier (2017) has completed a study on the readiness of SA for the Fourth Industrial Revolution and has performed Causal Layered Analysis (CLA) to develop scenarios for the future of SA. It will thus be used intricately, in this study, due to the relevance of the Fourth Industrial Revolution in health technologies. There are however no studies known to the author of futures studies done with respect to the health technologies industry in SA.

Collaboration cross-country has been shown to be an effective way of growing the health technology industry. Governments should provide assistance in linking the players in the innovation space such as research institutions, funding agencies, etc. and provide incentives for the private sector to create partnerships with the public sector to commercialise health technologies for the betterment of the country (Abuduxike & Aljunid, 2012). This will be another aspect that will be covered by looking at case studies from other countries to inform decisions that management should take for a desired outcome.

CLA is a methodology used in futures studies and takes into consideration that everyone has different perspectives and that those are multilayered realities (Inayatullah, 1998a). Moving through the layers (up, down and sideways) and looking into the past, present and future allows for a deeper analysis (Inayatullah,

1998a). The Six Pillars and CLA tools will be used to create possible future scenarios in the health technology industry in a South African context. This study will also create a desired future and recommendations on how it can be achieved.

If SA does not put a plan in place and implement it in order for health technologies to be realised and used appropriately, we may face issues such as an even poorer healthcare system, people immigrating in order to have a better quality of life, health workforce immigrating to find better employment, inadequate supply for the demand and further inequality.

1.8. STUDY OUTLINE

Chapter One provides an introduction and the outline of the study. This chapter provides the research problem, research objectives, research questions and the boundaries of the study. It introduces the health technologies and considers the challenges faced by the public and private sectors. The importance of the study and the research limitations are expressed. This chapter encapsulates the rationale of why this research study is conducted and the manner in which it is carried out.

Chapter Two discusses the research methodology that has been used by the researcher. This includes the research paradigm utilised in the study. The Six Pillars and CLA tools are discussed in detail in this chapter.

Chapter Three focuses on the literature study that will be used in an attempt to understand the research problem. It considers and expands on the global trends and consequences of the health technologies on the South African public and private sectors and examines the disruptive technologies shaping business and economies currently.

Chapter Four shows the first five pillars of the Six Pillars methodology inclusive of the CLA and scenario planning techniques being used to present alternative futures that are plausible.

Chapter Five will suggest an ideal, realisable future for all South African stakeholders through a ‘Future Vision of Health Technologies in SA towards 2035’. The chapter presents a summary of the study’s findings and conclusions, recommendations for management, limitations of the study and highlights of areas for future research.

2 CHAPTER TWO: RESEARCH METHODOLOGY AND DESIGN

2.1. INTRODUCTION

Chapter Two will focus on the research methodologies that are to be used to determine the answers to the research questions. The goal of futures studies is explained as well as the various methods to perform this type of research. CLA as well as the Six Pillars techniques are explained, and details around the usefulness of these methods to this particular research topic are provided. Africa's future possibilities and trends are briefly looked into, and futures studies for SA specifically in terms of health technologies is examined.

2.2. FUTURES STUDIES

Looking into the future implies some theory of social change and such theories began in Europe in the late eighteenth and nineteenth centuries by people like Adam Smith, Karl Marx and Max Weber and thus can be seen as theories of civilisation change (Goonatilake, 2008). These perspectives would have been seen through a particular viewpoint of a certain time and place. Futures studies came about after the Scientifc and Industrial Revolutions and thus revolves around the effects of scientific and technological developments on society (Goonatilake, 2008).

Forecasts and visions are epistemological activities as these are based on some theory of knowledge. Although no knowledge of the future itself is produced, some theories of knowledge do supply synthetic knowledge of a limited number of alternatives (Sardar, 2010). Foresight is the process by which people within an organisation are enabled to create a logical forward view and explore various possible futures (Conway & Voros, 2001). This must not be confused with prediction but rather, it is about informing strategy, guiding policy, detecting harmful conditions and exploring new opportunities. Foresight is demonstrated through futures studies

and in scenario planning. Contemplating the future is innate to humans, but foresight transforms these capabilities to advise organisational planning (Conway & Voros, 2001).

Professor Emeritus, Wendell Bell, of Yale University provided an overview of the theory and methods of Foresight and Futures Studies along with a view of the ethics and philosophy in the field in his book, *Foundation of Futures Studies* in 1997. He offers nine key assumptions and three general assumptions which are meant to be a theoretical base for studies of the future. Futurists wish to study possible, plausible, probable and preferable futures and understand the value in being prepared to a certain extent (Wheelwright, 2005).

The purpose of futures studies is a logical study of the future wherein the foundation is that there are several futures. Futures studies accepts the uncertainties that are embedded and searches for ways in which to guide the changes (Puglisi, 2001). It allows for the systematic exploration, creation and testing of possible as well as desired futures so as to improve decision-making. Futurists are able to call attention to problems and opportunities for leaders and the public (Glenn et al., 2017). Organisations now have to deal with the shift in level of complexity and amount of change in the world, and the only way to stay ahead of the curve is to expand their foresight capacities to avoid becoming obsolete (Conway & Voros, 2001). The image in Figure 2-1 below shows the brief outline of the process of foresight research.

Strategy is positioning of the organisation/industry in the future by outlining a preferred future and, to do so, one needs to understand the different futures possibilities (Conway, 2009). Every person has a worldview which is used to develop mental models about what is relevant and what is not. These judgements are based on assumptions that are deep within and trap people in the past, preventing exploration of changing trends and issues that affect the future (Conway, 2009).

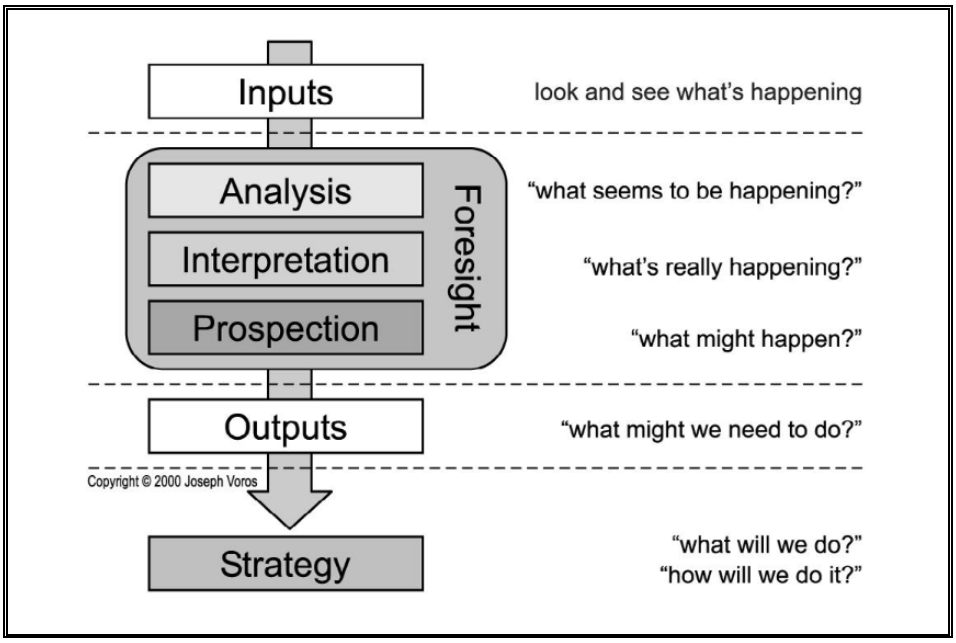

Figure 2-1: Overview of Foresight Methodology

Source: Voros (2005)

Jacque Fresco was an American futurist and worked in a variety of positions related to industrial design and he stated, “In order to design a future of positive change, we must first become expert at changing our minds” (Fresco, 2007; p9). That essentially eludes to the paradigm shift required to undertake futures studies.

2.2.1 CHARACTERISTICS OF FUTURES STUDIES

Concepts such as 'alternatives', 'options’ and 'sustainability' provide the building blocks, once developed and explored, for understanding otherwise elusive ideas about the future with greater clarity (Slaughter, 1996). Images of futures are ubiquitous and are discussed at all levels of society. Language, concepts and metaphors provide the symbolic basis of futures studies and the practitioners provide human, intellectual and application power (Slaughter, 1996). There are four types of futures studies - predictive, interpretive, critical and anticipatory action learning. The first type is built on empirical social sciences; the second is around understanding competing images of the future and not forecasting; the third is derived from poststructural thought and focuses on what futures benefit whom and lastly, the

fourth type focuses on role-players creating a future that is best suited to them based on their assumptions (Inayatullah, 1990, 2012). Critique is extremely important to allow for 'critical futures studies' and forms an internal quality control check (Slaughter, 1996).

Sardar (2010) produced four laws of futures studies namely:

First Law: futures studies are 'wicked' – it tackles 'wicked problems' (complex, interconnected, contradictory, factors placed in uncertain and fast changing environments). These studies do not offer a single solution but only possibilities and they reject the status and state of a discipline;

Second Law: futures studies are Mutually Assured Diversity (MAD) – recognition that there are different ways to be human and therefore different future paths, they offer an appreciation that culture is an essential relational attribute that consists of different knowledge systems, different histories, etc. Epistemology of futures studies is socially constructed as role-players are involved in the future and are obliged to live with the consequences of future outcomes;

Third Law: futures studies are sceptical – they take into account the first two laws and cannot be colonised by a single culture. Thus, they need to be sceptical of simple, one- dimensional solutions and this is in line with 'critical futures studies'; and lastly the

Fourth Law: futures studies are futureless – the impact, value and quality of all futures analyses can only be assessed in the present, as we do not know what the future holds. Futures methodologies like visioning and CLA, have a direct impact on the present, as they work on changing the role-players' perspectives and encourage them to work towards a desired future.

Futures studies compared to planning is longer-term, from five to fifty years, rather than one to five years (Inayatullah, 2012). Futures studies is disruptive, perplexing the current framework, using methods such as Emerging Issues Analysis (EIA) and scenario planning in order to enhance strategy effectiveness by ensuring that the plan is tough and resilient (Inayatullah, 2012).

2.3. METHODOLOGIES AND TECHNIQUES OF FUTURES STUDIES

There are various methods used to study futures namely: Environmental scanning, Delphi, Time series analysis, Visioning, and others. Some of these methods have been used in other disciplines but require a different application when being used for futures studies due to the goal of the outcome required (Puglisi, 2001). Emphasis is placed on allowing researchers to use these methods to uncover and explore plausible futures, but futurists are usually requested to go further to help create plans or strategies to deal with those futures (Wheelwright, 2005). Futures studies may be undertaken independent of the final users, having to present the final results to them or alternatively, to be inclusive of them in a participatory role, ultimately getting their buy-in and assisting them in using the results more effectively (Puglisi, 2001).

Explorative studies examine the future from the present and plausible futures, whereas normative studies investigate the process to reach a specific aim by defining objectives and desirable futures (Puglisi, 2001).

Most foresight processes generally include and integrate a few approaches using different methods at different stages and for different purposes. The final choice of methods is dependent on the context, the budget, time, role-players, etc. A few of the techniques used in futures studies, including the ones that will have been used in this study, will be explained below.

2.3.1 ENVIRONMENTAL SCANNING

Environmental scanning is composed of methodically exploring the external environment so as to understand the nature and speed of change in that environment, as well as to recognise potential opportunities, challenges and future developments (Conway, 2009). The aim of this method is to create information that will allow the development of scenarios. Relevant issues and survey areas need to be defined and trends both past and present should be identified in order to forecast for the future (Puglisi, 2001). This is a long and difficult process and is dependent on the adequate measurement of components of the issue being studied, but is a valuable technique (Bell, 1997a).

2.3.2 SCENARIOS

One of Bell's (1997b) assumptions states that "…future outcomes can be influenced by individual and collective action" and another speaks to the future not being totally predetermined which lends itself to scenario development to provide plausible and preferable futures. Scenarios have been used to assist organisations anticipate and acclimatise to their unpredictable and uncontrollable contexts for years (Kahane, 2010). The scenario tool was used first by militaries, then companies and are now being used by governments and NGOs. It is an amazing way to explore possible futures which include components that cannot be displayed, such as innovations, and hence, are able to include subjective analyses (Puglisi, 2001). The future is unpredictable due to the fact that although people cannot control it, they can influence it (Kahane, 2010). Due to the uncertainty of the future, these scenarios are hypothetical, but this does not render the method invalid as it is vital for forecasting and preparation. Scenarios are meant to allow for dealing with uncertainties and decision-making that is flexible and robust. According to Blyth (2005), if faced with critical decisions that need to be made for the future of an industry, and the business environment is complex and dynamic, then scenarios offer numerous advantages over traditional forecasting techniques.

The Institute for Alternative Futures suggested a standardised set of scenarios for business futures which are as follows: Official Future - Business as Usual; Hard Times; 'Structurally Different' Visionary Leadership and Technological 'Transformation' (Wheelwright, 2005). The fixed matrix system is another popular approach among futurists for scenario development and is limited to four columns representing scenarios of which the rows of the matrix represent the key forces that have been recognized (Wheelwright, 2005).

Scenarios are able to produce four types of results according to Kahane (2010):

- General insights and understanding on what is occurring, what could occur and the implications thereof,
- Relationships and alliances that are stronger among stakeholders across sectors,

- Objectives and commitments that clarify what needs to be done, and
- Innovative actions to create a desired future together.

Once scenarios are formed, they need to be tested, according to Blyth (2005), who poses the questions: Is the scenario plausible to a critical group of managers/decision makers internally and externally to the organisation or industry? Is it internally consistent? Is it relevant to the topic or issue? Is it differentiable from signals of the present? Is it challenging or novel where the organisation's or industry's vision is stretched?

Adendorff (2013) makes special mention that alignment between scenario-based planning and good governed leadership is necessary, especially for developing countries to ensure sustainability. Acknowledgement of the 'wild card' conditions, defined in the book by Ralston and Wilson (2006) as cited by Adendorff (2013), that are of high impact and beyond anyone's control is made to highlight that scenarios could change dramatically. Kahane (2010) notes that scenario processes work due to their unusual nature of being "informal and noncommittal, logical and challenging, inclusive and holistic, collective and constructive, choice-eliciting and generative".

2.3.3 VISIONING

Images of the future determine human behavior and decisions in the present (Bell, 1997b). This method studies the desired futures states and specifically gives values a high importance while requiring the creation of several ideas in order to choose the most appropriate one by using judgmental thinking (Puglisi, 2001). According to Puglisi (2001), the process for building visions is done in six steps as follows:

1. Present problems identification,
2. Past successes recognition,
3. Exploration of wishes for the future,
4. Definition of goals for the future,

5. Identification of the resources that are available and key actors required to fulfil vision, and

6. Vision and action plan construction.

The only way to ensure the implementation of future visions and strategies is through the commitment of stakeholders. Visioning may be used to recognise values, fears, desires and the ambitions of communities (Adendorff, 2013).

2.3.4 FUTURES WORKSHOPS

The goal of futures workshops is to involve the stakeholders in imagining and planning for their future. This exercise allows for people to discuss their interests and it allows synergistic creativity to occur (Puglisi, 2001). Scenarios using a deductive approach is suitable for a workshop as there could be time and other resource constraints (Blyth, 2005).

2.3.5 CAUSAL LAYERED ANALYSIS (CLA)

This method was developed by Inayatullah (1958) and it attempts to deconstruct what is “known” about a present situation and to identify the problem’s social causes as well as its history. This method considers a specific problem or question, seeking a greater understanding of underlying causes of the problem and their roots in the past. The method then reconstructs the collected information into alternative scenarios. The aim of this method is to explore possible futures that have been developed by considering the present and the past and it allows for vertical space in different categories (Inayatullah, 2005). CLA has four main levels of analysis which are as follows:

Litany – study of trends and issues of the future that have disconnected elements,

Social/Systemic Causes– interpretation of qualitative data (social/economic/political/cultural),

Discourse/Worldview – deeper level that deals with debates such as population and consumption, etc. and the role they play in framing issues, and

Myth/Metaphor – deals with the unconscious levels of the problem (Inayatullah, 2005).

The litany level generally looks at quantitative trends or problems that have been presented by the media. This level tends to bring about feelings of apathy, helplessness or projected action and is the level that requires little analytical analysis (Inayatullah, 2005).

The social causes level is where interpretation is provided on quantitative data. The role of the state and actors are investigated at this level, but there is generally no contestation on the framing of issues (Inayatullah, 2005).

The third level discusses the discourse/worldview that supports the issue and the task is to find deeper structures that are not actor-dependent. Efforts to address the issue are key and exploration of the various debates that make up the issue is undertaken at this point (Inayatullah, 2005). Due to the different debates, alternative scenarios can be produced which add the horizontal layer to the analysis (Inayatullah, 2005).

The fourth myth/metaphor layer is made up of deep stories, unconscious, sensitive dimensions of the issue and provides another level to the worldview (Inayatullah, 2005). This level is more concerned with arousing visual images.

Scenarios are different at each of the levels as well as the people responsible for solving the issue. The advantages of this method are based on the greater depth of scenarios and deeper discussion while also being able to separate different perceptions, but they still use horizontal and vertical spaces (Inayatullah, 1998a).

This method is not about predicting the future but about creating alternative futures and is understood to form a part of critical futures research. Each of the dimensions (empirical, interpretive, critical and emerging) makes different assumptions of the real, the truth, the role of subject as well as the nature of the universe and the future (Inayatullah, 1998b). Various epistemological positions are brought in through CLA which provide holistic policies. Deconstruction, genealogy, distance between post structural thought and future studies, alternative pasts and futures and reordering

knowledge are the five crucial concepts of the “post structural futures toolbox” (Inayatullah, 1998b). CLA is dependent on the way in which a problem is framed and thus changes the policy and the actors that create transformation.

2.4. SIX PILLARS OF FUTURES STUDIES

There are six concepts in futures studies: used future, disowned future, alternative future, alignment, models of social change and uses of the future. These are the basis for futures thinking (Inayatullah, 2008). According to Inayatullah (2008), futures thinking allows for a paradigm shift and decolonises the world that people think they want. A conceptual framework known as the Six Pillars approach is often used and each pillar will be discussed further in detail below. The first pillar is “Mapping the future,” wherein the primary method is the futures triangle; the second pillar is “Anticipating the future” using EIA as the central methodology; the third pillar is “Timing the future,” with micro-, meso- and macrohistory; the fourth pillar is “Deepening the future” with CLA; the fifth pillar is “Creating alternatives” using scenario planning and the sixth pillar, “Transforming the future,” uses visioning as one of its methods (Inayatullah, 2007, 2008, 2012).

2.4.1. MAPPING THE FUTURE

In this pillar, the past, present and future are mapped using the Futures Triangle depicted in Figure 2-2 below (Inayatullah, 2008). It assists in giving clarity on where the role-players have come from and where they plan to go. The ‘Shared History’ method allows for main trends and events leading up to the present to be recorded to create a historical timeline which develops a framework to move forward (Inayatullah, 2012). The futures triangle maps views of the future at present three dimensionally and is considered as an environmental scan. Pushes of the present refer to quantitative drivers and trends that are shifting the future, the popular ones are an ageing population, Fourth Industrial Revolution, mobile Internet penetration and so forth (Inayatullah, 2012).

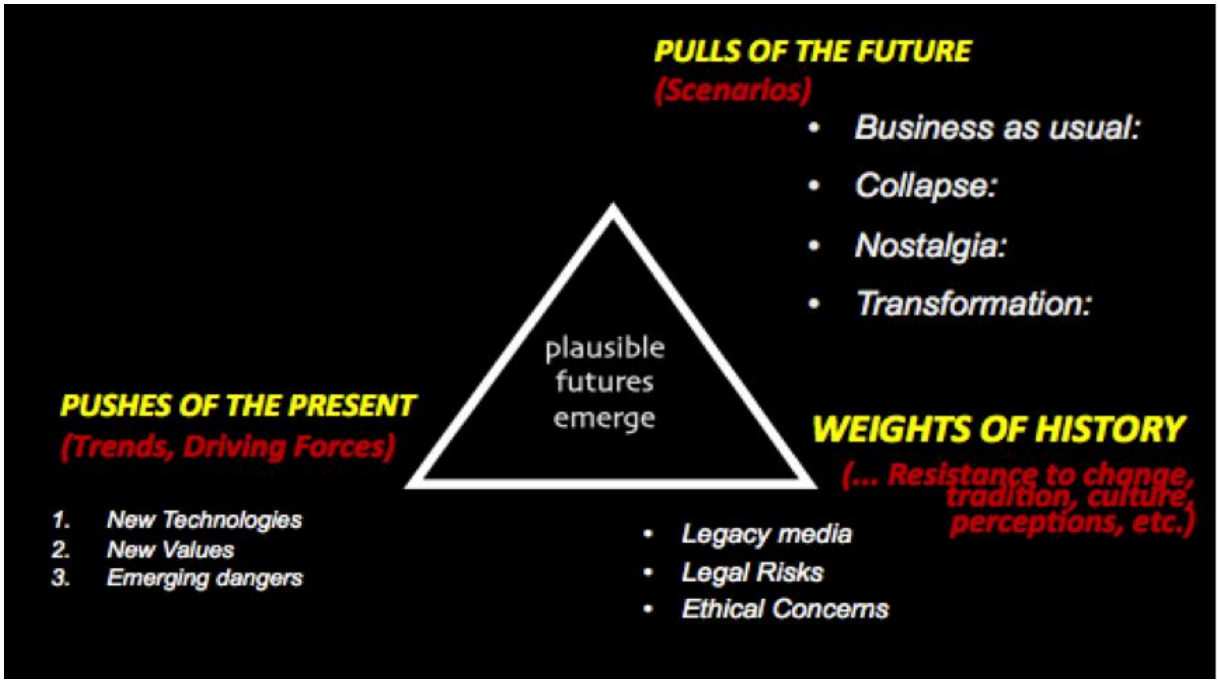

Figure 2-2: The Futures Triangle

Source: TIME magazine (2014)

There are five archetypal images that people tend to gravitate towards when imagining the future possibilities. These would include:

1) Evolution and progress — more technology and man as the focal point of the world; 2) Collapse — humans have exceeded their limits and this ultimately points to a deteriorating future; 3) Gaia — the world is a garden with cultures as its flowers, there is emphasis on repairing the damage caused to humans and to nature; 4) Globalism — the move to a free market system to eliminate barriers and to bring riches to all and, 5) Back to the future — emphasises the need to return to simpler times before technology disruption (Inayatullah, 2008).

Then there are the weights which are barriers to the change needed with each image having a varied weight (Inayatullah, 2008). Analysis of the three forces allows for the creation of a plausible future.

2.4.2. ANTICIPATING THE FUTURE

This pillar deals with EIA to identify bell-weather regions, where new social innovations start (Figure 2-3) (Inayatullah, 2012). It assists in identifying issues before they become unmanageable and costly as well as looking for new possibilities and opportunities (Inayatullah, 2012). EIA minimises harm and assists the role-players to respond to emerging challenges quicker (Inayatullah, 2008).

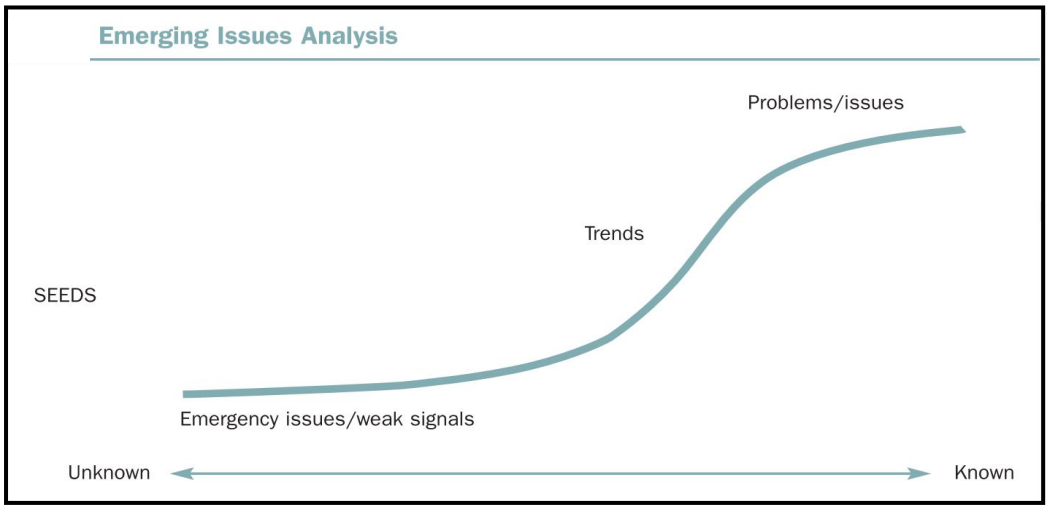

Figure 2-3: Emerging Issues Analysis

Source: Inayatullah (2012)

2.4.3. TIMING THE FUTURE

This pillar speaks to the search for patterns in change along with the stages and mechanisms of long-term change. According to Inayatullah (2008), a number of macro-patterns are critical if one wishes to understand the shape of time:

- The future is linear, has stages and progress lies ahead;
- The future is cyclical, there are both ups and downs and acknowledgement of where one is can lead to more effective strategy and being better placed to decide when and how to act;

- The future is a spiral, in which parts are linear and progress-based with other parts being cyclical. Positive spirals can be developed with good, futuristic leadership;
- New futures are generally pushed by a minority who innovate instead of following the masses;
- Hinge periods in history refer to the action of a few that make a dramatic difference.

At a meso-organisational level, it is only necessary to find the few champions that are willing to transform to start the process. Micro-patterns consist of microtiming which is the unconscious structure people use to imagine their lifecycle and microhistory which is guided by how one sees the stages of life (Inayatullah, 2012). The macro-, meso- and micro-patterns of change need to be used to influence social reality (Inayatullah, 2008).

2.4.4. DEEPENING THE FUTURE

CLA is the method used for this pillar as it seeks to deepen the future through its four levels which are described in a previous section. CLA aims to integrate these four levels of understanding as each level is true and solutions are required for each level (Inayatullah, 2012). Interventions at the first two levels are generally short-term solutions. Efficiency experts intervene, and governmental policies that require public-private partnership arise. Worldview change and myth solutions are much harder and longer term where one needs to look outside the framework, and rewiring of the brain needs to occur respectively (Inayatullah, 2008). There is another method, which is the four-quadrant mapping that was established by Ken Wilber and Richard Slaughter, and it develops the inner dimension of CLA (Inayatullah, 2008). The four quadrants are namely: inner-individual, outer-individual, outer-collective and the inner-collective with descriptions in Figure 2-4 below. Both the CLA and the four quadrant method go together to deepen the future (Inayatullah, 2012).

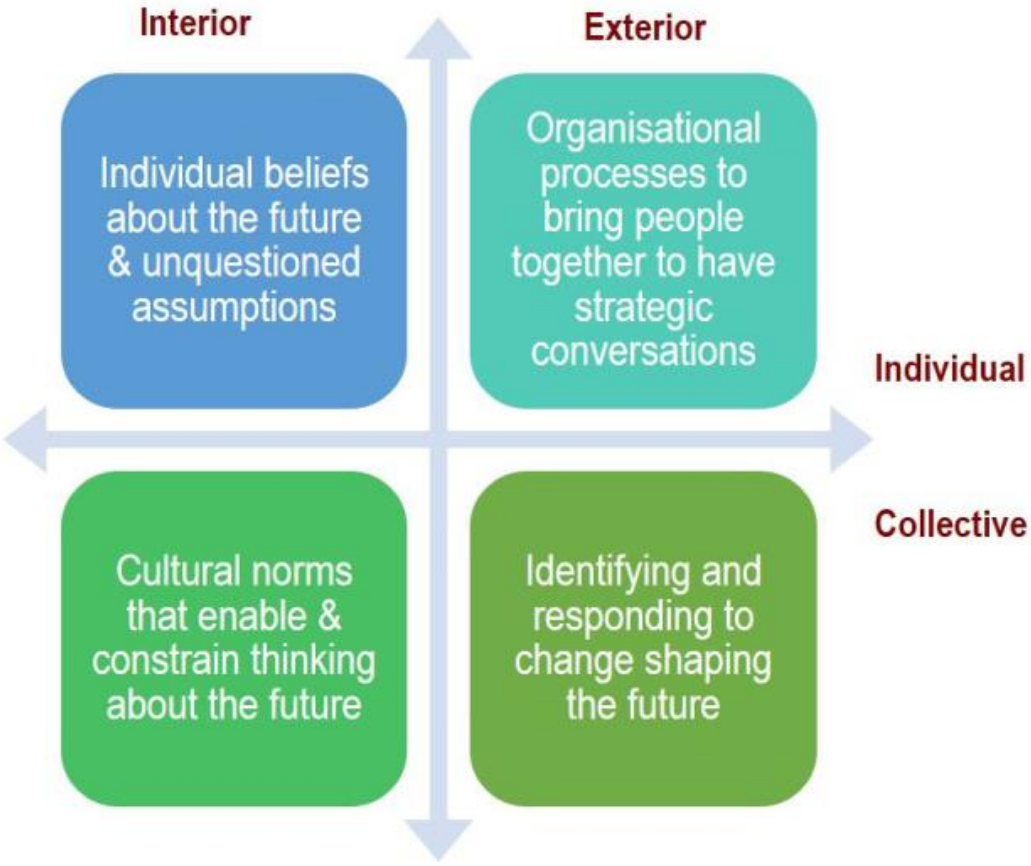

Figure 2-4: Four Quadrant Mapping

Source: Conway (2018)

2.4.5. CREATING ALTERNATIVES

The fifth pillar is focused on creating alternative futures through scenario planning. These expose the present, shape, reduce risk, offer alternatives and create more flexible mindsets (Inayatullah, 2008). There are various scenario methods. One is derived from the futures triangle and EIA whereby a range of scenarios or stories of the future are formed. Another scenario technique is the double variable method which detects two major uncertainties and generates alternatives based on them. The third type deals with scenarios archetypes and was developed by James Dator in 1979 and they are made up of:

- Continued Growth – current conditions are enhanced

- Collapse – too many contradictions which lead to failure of growth
- Steady State – stop growth and find a balance between humans and nature
- Transformation – changes basic assumptions of other three types by dramatic alteration (Inayatullah, 2008).

Peter Schwartz, from the Global Business Network, created an organizational, focused scenario method. The scenario structure is composed of four cases: "**best case** (what the organisation aspires to); **worst case** (where everything goes bad); **outlier** (a surprise future based on a disruptive emerging issue) and **business as usual** (no change)" (Inayatullah, 2012). This method is suited to a shared culture within organisations. This is the method that was chosen to be used in this research study.

2.4.6. TRANSFORMING THE FUTURE

The final pillar focuses on transformation which narrows the future towards the preferred. Visioning, Backcasting and Transcend are three methods that are generally used in this pillar (Inayatullah, 2012). The three methods to create a vision are: analytic scenarios, interrogation of role-players, and creative visualisation (Inayatullah, 2008). Backcasting fills in the gap between the future and the past and can be used to avoid the worst case scenario. The transcend method aims to find win-win solutions when a conflict between visions occur (Inayatullah, 2008). Visions assist in bringing people together and focusing the goal as well as giving them a sense of what can be achieved and having the longer term in mind.

2.5. FUTURES STUDIES FOR AN AFRICAN VISION

The African continent is currently undergoing various changes with regards to economics, socio-politics, demographics and technology which are all interlinked and will be responsible for shaping the future (Bello-Schünemann, Cilliers, Donnenfeld, Aucoin, & Porter, 2017). According to Bello-Schünemann et al., (2017), key points for the future in Africa are:

- Africa has the fastest growing population in the world and is expected to increase by around 50% over the next 17 years. This is likely going to compound poverty and the lack of opportunities and the demand for services, such as healthcare, will be put under extreme pressure
- The need for upskilling and development of human capital is high in order to increase productivity and economic growth. This will allow for the ability to handle external factors
- While Africa is in need of infrastructure for connectivity, the need for basic infrastructure should not be neglected
- Rapid urbanisation can be dangerous if not regulated, but there is also the opportunity for economic growth by capitalising on it.
- Africa has a high burden of conflict which will not disappear, and investment into security, prevention of conflict, etc. must be made. Although certain parts of Africa are improving, this is not the case for all of the continent.
- The demand for democracy is common and will continue to increase in the future.

Cameroonian political philosopher and professor Achille Mbembe discusses "African Futures" in an interview which states that Africa is undergoing both a demographic and urban revolution and that the youth will play a vital role in the future of Africa (Durosomo, 2015).

2.6. FUTURES STUDIES FOR SOUTH AFRICA

The Mont Fleur Scenario project, that was facilitated by Adam Kahane between 1991 and 1992, concentrated on what would happen to SA through the transition past apartheid. Four scenarios were created, three of which would not produce great outcomes and one (Flight of the Flamingos) that was preferable (Kahane, 2007). It was a contentious time in SA, but the process was able to get political, business and civil society leaders to focus on what they had in common which was the future of

SA. This exercise and the scenarios had made its way to Nelson Mandela and it had influenced one of his decisions which was able to shift the economic thinking and avoid an economic disaster (Kahane, 2010).

According to Sunter (2018), SA is at a tipping point with regards to the positive or negative fate that awaits according to predicted scenarios playing out. Six flags were mentioned to be of importance:

1. Corruption – will justice prevail for past incidences and what will continue to happen going forward?
2. Improvement of health, education systems and general infrastructure – state-owned enterprises need transformation
3. Leadership style – people need to be united and have a similar vision for the country
4. Pockets of excellence – these need to be revered and used to uplift the country
5. Entrepreneurship – this needs to be supported in order to provide economic growth
6. Land Reform – needs to happen but in a way that will provide a win-win situation for all (Sunter, 2018).

The study undertaken by Adendorff (2013), proposed the Umbrella Vision 2055 in which 54 million people would be able to live well. He states unequivocally that the only way SA would be able to create that vision is if all the role-players work together. There are numerous obstacles that will need to be overcome such as crime, corruption, an uneducated population, limited access to technology, etc. as well as the difficulty of manoeuvring in an ever-changing macro and micro-environment, but there is huge potential and opportunities that are on the cusp of being unleashed (Adendorff, 2013).

In order for an alternative future to occur, standardised groups must be tested with different futures and original worldviews being created, and finally a new story must

be offered which supports the change (Milojević & Inayatullah, 2015). SA has often been criticised about operating in crisis mode on a reactive basis when external conditions change, rather than implementing alternative plans already considered and put in place as part of a proactive strategy. Conway (2009) proposes that strategic thinking would bridge the gap and assist to function proactively.

According to the U.S. Commercial Service (2017), the private health sector in South Africa is interested in new, state of the art technology and improving healthcare systems but most hospitals operate in silos and have in-house internal systems. The private sector is very stylish and has world class facilities with centers of excellence. However, about 93 percent of equipment is imported. There is also interest in remote diagnostics for rural areas where there are access issues and high patient burden, but diagnostic imaging facilities are said to be underdeveloped. The public sector is focused on implementing an ideal clinic policy to meet service standards (U.S. Commercial Service, 2017).

The National Development Plan's main aim is to eliminate poverty and reduce inequality by 2030 and hopes to achieve this by gaining encouragement from its people, developing an inclusive economy, building capabilities, improving the capacity of the state, and promoting leadership and partnerships in society (National Planning Commission, 2011). The plan cites the six most important elements of the health system as identified by the WHO and included in that list is 'Medical products, vaccines and technologies'. Unfortunately, SA's health system's performance has been poor, despite good policy and relatively high spending as a proportion of GDP which is possibly why the Vision 2030 for heath specifically is around raising life expectancy, reducing infant mortality, reducing number of youths with AIDS and reducing the burden of disease. However, the South African medical community is said to be generally interested in new technology developments and new products (U.S. Commercial Service, 2017).

2.7. QUANTITATIVE AND QUALITATIVE RESEARCH

Quantitative and qualitative methods are not distinct categories or polar opposites (Creswell, 2014). There is a historical evolution to both techniques with the quantitative approach leading in the social sciences from the late 19th century until the mid-20th century and qualitative research drawing interest later in the 20th century (Creswell, 2014). Quantitative research links to research in the natural sciences and positivism is a paradigm that involves a deductive process for testing objective theories by examining the relationship among variables (Collis & Hussey, 2009).

Qualitative research is used for exploring and understanding social issues which involves asking questions, data collection in a specific setting and inductive data analysis, which implies building theories from data and interpretations by the researcher (Creswell, 2014). Qualitative research is linked to the interpretivist paradigm that involves an inductive process due to the belief that social reality is subjective and shaped by perceptions (Collis & Hussey, 2009). Interpretivism was developed due to the criticisms of positivism being used for social sciences. The qualitative research process is emergent, which means that the initial design for research cannot be forcefully prescribed. Some or all phases may vary once the researcher begins (Creswell, 2014).

Qualitative research is based on a constructivist epistemology and uses a framework which is flexible, descriptive, sensitive and holistic (Yilmaz, 2013). It draws on naturalistic methods for data collection and analysis and delivers an in-depth understanding of people's experiences with meanings (Yilmaz, 2013). Critical futures studies challenge the current worldview and looks for disguised assumptions.

Due to the interpretivist approach used in this study, the various themes and concepts from the research will be drawn together, filtered and condensed to explain what is occurring (Collis & Hussey, 2009). Theory will be developed from the data gathered from the interviews, questionnaires and case studies. This should provide direction and give insights to the connection and patterns in the data.

The research process has five steps namely; review of applicable literature, creation of knowledge, foresight, value creation and reflection. This will then be integrated into strategies meant for management to implement in order to achieve the desired future vision in healthcare in South Africa.

2.8. ETHICS IN FUTURES STUDIES

Ethics can be defined as the “science of morals or the rules of human conduct” (Fricker, 2002). Wendell Bell as cited by Lang (1998) offers direction to address the issue of futurist studies and ethics. The core function of a futurist is to make the world a better place and a set of ethics should be drawn from this foundation. While a futurist aims to meet the expectations of their clients, they need to clearly state that the recommendations put forth must be examined for consequences to society (Lang, 1998). Akintan (2014) provides guidelines for the futurists’ professional code:

- Futurists should carry themselves out in a professional manner upholding ethical principles
- They should participate in work that benefits mankind and should concern themselves with public interest
- Futurists have an obligation to probe for the truth, test conceptions empirically and logically as far as possible
- Unethical behaviour such as placing self-interest above that of the client, concealing of information and inflating expenses must be avoided (Akintan, 2014).

Futures studies experience ethical problems through: values present in foresight exercises by examining the motivations for that creation; people are innately oriented towards the future and, therefore, the future in a constituent dimension of ethics and developing foresights as a professional for a client requires that both are protected against possible inappropriate behaviour as with any other professional (Poli, 2011).

Ethics and futures studies need each other even though they progress in their own respective ways (Poli, 2011). Corporate organisations have an affect on the lives of many people and, what they do today, has consequences for the future of many people. It is therefore required that these influential organisations act ethically in the present so as to prevent problematic consequences in the future (Fuller & Tilley, 2005).

2.9. CONCLUSION

This chapter provides a synopsis of futures studies and the different methodologies for research. It gives an in-depth look into Scenarios, CLA and the Six Pillars as these will be main components in this study. The connection between ethics and futures studies is also explored.

The following chapter will present an overview of the available literature, as well as a look at trends and disruptive innovations that comprise the health technologies industry.

3 CHAPTER THREE: LITERATURE REVIEW

3.1. INTRODUCTION

The first industrial revolution occurred from the years 1760 to 1840 and revolved around the steam engine; the second revolution took place in the latter part of the 19th century and involved the growth of industries such as steel, oil and electricity, and used electric power to allow for mass production while the third revolution began in the 1960s with the advancement of technology from analog electronic and mechanical devices to digital technology (Harvey, 2017). The Fourth Industrial Revolution follows on the previous Digital Revolution with new ways in which technology implants itself into societies as well as the human body. It is also important to note that technology is becoming connected quite progressively and there is somewhat of a convergence of the digital, biological and physical dimensions. Policymakers, academics and corporates must acknowledge the importance of these advances and the opportunities that lie therein (Harvey, 2017).

The World Economic Forum has a ranking for the preparedness of countries to apply Information and Communications Technology (ICT) advantages and Mauritius is Africa's golden child with a ranking of 45 out of 143 countries and is said to be the most connected country in sub-Saharan Africa (Maharaj & Barnes, 2015). Mauritius is also acknowledged for its affordability with the second lowest broadband costs in the world which has allowed the country to transform into a cyber island that is home to data management, e-commerce and call centre companies (Maharaj & Barnes, 2015). This shows the potential for transformation in terms of connectivity for the rest of Africa if they have the right vision.

Health technology innovations use the data, graphics and codes for communication across the world to comprehend and forecast health indicators (Tranmer, Meys, & Damicis, 2018). Being able to use the data available through items that are already possessed by a substantial number of people like smart phones, watches, etc. to provide people with the ability to make better choices about their health and alert

them to predisposed conditions is one of the main functions of health technologies (Tranmer et al., 2018).

Worldwide, hospitals are slow to adopt new technologies such as robotics and AI even though these have been tested and used successfully in other sectors, and medicine itself has also been slower to change with safety being the major issue (Jaiprakash, Roberts, & Crawford, 2016). However, financial pressures in the near future may force government and industry to look towards robots if they can do work more efficiently for the same price or cheaper (Jaiprakash et al., 2016).

Patients that belong to low-income populations are the ones who experience difficulties complying with medication routine, self-care and communicating with providers (Moore & Richards-Kortum, 2016). Digital health technologies are tools that can empower them with information as well as allow for effective communication with their healthcare providers, but the reality is that most of these people either cannot access these tools or afford them (Moore & Richards-Kortum, 2016). The introduction of health technologies has the potential to reduce inequalities in terms of access to healthcare and this is a major problem for developing countries. Patients are also sometimes reluctant to adopt health technologies due to the time needed to input data or the anxiety of tracking data and the disbelief of physicians in the data, but these issues can be addressed if developers are willing to work with their stakeholders (Moore & Richards-Kortum, 2016). Healthcare providers are also at times, less keen to adopt technologies as well and this needs to be addressed in line with future skills that will be needed by them for the more industrialised and technology-driven world. The incorporation of ICT in any business will be seen as a move in the right direction, as the world can be seen to be moving in that direction, and health businesses are also set to benefit from these technologies in terms of potential profits.

3.2. GLOBAL TRENDS IN HEALTH TECHNOLOGIES

According to the WHO (1998), the global population should increase by about 8 billion by the year 2025. In 1997, 17.3 million of the global deaths were due to

infectious and parasitic diseases; 15.3 million were attributable to circulatory diseases; 6.2 million were caused by cancer; 2.9 million were due to respiratory diseases and 3.6 million owing to perinatal conditions. The expectation is that no country will have a life expectancy of less than 50 years for its citizens (WHO, 1998). Although aging will be a part of life, biological breakthroughs could elongate the lives of healthy people to an extent that could not be imagined today (Glenn et al., 2017). Infectious diseases will still be a major issue in developing countries and due to the growth of these economies, non-communicable diseases will become more widespread which would be due to embracing "western" lifestyles (WHO, 1998). Health status is influenced by macro issues such as political, environmental, social, technological and economic conditions, but most significantly by population growth, inequalities in wealth, conflict, power and resource constraints (Sapirie & Orzeszyna, 1995).

According to the WEF (2018c) report, by 2022, 85% of respondents are likely to have expanded their adoption of user and entity big data analytics. Therefore, it can be presumed that large proportions of companies are likely to have expanded their adoption of technologies such as the IoT, app- and web- enabled markets as well as using cloud computing. Machine learning and augmented/VR should receive major business investment (WEF, 2018c).

Internationally, more emphasis has been placed on patient-centred healthcare and there is more participation from patients when designing healthcare services (Mühlbacher & Kaczynski, 2015). According to CDWG (2017), healthcare leaders have realized that technology creates a win-win situation for both patients and providers in that the investment into efficiencies to improve patient satisfaction have a positive outcome for hospital profitability. It is important to keep in mind that evaluation of health technologies should include poltical analysis that is discerning to thereby inform better decision making (Mühlbacher & Kaczynski, 2015). Figure 3-1 below shows an overview of the different health technologies that have come through the digital health revolution.

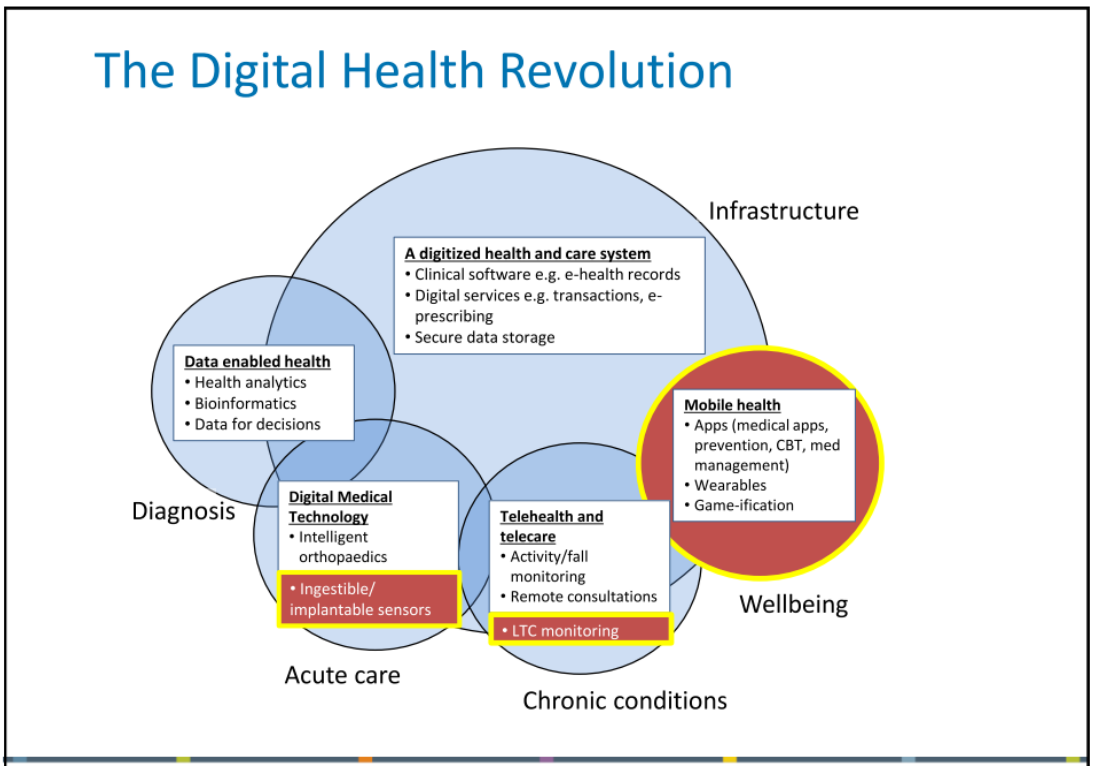

Figure 3-1: Digital Health Revolution

Source: Goldwater (2017)

3.3. CONSEQUENCES OF HEALTH TECHNOLOGIES

Technological progress, as mentioned previously, is a main driver of economic growth and improvements in living standards. It increases productivity which grows per capita income and consumption along with influencing the quality of work and structure of societies. Technological applications such as 3D/4D printing, AI, robotics, nanotechnology, drones, VR will make past developments in this field seem quite slow (Glenn et al., 2017).

Activity trackers and blood pressure or glucose monitors are digital health technologies that have been developed by the private sector to improve chronic disease management and empower patients (Moore & Richards-Kortum, 2016). According to The Commonwealth Fund, which is a private foundation, digital health technologies are useful in increasing patient engagement, narrowing communication

holes, identifying and customising services as well as cultivating better decisions (Moore & Richards-Kortum, 2016). In the broader health system, hospital costs could potentially decrease significantly by creating efficiencies through health technologies and improving patient satisfaction simultaneously (Tranmer et al., 2018).

3.3.1. LABOUR

Future jobs in healthcare, education as well as entertainment are some of the industries that are likely to be most impacted by technological advancements (WEF, 2015). It is important to remember that job destruction and job creation are also determined by legal, economic or socio-political factors. Organisations will have to look at the cost benefits of new automation technologies in line with productivity (Bruckner et al., 2017). The truth is that labour costs increase with time, whereas AI and robotics costs will decrease, and therefore, new forms of economics need to be considered to avoid social disasters of large-scale unemployment that have been predicted (Glenn et al., 2017).

Up to now, developing countries with low wage rates have not been visibly affected by automation and there are numerous legal and regulatory implications (Bruckner et al., 2017). If AI were to be used in healthcare, decisions around whom would be liable for malpractice claims needs to be made. Bruckner et al., (2017), are of the opinion that governments and the UN should guide in this aspect with general policy allowing these new technologies and innovation, rather than trying to evade them due to fear. Proactive policies are required for a broad share of the benefits and support of displaced workers. New technologies are likely to change the nature of the skills required and this should be addressed by curriculum changes within schools and universities (Bruckner et al., 2017).

Contrary to popular belief, economist James Bessen found that only one job out of the 270 that were listed in the 1950 US Census became fully obsolete due to automation and that was the elevator operator (Keywell, 2018). Many other jobs did end up disappearing but only because they evolved. According to Bruckner et al., (2017), new technologies will likely increase the demand of human labour in the long run based on history. However, highly skilled workers with the ability to be flexible,

solve problems, be creative, etc. will have greater benefit than the lower skilled workers who are facing competition from very capable machines. The nature of work is changing with machines expected to perform about 42 percent of current tasks in the workplace by 2022, compared to only 29 percent today (Keywell, 2018). The two investment decisions that are mentioned to be important are whether to prioritise automation and whether or not to invest in workforce reskilling (Keywell, 2018).

A telecommunications company in the US, AT&T, is being proactive in their approach after realising that only half of their employees had science or technology skills and were under risk of becoming obsolete. So they have launched their 'Future Ready' global reskilling programme investing $1 billion (WEF, 2018c). Mr Klaus Schwab, Executive Chairman of WEF, mentioned that companies need to think about the future in this regard and that governments are responsible for creating enabling environments for workforce reskilling (WEF, 2018c).

Augmentation of jobs that already exist through technology will create new roles such as piloting drones or remotely monitoring patients by healthcare workers and this will ultimately allow for new opportunities for these workers (WEF, 2018c). The increased demand for new roles should be able to balance the decreasing demand for older positions, but this is not a given situation, and hence, the need for businesses to understand their pivotal place which requires investment for this transition (WEF, 2018c). The social effects of unemployment are overwhelming and cannot be underestimated. Forecasts indicate that Africa has a rapidly growing population which could mean that there would be a healthy market of young consumers and producers, but it could also mean that youth unemployment could become a much bigger issue mixed with inadequate governance (Harvey, 2017).

Governments and businesses will have to show great leadership and entrepreneurial spirit when it comes to making sure the future of jobs results in positive outcomes (WEF, 2018c).

Gunderman (2015) refers to Anthony Jones, a physician with vast experience in health technology development, who, after watching a Star Wars movie, was sure

that there would never be a robot or any technology that could compare to the human touch or of compassion. They could store and process more medical information but do not possess those softer skills that a human provides. Medical students will however, be able to spend less time learning theory and more time analysing the psychology of the illness and offer empathy in the future (Gunderman, 2015). Skills required for health technology companies range from medical backgrounds to advanced computing and analytical abilities (Tranmer et al., 2018). In order to proactively develop these skill sets, companies should:

- Promote Science, Technology, Engineering and Mathematics (STEM) training in both public and private schools
- Escalate awareness of opportunities within the healthcare space
- Create and build strong sector partnerships that would allow for training in areas of cloud computing, telehealth, data science, etc.
- Pursue training of existing healthcare workers on computer skills to add to their medical knowledge to be competitive (Tranmer et al., 2018).

Some hospitals have realised that making themselves more ‘factory-like’ would make them more efficient and have adopted the ‘lean’ mentality that is used successfully in the automotive industry (Jaiprakash et al., 2016). This seems to cause anxiety because thoughts of money and job cuts come to the fore, but the idea is more around giving humans the opportunity to carry out complex circumstances in hospitals and letting robots and the like take care of the more repetitive tasks which again refers to job augmentation (Jaiprakash et al., 2016).

3.3.2. INEQUALITY

Severe imbalances in people’s opportunities grow from inequalities in income as well as in health, education, technology access and shock exposure (UNDP, 2018). The WHO defines social determinants of health as the conditions in which people are born and grow up in as well as the forces such as economic, political and social policies that shape those arrangements (Oni, Mutseyekwa, & Yeshak, 2016). Social determinants can affect health in a negative manner and gaps reveal inequality due

to gender, location and group identity. There are also huge inequalities when it comes to health across countries. Life expectancy, women's income and educational achievements are the biggest gaps between countries with low human development compared with the higher human development countries (UNDP, 2018). Poor people experience lack of basic needs in some countries and have limited access to education, medical care and finance which compounds health inequity (Oni et al., 2016).

Since the 1970s, wage inequality has increased in developing countries which can be linked to the complementary relationship between IT and cognitive skills which have divided the high-skilled workers significantly from low-skilled labourers (Bruckner et al., 2017). This provides the action required by government to implement policies for redistribution of income if technology increases unequal income distribution (Bruckner et al., 2017). Governments and businesses need to work collaboratively to ensure technologies are used but reduce inequality simultaneously (Coleman, 2016). Governments can use different methods to minimise generational inequality. These methods include wealth and inheritance taxes that support younger people; raising the retirement age to assist people to regulate for longer life expectancy; pension systems, as well as work training and skilling programmes that promote digital literacy for the youth (WEF, 2018a).

The benefits of health technologies has been seen, but these benefits can only be realised if patients who need them have access. this eludes to the other major device/health gap between those who would receive the most advantage from using health technologies to those who can access them (Moore & Richards-Kortum, 2016). Africa also has a data issue which adds to the inability to scale up health innovations (Oni et al., 2016). Solutions to health issues are more challenging without information on who is sick and what they are exposed to that makes improving health impossible. There have been positive approaches with both technological innovations and indigenous knowledge to solve health issues but scaling is an issue, and this can be attributed to lack of funding as many of these projects do not get to see the market (Oni et al., 2016). Low income populations experience a high risk for getting diabetes but they would most likely not be able to

afford the health technologies available to assist in monitoring and managing their condition. This expands the health gap (Moore & Richards-Kortum, 2016).

Many devices that are currently on the market are also not user-friendly, and most require a computer connection which then causes a hindrance in providers receiving the required data from the patient due to the intricacies around electronic communication (Moore & Richards-Kortum, 2016). There are also low adoption rates with patients that have multiple chronic conditions for various reasons, and this brings about the need to involve stakeholders in the development process. This could assist in lowering costs, thereby encouraging better disease management and reduction in health gap (Moore & Richards-Kortum, 2016).

Insurance companies can also improve access to digital health by providing incentives such as reimbursements for health data, coverage of evidence-based technologies and support along with monitor patient risk profiles (Moore & Richards-Kortum, 2016). It is important to note that most medical schemes cover in South Africa are mostly used by high income earners with the majority of South Africans (around 84%) using public sector services but there is also a large amount spent out-of-pocket that is not covered by government or insurance schemes (Erasmus, Ranchod, Abraham, Carvounes, & Dreyer, 2016). A suggestion by Oni et al., (2016), is that governments need to get involved by creating central systems that monitor health and social determinants to provide a better understanding of health inequity. This can only be achieved if public and private organisations work together to get better measurements and capturing of data which also enables shared learning across Africa. Their team strongly believes in collaboration across disciplines and countries and have seen it work (Oni et al., 2016).

3.3.3. THE HEALTHCARE SYSTEM IN SOUTH AFRICA

The healthcare industry has evolved steadily throughout the ages prompted by economics or social trends that exist (Singh & Mar, 2014). It is expected that in the future, health and wellness will infiltrate our daily lives. Technology has rapidly tramsformed the way healthcare is delivered and the focus has shifted significantly to one of more patient-centric approach (Singh & Mar, 2014).

The Minister of Health in South Africa, Dr Aaron Motsolaledi has started the process of getting the National Health Insurance (NHI) up and running but according to Wilson (2018), this could take up to 15 years. Stoltz and Wolvaardt (2011) have advised that a national health information system is important to provide a common platform for patients, healthcare providers and facilties in private and public sectors and this would assist in repairing the current state of affairs. The NHI aims to address issues of inequity and quality which, if implemented successfully, would minimise the need for private healthcare (Erasmus et al., 2016). The National Department of Health (NDoH) has partnered with the Council for Scientific and Industrial Research (CSIR) and developed the Health Patient Registration System (HPRS). In March 2017, 6 355 759 South Africans had been registered and this is the first phase in getting an electronic patient record system running in SA (Department of Health, 2017). A common record system allows continuation of treatment and avoids wastage and duplication issues, but this needs to be done with the appropriate regulations for data collection and protection of privacy (Stoltz & Wolvaardt, 2011). Another dire problem that SA faces in the healthcare space is the severe lack of skilled healthcare professionals (Stoltz & Wolvaardt, 2011).

Healthcare will need to be immediate, safe and connected to ensure that patients are satisfied (Singh & Mar, 2014). In order to be successful, organisations need to look into new business practices and policy frameworks to facilitate the new way of doing things (Singh & Mar, 2014). Nurses need to embrace technology more readily. Going into the future with the advancement of telehealth and other health technologies, their jobs will change form, but this will give them the opportunity to relinquish certain tasks to automation and make more time for nursing (Gionet, 2017).

3.3.4. REGULATORY ENVIRONMENT

The highly regulated environment of healthcare sets up a hindrance for innovation with rapidly evolving technologies either experiencing a difficulty with there being a gap in regulation that increases risk for healthcare providers or trying to mould old regulations around the new technologies (PwC, 2014). Regulatory agencies face the

problem of trying to balance potential benefits in this quick paced field and ensuring patient safety (PwC, 2014).

Regulatory frameworks and public policies need to be in line with technology development due to the concerns around security and mass distribution of technology (Tranmer et al., 2018). Value can be added to the ecosystem through these regulatory bodies by the development of frameworks that are able to accommodate these rapid innovation cycle technologies (PwC, 2014). The Food and Drug Administration (FDA) programme in the US has created an initiative that will expedite the regulatory process for health technologies. This will allow technology companies to get pre-approval if the technologies meet certain criteria (Tranmer et al., 2018). According to Iyer (2016), regulatory conditions would determine how the health technologies market progresses:

- Policies transformation and dynamic mechanisms would need to be instituted in order to achieve transparency within the sector amongst healthcare providers,
- Faster approval methods for new products and drugs which would also lessen hesitation from investors,
- Need for global requirement for the restructuring of data in healthcare and privacy of patient data,
- Additional protection for patients and providers recognised in policies when using big data, social media or wearables.

3.3.5. IMPACT ON PATIENTS

Digital transformation in the healthcare sector is intensely consumer driven where healthcare is tailored to meet the criteria of being the right care at the accurate time, in the correct place at the best cost (WEF, 2015). The field of diagnostics is also changing rapidly with predictive analytics, wearables and sensor technologies allowing for real-time data collection that can predict when an asthma attack could occur or having a healthcare professional send an alert directly to a mobile phone (WEF, 2015).

According to the WEF (2015) report, some of the obstacles in relation to healthcare digitalization are: “liability, data ownership, technology, the standardisation of terminology, context-driven personal health records, user-experience-focused interfaces to utilize data, local and international regulation and data privacy”. Increased access and digital use of data create geopolitical risks and the potential for data breaches. Health records access could be manipulated for cybercrime and army activities. However, Health 2.0 is said to have the ability to transform value chains in the bigger industries such as pharmaceuticals, biotechnology and healthcare services moving towards a consumer-centric vision and moving away from traditional healthcare (WEF, 2015).

Although technological innovations are improving healthcare, when a patient is unwell, there is a lot to be said about the human relatability, compassion and empathy aspect (Gunderman, 2015). Ethics in the future will have to be audited and regulatory protection mechanisms put in place (Glenn et al., 2017).

3.4. VARIOUS HEALTH TECHNOLOGIES

New technologies in the health field address many issues such as devices for prevention, detection and treatment as well as application of healthcare management systems. According to Sapirie and Orzeszyna (1995), there was the acknowledgement of the need for technologies to be focused on health issues of developing countries as well as matters of availability, accessibility, transfer and monitoring to be looked into. The internet has given incredible power and knowledge to patients, as well as provided easy access to knowledge for many healthcare practitioners worldwide (Mytton et al., 2010). The company Apple, is also trying to break into the medical device market with a wearable that could detect abnormalities of the heart (Tranmer et al., 2018). SA’s market for medical devices is still controlled by the U.S. with a 28 percent market share. However, there has been a move to look towards Asian countries for better prices (U.S. Commercial Service, 2017). Introducing new technologies is a sensitive process in certain healthcare settings and new risks and unforseen dangers are possible.

A surprising story from Rwanda is the technological advancement being seen in that country with regards to healthcare. AI-based algorithms on mobile devices are allowing Rwandan people in remote villages to be diagnosed, telemedicine is being used efficiently, blood is being delivered by medical drones and they have a functioning central health records system (Meskó, 2018). In ten years, around 90% of the population is covered by community-based health insurance and the Rwandan government has made smart health a priority by including it as one of the pillars in their ICT policy. Ninety percent of the country is connected to 4G and fiber optic infrastructure has been installed almost all over the country (Meskó, 2018). Mobile phone usage is said to be at 75% and the Rwandans were introduced to digital transformation incrementally, with the electronic identification in 2016, the electronic passport and then electronic health records (EHR) in collaboration with WHO, intergovernmental organisations, Global Fund, etc. The EHR system now manages financial aspects, consultations, registration and so forth. Due to looser regulations, they have been able to work with start-ups from other companies. Rwanda also had to formulate regulatory policies and standards for digital healthcare to operate successfully. The future looks bright for Rwanda as they plan to use AI and robots to perform smaller surgeries (Meskó, 2018).

The focus on health technologies is not only how these can be better treatment options but on how to keep costs low so that more people get to benefit (WEF, 2016b). Smart wellness programmes are being offered through the big data realm along with precision medicines and emphasis on prevention to allow for quicker intervention and cheaper costs (WEF, 2016b).

3.4.1. BIOTECHNOLOGY

According to Rowley (2002), biotechnology is the meeting of chemistry, biology, physics, computer science and engineering that work in synergy. Biotechnology is seen to some as the next revolution and they think that it will affect all facets of society with its applications and speed of development (Rowley, 2002).

The core purpose of biotechnology in health is to find solutions to diagnose, prevent, treat and monitor dieseases (Rowley, 2002). People are now using genomics to improve the gene pool by selecting particular characteristics in offspring, eliminating hereditary diseases and so forth. The practice of medicine should fundamentally change to a more holistic approach, customisable and with a focus on prevention rather than treatment through the promising applications of biotechnology.

3.4.2. BIOSENSORS

One of the technologies under the biotechnology umbrella is the biosensor technology which connects chemistry, biology, informatics and engineering (Rowley, 2002). Biosensors are applied for disease diagnosis, gene identification, etc. These devices are fast developing and can be incorporated into jewellery, clothing, etc. to monitor individuals as well as environments (Rowley, 2002). Wearable technology (wearables) that are familiar to most people are the smart watches, smart shoes and health monitoring bracelets (Bennett, Phillips, & Davis, 2017). These devices can record how many steps you've taken, how many hours you were asleep, blood pressure, etc. with the use of sensors (Tsekleves, 2015). Customisation is key with these technologies as health and fitness applications and wearables are deeply personal (Millington, 2018).

Companies are looking into monitor data from these devices as they could penalise staff as well as reward them according to wellness programmes. BP is one such company that has given free Fitbits, a smart wrist bracelet, to their staff under the condition that they have access to their data which allows insurance premiums of the company to decrease if employees are active and this individual activity has been incentivised by the company which creates a win-win scenario (Tsekleves, 2015). This however, does lead to the thought of how long will it take, if ever, before the wearable is a mandatory part of uniform for employees so that the employer has control over things like sick leave and so forth.

The data collected could be transferred to their physicians and public health departments (Rowley, 2002). Crucial feedback on brain activity, stress levels, etc. could be delivered to providers allowing for enhanced patient-provider engagement

which leads to better medication compliance and management of conditions (Iyer, 2016). There is also enormous potential for wearables to be used in clinical trials for efficacy, safety and life quality (Iyer, 2016). As can be seen in Figure 3-2, there is the potential for wearables to be used at multiple sites of the body to ascertain different types of information is large.

Figure 3-2: Potential Applications for Wearables

Source: Bourla (2018)

Technology that consists of a wearable brain-wave detecting devices and software is being developed that will allow patients to control the cursor on a computer without using any limbs but by simply thinking of it. This opens up numerous possibilities and life-changing opportunities for people with paralysis (Gunderman, 2015).

3.3.6. mHEALTH

The two major smartphone operating systems (Android and Apple) have around 165 000 applications dedicated to healthcare and this will increase dramatically as mobiles use further spreads around the world (Iyer, 2016). Smartphones have an advantage over other technologies with portability, consistent internet connectivity, computing power for applications and the fact that most doctors have one (Perera, 2000). Its use has broadened quickly with custom made applications and specialists coming up with apps in their own speciality areas. For instance we now find orthoaedic support, anaesthetic techniques and so forth and this is only bound to increase (Perera, 2000). Applications rely on the mobile devices' sensors and most of them have to do with general health and fitness but this will diversify in future (Iyer, 2016). Condition-specific applications have the potential to provide better treatment with the inclusion of healthcare providers. Future applications need to be easy-to-use, instinctual and able to provide accurate and up-to-date clinical information (Iyer, 2016). This avenue also gives many start-up companies in the healthcare industry a chance to exploit opportunities and the hope is that demand-led drivers will expand the industry further (Iyer, 2016).

A huge benefit of mHealth is the ability to provide solutions to patients in remote areas where logistics and costs for traditional healthcare would normally be limiting, which is often the case in developing countries (Iyer, 2016). Patients in these countries are more inclined to use these applications than those in developed countries, and it is more likely that the doctors and governments in those emerging countries would be willing to pay for these services as well (PwC, 2014). This implies greater demand and less deep-seated interests to hinder novel approaches which provides an opportunity for these countries to move faster in this field (PwC, 2014).

mHealth has the power to alter relationships within the healthcare space as doctors look to the technology due to its assistance in monitoring patient compliance, retrieving records and interacting with colleagues (PwC, 2014). Chronic conditions are a major issue around the world, and intervention along with prevention provides an important building block for making populations healthier (PwC, 2014). mHealth could specifically target patients who suffer from chronic diseases and, with the

addition of sensors, devices and other tools would be able to alter behaviours in appealing and sustainable ways (PwC, 2014).

Security, however, is a major concern when it comes to mobile devices, and therefore, providers should put the relevant measures in place when using such platforms or limit the type of information collected to only the extremely necessary (Iyer, 2016). Transparency and communication encourages further usage by patients and willingness to share data. Strong and secure infrastructure is required for healthcare systems to function optimally and for interoperability of these systems, which is represented in Figure 3-3 below, to be managed as there are many places that do not have reliable internet and connectivity (Iyer, 2016).

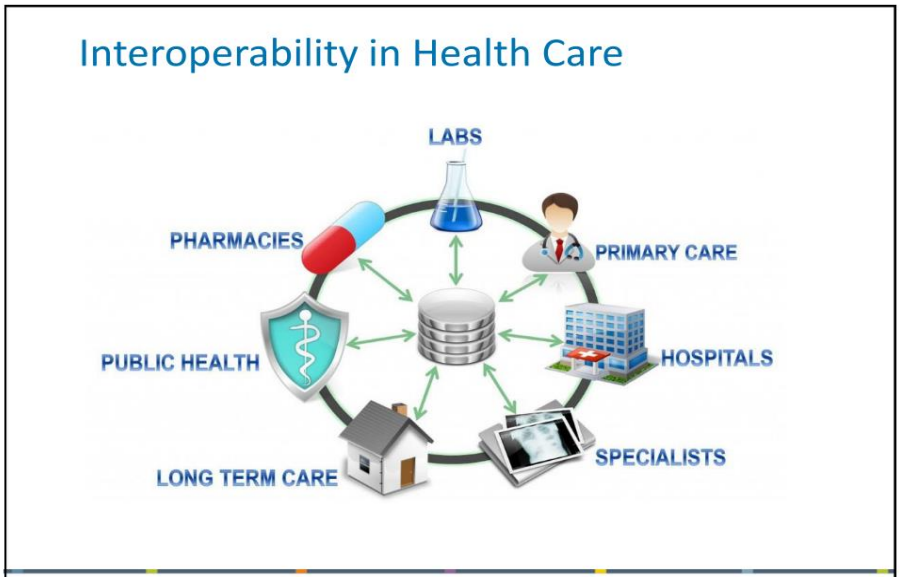

Figure 3-3: Diagrammatic Representation of Interoperability

Source: Goldwater (2017)

3.4.3. CURES FOR DIESEASE

Specific therapies are being developed to target different areas that have been identified through biotechnology research. Effective therapeutic results can be achieved through rational drug design by creating an optimal shape (Rowley, 2002). The most transformative and inspiring health story is the Acquired Immune Deficiency Syndrome (AIDS) pandemic, with the advent of antiretroviral drugs that

managed to control this disease that was once thought to be unstoppable (Gostin, 2016). There are still health challenges like tuberculosis and cancer that await the same kind of magnificent intervention. A huge factor in the release of resources for new vaccines, research and treatments for AIDS was the social mobilisation and access to medicines campaigns with activists who fought against trade freedom principles to prioritise positive health outcomes (Gostin, 2016).

Gene therapy is able to prevent hereditary disease, but there are ethical concerns around this technology (Rowley, 2002). Vaccines promote immunity against specific pathogens/cancer cells and biotechnology allows for the production of more effective vaccines which leads to the possibility that in the future, genetically altered food such as potatoes, bananas, etc. could be used to stimulate immunity (Rowley, 2002). Genetically modified organisms produce specific substances that are harvested and turned into pharmaceuticals (Rowley, 2002).

3.4.4. BLOCKCHAIN

The blockchain technology has the ability to change industries like the health insurance industry which relies on the coordination of various intermediaries for numerous reasons (CB Insights, 2018). Blockchain does more than digitise currencies but is rather a decentralised and worldwide computational infrastructure that is able to modify existing processes within various industries (Herweijer, Combes, Swanborough, & Davies, 2018). The important characteristics of blockchain are its innovative cryptography along with its distributed and indisputable ledger that allows for the secure and inexpensive transfer of any assets (money, goods, property, etc.) amongst stakeholders without outside intermediaries (Herweijer et al., 2018). One of the major advantages of blockchain is that it is currently tamper-proof with no failure points. This generates trust in the system and digital signatures are being used to validate transactions which ultimately means that changes can be tracked since all the ‘blocks’ are connected (Herweijer et al., 2018).

Medical records have been known to get erroneously stored or moved between healthcare providers and insurers which leads to problems for patients. The US healthcare industry has also experienced challenges in managing patient records

with different healthcare professionals each requiring different patient information and having this data kept scattered, out of date and not easily shared (Rutschman, 2018).

Blockchain could maintain an industry-wide, coordinated storage place of healthcare data while still protecting patient privacy and saving an enormous amount of money (CB Insights, 2018). Through the technology, medical records can be cryptographically secured and shared amongst healthcare providers thus allowing for a more efficient health insurance ecosystem (CB Insights, 2018). Sharing data and being synchronised is currently a challenge for the healthcare industry as the back-end infrastructure for medical records is obsolete and everyone relies on their own standards and formats for storing patient data. The blockchain technology would return control to patients, enabling them to review, update or even add data that they observe about themselves (Rutschman, 2018). It would allow years of patient data to be kept secure and make human errors traceable along with fraud and hacking extremely difficult (Rutschman, 2018).

However, private, permissioned blockchain technology still needs to be developed fully as the current public blockchains would not work (CB Insights, 2018). Insurance companies and start-ups will have to overcome regulatory and legal hurdles before industry-wide disruption takes place. To enable such a transformation across industries, collaboration between stakeholders with varied backgrounds will need to occur to support the systems shift for the roll-out (Herweijer et al., 2018). Blockchain will also require the ability to be upscaled successfully to increase user adoption. It is currently highly complex in order to enable majority uptake and this would need to improve blockchain literacy and lessen usability barriers (Herweijer et al., 2018). According to Herweijer et al., (2018), there has been a surge in IoT and AI applications that are able to collect and process big data automatically. These applications could be used in blockchain platforms and the increasing amount of smartphones access makes this more relevant.

The blockchain technology can also be used in other aspects of the healthcare industry such as: sharing data on aggressive pathogens, outbreaks and even within pharmaceutical companies who rely on inefficient databases to monitor drug

shipments (Rutschman, 2018). SA should look towards Estonia for inspiration as the country has been successfully using blockchain technology from 2012 for its healthcare data and transactions and the country has managed to electronically capture 95% of health data and 99% of the prescriptions are digital (Rutschman, 2018). Figure 3-4 shows promising ways in which blockchain can be used in the healthcare space.

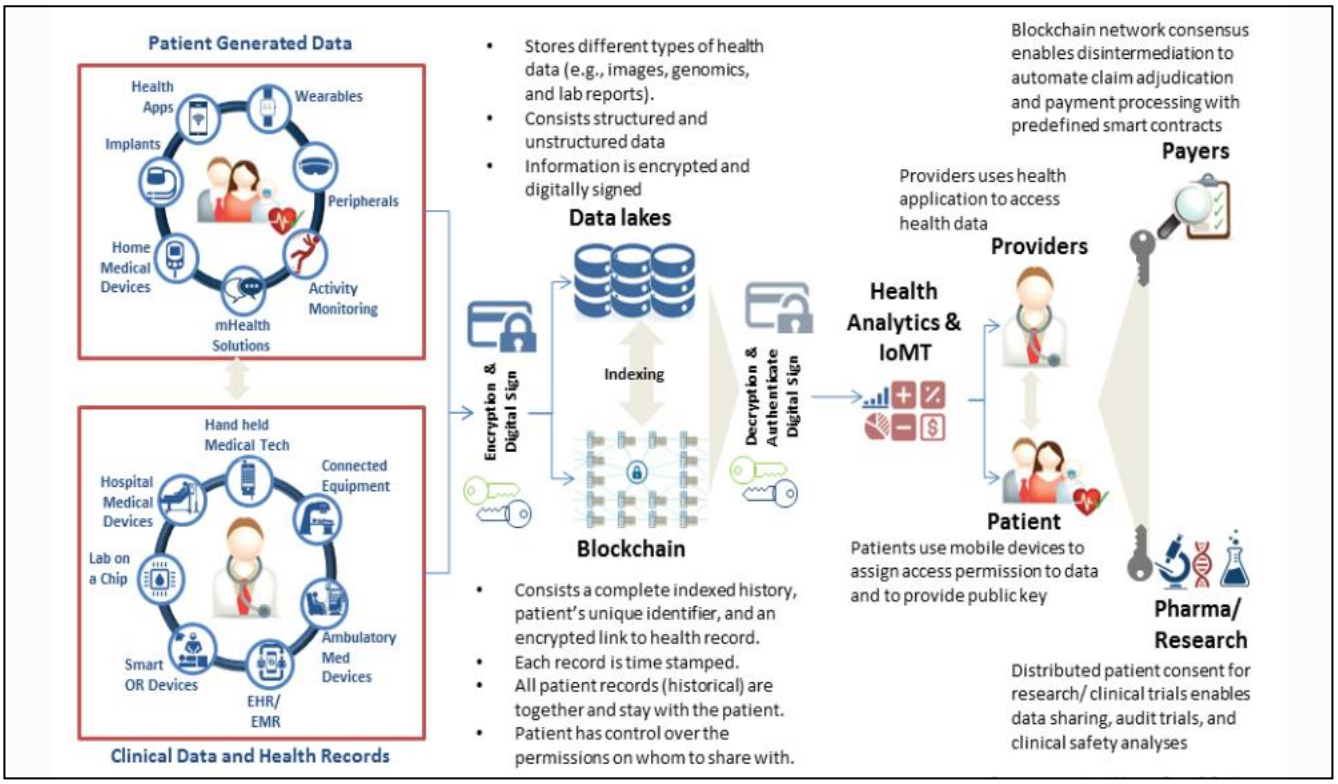

Figure 3-4: Promising Use of Blockchain in Healthcare

Source: Das (2017)

3.4.5. NANOTECHNOLOGY

Nanotechnology has resulted from numerous fields such as chemistry, biology and physics and is concerned with nano-sized molecules that behave in a completely different way in comparison to their bulk counterpart. Thiscreates new concepts and

opportunities (Tegart, 2004). This technology has the potential to be able to assist with solutions for global problems such as the depletion of natural resources, rising population and quality of life (Vishnevskiy & Yaroslavtsev, 2017). In line with businesses, this technology has become vital to increase competitiveness with regards to progressions of science and technology capabilities (Vishnevskiy & Yaroslavtsev, 2017).

According to Vishnevskiy and Yaroslavtsev (2017), nanostructured implants and prostheses markets have allowed for the generation of materials closely matching the ones found in humans and are an example of the potential for changing approaches in the healthcare space. Due to the special characteristics of these molecules at that size, drug delivery systems have been researched and it was found that nanoparticle carriers would drastically increase effectiveness of drugs as well as decrease costs and toxicity due to the targeted approach (Vishnevskiy & Yaroslavtsev, 2017).

Inayatullah (2004) cites Robert Frietas and his book *Nanomedicine* which speaks about the emergence of nanomachines being the answer to every healthcare provider's problem. Controllable micro-robots with nano-sized parts could potentially allow doctors to perform reconstructive surgeries at cellular levels and molecular machine systems could be used to maintain better health situations at that level (Inayatullah, 2004). Clearly, introducing new technologies has the potential to raise the active life of people, decrease disabilities and overall improve the quality of life for humans (Vishnevskiy & Yaroslavtsev, 2017).

3.4.6. INTERNET OF THINGS (IoT)

There are less people in the world than there are connected devices and in a couple of years, this number will surpass 20 million which is driven by the continuous upgrading of technology and the decreasing costs around computing and connectivity (Harvey, 2017). The IoT started from computers and the internet but really catapulted with the advent of mobility (mobile phones, social media, etc.) which introduced a framework for connectivity (Keary, 2016). 'Things' like sensors, radio-frequency identification (RFID) devices, monitors and so forth are able to

connect to the internet and these technologies allow for capturing to then identify, monitor or sense other devices that are also connected (Dutton, 2014). The scale of IoT could have huge impacts on society by enabling products or objects to send, receive or store data in transformational ways (Dutton, 2014).

The internet is considered the core of the IoT which brings technology and systems together and with the assistance of data scientists can provide value to the data that is derived to ultimately make better decisions (Keary, 2016). These systems could use AI to automate decisions thereby not relying on humans as well as increasingefficiencies which would transform business processes (Keary, 2016). Data needs to be used appropriately which creates huge risk factors, especially in the healthcare area. this leads to the need for new policies and governance around data security, privacy and ownership (Harvey, 2017).

3.4.7. CLOUD TECHNOLOGY AND DATA ANALYTICS

Cloud technology has a major benefit in that it creates the ability for sharing of information between multiple stakeholders and across several devices with no hassle (Iyer, 2016). This would offer a clear improvement to the clinical space which is overwhelmed by administrative hurdles and it would provide efficiency and better quality of service to patients because all providers would have access to all the information needed (Iyer, 2016). The technology would enable better day-to-day hospital management and coordination with several providers (Tranmer et al., 2018). The US Secretary of Commerce, Penny Pritzker, also made mention of the importance of the free flow of data online as it affects smaller companies through the enabling of innovation and entrepreneurship (WEF, 2016b).

EHRs are required to work together with the internet to improve diagnostic abilities and to allow machine learning to increase. For this to happen, healthcare providers need to embrace cloud-based storage systems (Tranmer et al., 2018). Digital healthcare would have an advantage if data was integrated across all layers. this would boost sharing and thus improve engagement between providers and patients (Iyer, 2016).

The spread of mobile devices, sensors that are online and digital collection of information has made it possible to obtain real-time, detailed data in many areas even patient care (WEF, 2016b). Digital platforms make instant interaction, information exchange and collaboration possible. Big data and analytics are technologies that are poised to make some big changes within the healthcare sector within the next few years (Iyer, 2016). Companies involved in developing drugs or medical devices can use big data to plan the value chain from discovery to final stages along with innovations for chronic illness cures being derived from data (Iyer, 2016).

SA has embarked on a development, the Square Kilometre Array (SKA), to install 3000 radio telescope dishes which will make it the world's biggest and most sensitive telescope (Walwyn, 2015). The project has already upskilled people in SA with regards to big data processing, engineering and high-speed internet and as Walwyn (2015) mentions, the social return on such technological investment surpasses initial funds and has the potential to create economic incidentals. The South African government would benefit if more funding for innovation and the development of essential health products and devices, not just basic research, was provided in the public health sector (Walwyn, 2015). Collecting health data could enable measurement of the country's economic development and would thus also become of value to more and more governments (Iyer, 2016). The Health Information Exchange presented in Figure 3-5 below shows the electronic movement of health-related data across organisations and consists of a bi-directional sharing of patients' health information among providers and other permitted professionals in the healthcare space (Goldwater, 2017). Sharing health information would allow healthcare providers to coordinate their services, make better informed decisions to improve patient safety, reduce duplicate testing, ensure higher quality of care, benefit from cost savings and improve efficiencies as well as allow public health departments to meet the needs of their stakeholders in an enhanced manner (Walker, Huerta, & Diana, 2016).

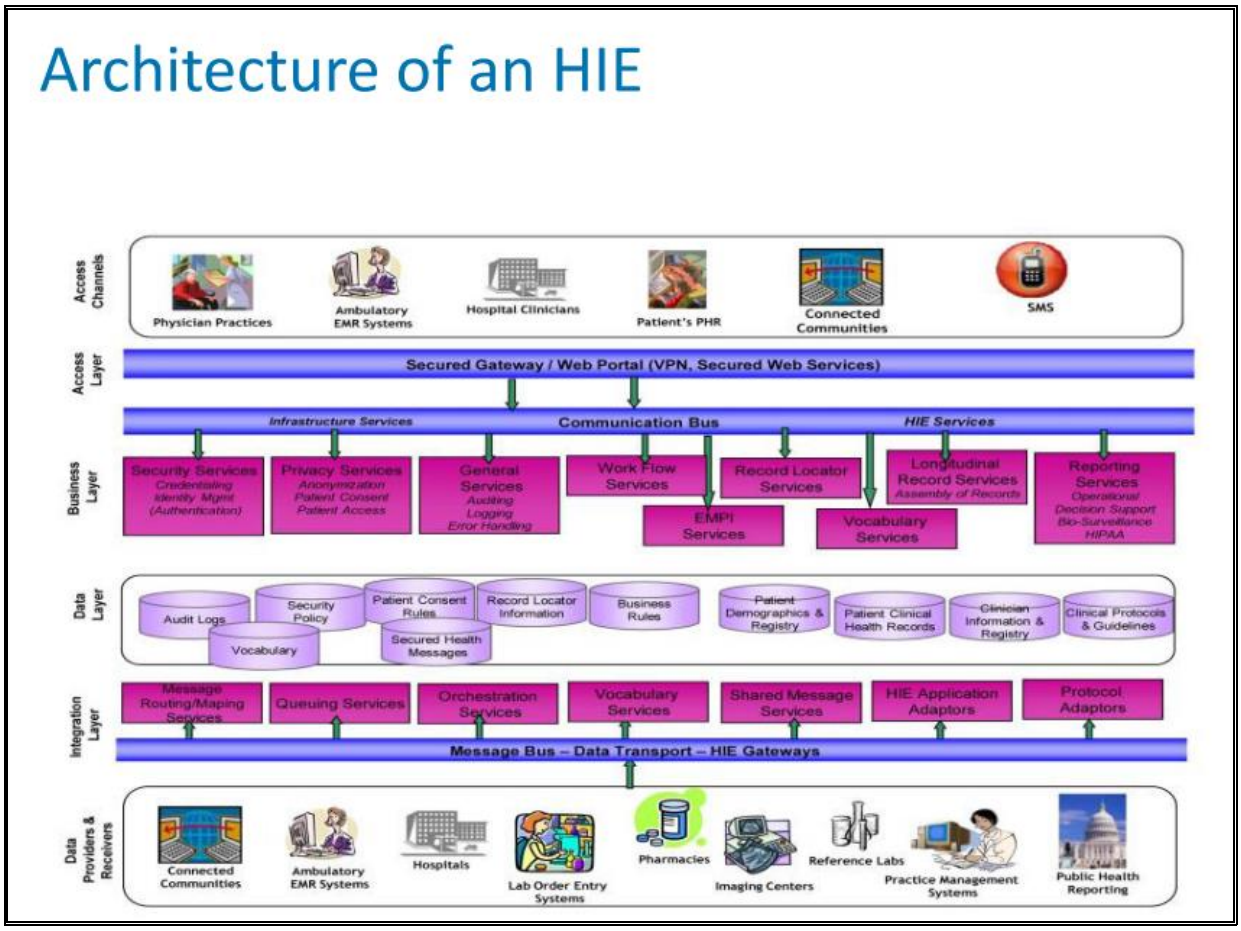

Figure 3-5: Health Information Exchange Representation

Source: Goldwater (2017)

3.4.8. ADVANCED MANUFACTURING

Three-dimensional (3D) printing (additive/layered manufacturing) has changed considerably from just being able to print plastic. With the assistance of advanced software, complex shapes can be made as well as different materials used (MacDonald, 2018). 3D printing has become quite popular due to the reduction in costs and higher quality products and speed (Yan, Dong, Su, Han, Song, Wei & Shi, 2018). This technology has the potential to eliminate issues encountered by traditional methods of integrating human tissue or organs into people through auto-transplantation, xeno-transplantation or artificial mechanical organ implants and could solve donor shortage problems (Yan et al., 2018).

Several bacterial colonies have been produced by 3D printing with a porous gelatin formation around the bacteria (MacDonald, 2018). Another key area of 3D printing will be in the ability to quickly make customised organ/medical models cheaper and more accurate for doctors to surgical train upon preoperatively (Yan et al., 2018). Approximately ten million people globally need surgery for prevention of corneal blindness and about five million lose their sight because of corneal dysfunction annually (Tighe, 2018). Thus, the Newcastle University in the US, having been able to 3D print human corneas, has come as great news and the possibility that it could alleviate the shortage of corneas worldwide is inspiring (Tighe, 2018). An artificial cornea was created using stem cells from a healthy donor mixed with a seaweed gel and collagen to generate a 'biological ink' which was then used to 3D print circles (Tighe, 2018).

The main difficulty in 3D printing tissues or organs is being able to produce the highly complex vascular network which is why more researchers are now focusing on blood vessel printing (Yan et al., 2018). Scaffolding is an important step in this type of printing and comes with its own set of challenges to create a foundation for the cells to lay on (MacDonald, 2018). Other successful examples of 3D printing in the medical field include: a bionic ear created with chondrocyte-hydrogel and silver nanoparticles which ended up having better audible function than a human ear; biopolymer materials were used to generate an operational cardiac valve and researchers have been able to 3D print an artificial trachea which they implanted into a baby with a breathing defect and thus performed the world's first 3D printed human organ transplant successfully (Yan et al., 2018). These applications are not widespread due to further research that is required, but noteworthy achievements have been realised.

3.4.9. AUGMENTED AND VIRTUAL REALITY

Augmented reality (AR) and VR are two of the ways that technology can change the way you look at the world and is part of the digital revolution that merges physical and digital fields (WEF, 2016b). AR differs from VR in that it allows a virtual two or 3D computer-generated image to be superimposed onto a real environment whereas

VR creates a simulated environment (Carlson & Gagnon, 2016). The WIRED Health conference held in London in 2017, which hosted health professionals and technologists, had a large focus on VR. VR is mostly known for its use in recreational activities but the conference highlighted companies that are involved with VR for an engaging solution for physical and neuro-rehabilitation as well as assisting with restoration of eyesight (Dalton, Madry, & Dallas, 2017).

VR programmes are involved in surgery much more commonly recently with a control trial findings which links improved laproscopic surgical skills with proficiency based VR simulator training as well as ear, nose and throat surgery indicating that technical skills gained through VR methods are better than the traditional ways (Sadideen, Goutos, & Kneebone, 2017).

AR has the potential to offer influential, related and well positioned experiences for students who can use them to build novel understanding based on their interactions with virtual items (Zhu, Hadadgar, Masiello, & Zary, 2014). The technology is being applied across fields of study but the benefit it provides with clinical students is the lack of invasive procedures required (Zhu et al., 2014). The following are views associated with using AR for healthcare training:

- Contextual learning for medical students assists in realising core competencies like decision-making and adaptation of global resources,
- AR provides more authentic studying and satisfies various learning styles, thereby providing a more personalised experience, and
- Mistakes made during these trainings mean that patients remain safe (Zhu et al., 2014).

3.4.10. ARTIFICIAL INTELLIGENCE (AI)

AI has seen the introduction of digital personal assistants, robots and driverless cars (WEF, 2016b). Developing AI technologies are inclusive of natural language processing, machine learning and computer vision which are able to self-adapt and

are interlinked with pattern-recognition and data mining to provide solutions (Accenture, 2017). Some of these would include:

Cognitive robotics – robots that acquire knowledge from experiences and the environment;

Virtual agents – chatbots that are online who are substitutes for call-centre agents and sales support;

Data visualisation – recovery and modification of data irrespective of its format or storage;

Recommendation systems – marketing on social media channels and directed content;

Identity analytics – defining of access to vital data and operations from information within command systems; and

Speech Analytics – software that can identify patterns in speech to recognise stress and emotions for the improvement of communication and extraction of information (Accenture, 2017).

Cautionary advice has been provided in terms of the consequences of giving machines ethical accountabilities and possible dangers that people need to consider (WEF, 2016b). As machine learning advances, solutions to major societal issues could be achieved, but it will definitely require the engagement of several stakeholders and collaboration to ensure matters such as transparency, accountability and privacy (WEF, 2016b). There are numerous forms of robots, cobots and automation in factories, but AI is far from taking over people's lives at this moment because the AI that is currently on the market is not as intelligent as one would think compared to ideas that have been portrayed in movies (WEF, 2016b).

According to estimates by The United States Agency for Healthcare Research and Quality, AI alternative treatments or early stage detection could prevent 4.4 million hospital admissions in the US which translates into saving costs of around $30 billion for which nearly 50% can be linked to diabetes and heart disease (Tranmer et al.,

2018). Researchers in Boston, US, have been able to predict hospitalisations due to diabetes and heart disease based on their EHRs with up to 82% accuracy and almost a year ahead (Tranmer et al., 2018). This helps in hospitals to reduce costs by knowing if an alternative treatment should be considered or if a patient requires admission.

Market prediction is that AI will be worth $35 billion by 2025 with twice the economic growth rates that are currently being seen. This eludes to the potential of robots being a major part of life in the near future (Accenture, 2017). SA however, is hindered by companies who are stuck with legacy systems, technologies and corporate arrangements as well as infrastructure that is a lost investment with employees who might not be able to deal with the AI uprising happening globally (Accenture, 2017). In SA, around 78% of executives realise the need for innovations like AI and the like to improve their organisation's competitiveness, but only about one third of these companies have planned for such investments (Accenture, 2017). Accenture (2017) analysed the economy of SA and other countries to discover that AI could potentially increase the annual economic growth rate in SA by one percentage point and additionally could double the size of the economy.

Automating diagnosis, as well as prevention and the probability for individuals to get a disease and forecasting disease outbreak are some of the activities that AI can provide. These will yield positive health results and would help providers with planning (InsightBrief, 2018). Robot-assisted surgery is linked with AI and is projected to create a large financial return of about $40 billion per annum in the US by 2026 and result in hospital stay reduction (InsightBrief, 2018). This type of surgery is recognised as the gold standard for treatment of prostate cancer along with bladder and kidney cancers. The da Vinci robotic technology, which is available at three Netcare hospitals in SA, allows surgeons to visualise the prostate, neighbouring tissue and neurovascular packs in 3D with excellent definition and hand controls that provide the surgeons with advanced control to perform intricate procedures with precision (Netcare, 2018). Other benefits that can be seen with this technology are decreased requirements for blood transfusion, decreased risk of infection, minimised pain post-treatment and shorter recovery times (Netcare, 2018).

An example of this type of technology being used successfully was recorded in October 2018 when an oncologist from a city in SA, Port Elizabeth, treated a patient's brain tumour with new remote technologies and Gamma Knife radiosurgery equipment from 1000 kilometres away (Chowles, 2018a). The Dr. Walton who performed the surgery was thrilled and honoured to have learnt about this technology and is enthusiastic about its potential going forward (Chowles, 2018a). This facility is the only one of its kind in SA at the moment but based on the positive outcome and the significant benefits in the quality of life and survival rate, it is surely not the last.

Along with the benefits, there are challenges that the healthcare industry will experience when dealing with AI namely: security and privacy concerns; lack of interoperability with other platforms; higher standard of performance required and oblivious to patients' emotional indicators (InsightBrief, 2018). To prove the importance and the spreading of these types of technologies, WEF invested in and unveiled recently the Global Centre for Cybersecurity which is a platform dedicated to enabling a safe space for technologies such as AI, drones, IoT, etc with the assistance of multiple stakeholders (WEF, 2018a). The progress towards an AI ecosystem depends on partnerships and collaboration between several stakeholders acroos the private and public sector in order to provide access to entrepreneurs, universities, etc (Accenture, 2017). A huge aspect of enabling optimal adoption of AI into healthcare is to address the apprehensions of the people by providers and the reassurance that AI will not be replacing humans in this field but rather modifying applications.

3.4.11. DRONES

Unmanned vehicles/aircrafts, or, more commonly referred to as drones, are taking over the skies with innovators coming up with new applications for this remarkable technology which range fromphotography to geo-tagging solar farms (WEF, 2018b). As mentioned above in the Rwandan example, drones are becoming more useful in the health arena with the delivery of vital medical supplies. They also have the potential to supplement efforts for searches for injured persons in remote locations

(Bennett et al., 2017). Drones also have the ability to carry and deliver other medical equipment or supplies to inaccessible areas thus providing a life-saving function. The use of nanotechnology in manufacturing drones will significantly change the use and, potentially, will change the perception of drones in the future when we consider the possibility of the almost invisible sizes of drones (Marope, 2014).

In 2013, CSIR was of the opinion that SA was lagging far behind in exploiting this technology to benefit the country, especially in terms of national security and socio-enomically (defenceWeb/CSIR, 2013). Scaling up of this technology by allowing millions of these aircrafts to fly safely will need government regulation and standards that are clever to cover infrastructure, management of airspace, privacy and data ownership (WEF, 2018b).

3.4.12. PRECISION MEDICINE

The science of creating customised medicine based on genetic variations in drug reactions of individuals is called Pharmacogenomics (Rowley, 2002). Precision medicine has been gaining interest over the last few years with more than 17000 artciles being published in the last five years (Weil, 2018). It is known as the approach for disease treatment and prevention that considers varability in genes, the environment and lifestyle of individuals (Weil, 2018). This knowledge is vital in avoiding adverse drug reactions and making sure that the most effective drug is prescribed (Rowley, 2002). Precision medicine provides a prospect of personalising diagnosis and treatment to a specific individual or population with the added advantages of improved outcomes and results in lower costs due to the effectiveness (WEF, 2018b).

Precision medicine is seen to be progressing alongside biological measuring instruments and analytics. While the former quantifies and maps out the genetic make-up, proteins, etc., the latter allows for analysis to predict behaviours of the patients, thus providing preventative and personalized treatment (Weil, 2018). The cost of genetic testing has decreased considerably due to advances such as the next-generation sequencing technology which has added more disease-causing variations being identified and which implies that genetic testing will become more

common and provide more information (Dainis & Ashley, 2018). There is rich potential for precision medicine to diagnose better and to treat rare diseases specifically when therapeutics with particular molecular targets have been identified (Dainis & Ashley, 2018).

The use of AI and algorithms account for the genetic differences related to environment and lifestyle which produces potential for precision diagnosis at a much larger scale (Weil, 2018). Genetic data gathered can be used to realise genetic variations amongst subgroups and could then be used to understand what influences a specific condition (Rowley, 2002). According to studies undertaken by Dainis and Ashley (2018), successful and long-lasting treatments have been provided through this technology for oncology and cystic fibrosis. This will inspire new treatments in the near future. The ‘one size fits all’ for drugs is not the best way to treat people and this technology will allow a more effective outcome for particular groups of people (Rowley, 2002).

3.4.13. TELEHEALTH

Telehealth refers to the support of delivery of healthcare at a distance with a health educational component as well and involves a platform for collaboration, knowledge and expertise sharing and engagement of communities (Broderick, Lindeman, Dinesen, Kidholm, Spindler, Catz & Baik, 2017). It is a dynamic field that is continuously evolving due to the advancing of foundational technologies in relation to applications and users. Telehealth has been spreading far more rapidly than other technologies in the healthcare sector which can be attributed to the increasing acknowledgement of the ability of telehealth to increase access to healthcare and achieve better outcomes with more efficient use of resources (Broderick et al., 2017).

There are main points when considering scaling up telehealth and the sustainability thereof. These include the following: accessibility tof real life examples of the dire need for telehealth or where issues are being addressed successfully by this technology and the benefits; an enabling infrastructure to allow for adoption and diffusion and finally, confirmation of cost-effectiveness along with best practices for implementation (Broderick et al., 2017). Telehealth is considered a clinical tool and

thus needs to be led by clinicians. This can only happen if they accept the data, use it appropriately and see the major impact and benefit of its use (Brownsell, 2009).

Telehealth speaks to healthcare delivery as well as care management but these need to be combined for effectiveness. The main market drivers consist of telecommunications infrastructure with the addition of new technologies. Such as AI and Big Data as well as increased focus on patient-centred care (Broderick et al., 2017). According to Broderick et al., (2017), telehealth can serve as a vital strategic resource in healthcare and grow into being the standard of remote care. Cloud computing should support virtual care especially for the aging with video sessions from their homes and this would replace the difficulty of physical visits for these patients (Gionet, 2017).

mHealth solutions are the main vehicle for delivering telehealth services and more than 83% of countries are noted to have no less than one mHealth initiative (Rossi, 2017). Telehealth will need to use consumer innovations like mobile phones, sensors, data analytics in order to increase access to virtual care remotely and on-demand. IoT-based services and other connecting technologies will allow for remote monitoring and data analysis to enable self-management of health (Broderick et al., 2017). The current smart home personal assistants will be used to assist in integrating data flow and connectivity. As virtual care becomes more common, healthcare services will amalgamate between physical and online exchanges and new frameworks will develop to create value high quality services (Broderick et al., 2017).

3.5. HEALTH TECHNOLOGY ASSESSMENT (HTA)

Across the world, there are different mechanisms to regulate health technologies that enter the market and these are not standardised. The HTA is a separate process and is generally independent of regulatory decisions. Also, itis only being subjected to very few technologies even in developed countries (Mytton et al., 2010). The HTA is an organised, clear, unbiased and vigorous evaluation of a technology of which the main component is a systematic literature review (Mytton et al., 2010). The

assessment would contain information about the clinical effectiveness, economic, safety and ethical issues related to the use of the technology.

The level of regulatory control should be in line with the potential risks of the technology, in order to allow for the protection of the public, while still providing access to new technologies and encouraging an innovative business environment (Mytton et al., 2010). Regulatory controls are not meant to hinder trade and industry. The HTA is based on scientific principles and aims to achieve effective and safe health policies that are focused on the patient. For new technologies, where there may be limited literature, expert opinions are included in the HTA (Mytton et al., 2010). The good news for developing countries like South Africa is that HTA evidence produced elsewhere can be adapted for the local context. This minimises the costs around such an exercise significantly. HTAs would be able to provide important information for decision-makers within health systems and should be considered for this purpose (Mytton et al., 2010).

Clinical engineers who specialise in health technology are required to be involved in the planning, evaluation and implementation process of new technologies. Consideration of whether the technology will fit with the organization, what training is required, as well as the skills and needs of the users must be given (Mytton et al., 2010). Safety decisions on new technologies are imperative and although there would be a focus on the lowest cost products, safety cannot be compromised.

3.6. CONCLUSION

This chapter reviewed trends and technologies that are currently making waves as well as innovations that are changing or going to change the healthcare industry in the future. Consequences in terms of incorporating new health technologies have also been discussed with respect to jobs, inequality, regulatory systems and the impact on patients. The following chapter will explore the Six Pillar methodology, CLA and scenarios in respect of possible futures for health technologies in SA.

4 CHAPTER FOUR: FUTURE STUDIES – THE SIX PILLARS

4.1. INTRODUCTION

One of the major reasons that future studies is important is that potential trends in health can be identified and, thereafter, activities can be planned in order to exploit these trends to provide desired results (Sapirie & Orzeszyna, 1995). Most pharmaceutical biotechnology firms in India undertake foresight exercises for short term periods and this seemingly aids in predicting technologies, prioritising R&D areas, shaping the future and remaining competitive (Desai, 2014). All biotechnology-related regulatory agencies also use foresight to plan for regulatory processes and feel that it is vital (Desai, 2014).

WHO's Regional Director for Africa, Dr. Matshidiso Moeti, spoke at a launch event and voiced his delight that Africans are living longer and healthier but also articulated the need for health services to keep abreast of new developments and try to incorporate health trends and he mentioned countries like Algeria, Kenya and Mauritius as prime examples to follow in this respect (UN News, 2018). Due to the revolution of democratisation of technology, bandwidth has increased, megabyte memory and data transfer costs have decreased and the potential for its use in healthcare is huge (Miller, 2003). The implementation of specialised health programmes has also seen a dramatic decrease worth noting between the years 2000 and 2015, for the largest health risks in Africa which include HIV, diarrhoeal disease and respiratory infections (UN News, 2018).

One way to go about creating a desired future involves asking oneself several questions around what they think the future will be like; why they think it will be like that; what future state would they be afraid and why; what assumptions can they make about the future; what alternatives to these futures can they think of; what would their desired future be and what steps would they take to get to that state (Inayatullah, 2008).

4.2. QUALITATIVE STUDY

Qualitative research is one of the main methods used to study the social and individual world and does not utilise statistical or quantification methods but obtains insights not achievable with other research methods (Yilmaz, 2013). In contrast to quantitative studies that focus on outcomes, prediction and cause-effect connections through deductive reasoning, qualitative research focuses on context, interpretation and understanding through inductive reasoning (Yilmaz, 2013). Broad and more generic questions are posed in order to allow participants to explain themselves and it generally revolves around one common interest (Creswell, 2014). The findings in a qualitative study are more detailed and variable in content and purposeful sampling is vital to select and analyse a small number of people where in-depth information can be deciphered (Yilmaz, 2013). Bell and Inayatullah, both leaders in futures studies, have suggested that research methods be more qualitative and participatory in nature (Voros, 2007).

4.2.1. METHODOLOGY

The methodology through this study was exploratory, aiming to gain additional information from senior people in the healthcare space who have dealt with health technologies directly previously, or who have at least been exposed to them. It was important to the study to get a network of relevant stakeholders to gain better insight into the field and it's potential. Each participant has a leading role in his/her organisations and has a good understanding of health technologies. The spread of respondents based on their sectors can be seen in Figure 4-1 below. Based on the literature review undertaken for this study, collection of primary data was required to gauge a clearer understanding of people's perspectives in SA specifically.

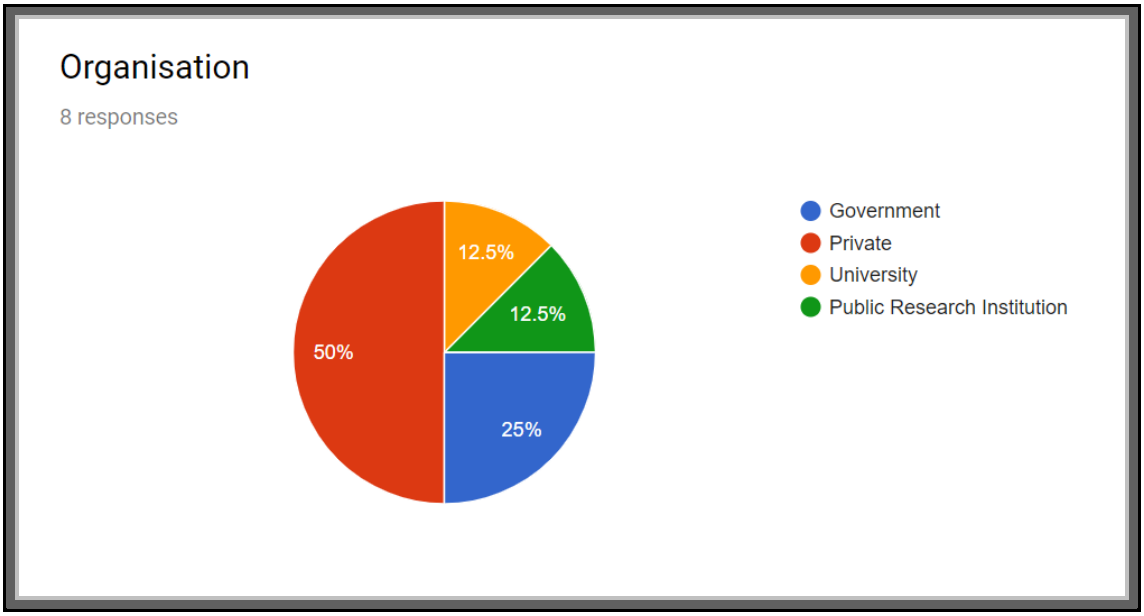

Figure 4-1: Respondents Divisions According to Sector

Source: Author's Survey using Google Forms

Surveys were developed using the Google Forms platform and selected participants were sent emails with a link to access the survey and complete it online. Ten participants were sent the link, but only 8 respondents completed the survey. The survey was semi-structured with a few closed and majority open-ended questions, giving participants the opportunity to elaborate if necessary. The questions can be found in Appendix 1.

The purpose of the research survey was to gain insight into what stakeholders believe to be the most important aspects, challenges, ideal future vision, working examples, assumptions, opinions on AI and possible private and public interventions with regards to health technologies.

4.2.2. RESULTS

The respondents in the study had the following designations:

Top Management - Dynamic Body Technology – start-up business
Senior Lecturer
Top Management - Medical Research Council

Top Management – Medmetrics – small business
Professor at Tshwane University of Technology
Technology Project Manager – Medical Research Council
Consulting Analyst - Healthcare
Medical Doctor

The detailed responses can be viewed in Appendix 1. All respondents were in agreement on the critical need of health technologies in SA, whether it be for affordability or access to healthcare services. Driving forces of health technologies included: increased health awareness, lack of adoption by clinicians, funding, ICT support systems, skills of heathcare providers, user-friendliness and reliability of technologies, cost, and higher quality treatments, limited resources in healthcare systems, interoperability and awareness. The opportunities for health technologies are numerous and positive. Suggestions for the private and public sectors had a major focus on the importance of collaboration and PPPs. Among the responses were ideas for the government to invest more time in upskilling healthcare providers, sort out regulatory issues, streamline approval processes and possibly introduce a dedicated unit within the NDoH to deal with health innovations and facilitate PPPs. All the respondents were particularly positive and welcoming of the use of AI and robotics within healthcare, as long as costs and infrastructure enable optimal usage.

These insights have informed part of the environmental scanning and were used along with the first pillar to complete the rest of the pillars, particularly the CLA, scenarios development and visioning of possible health technologies futures towards 2035.

4.3. FUTURES MAPPING

This study will consider and discuss the evolution of health technologies, key global trends in the health technology space and look at aspects that will affect its progress into the future. Thereafter, an environmental scan of SA and the healthcare industry will be provided to explain drivers and advances that will have an effect on the future. Environmental scanning (ES) refers to the attainment and use of information in the

organisation's external environment around events, trends and associations which assist in future planning (Choo, 2005). ES covers the political and regulatory environment, technological aspects, economic conditions along with social and demographic trends (Choo, 2005). This technique is used to drive strategic planning in many businesses as well as public institutions. In the first pillar, 'Mapping', the past, present and future are plotted and the main aim is to understand where one has come from and where one plans to go (Inayatullah, 2008).

4.3.1. EVOLUTION OF HEALTH TECHNOLOGIES

Every achievement in medicine and science is shaped by what was previously invented and health technologies, specifically digital health, has been developing for years and is just now at the front of progress (Heritage Partners, 2017). Health IT refocuses healthcare around patients without much industry disturbance, and IT results in improved and more efficient care (Goldwater, 2017). Heritage Partners (2017) have a timeline of significant technologies that have emerged over the years and a summary will be detailed below:

1940s – a system to manually-record data in a database was developed

1950s – the first implantable cardiac pacemaker was fitted

In the 1960s, IT drivers were costly mainframes and expensive storage with medical insurance coming about and eventually resulting in shared hospital accounting systems (Goldwater, 2017).

1962 – electronic data systems used mainframe computers to automate administration of insurance programmes,

1969 – the first programmable logic controller (PLC) was shipped and became the digital core for generations of automated medical equipement and laboratory instruments

1975 – the first super-computer which massed five and a half tons was shipped and AI R&D as well as deep learning was facilitated

1982 – compact user-friendly infusion pumps were permitted for home-use and, currently, these systems are wireless and able to be integrated. Laboratory information management systems appeared in research facilities with commercial versions following personal computers

1983 – the first wearable wireless heart rate monitor was introduced

1984 – healthcare informatics standards and focus groups emerged globally

1987 – the first commercial automated DNA sequencer was introduced

1989 – the first glucose meter for home-use was launched with one of the early biosensor technologies and it allowed for quantification of glucose levels digitally

1998 – eBioinformatics.com was formed in Australia to provide genomics applications but it is important to note that it was not accepted by the industry initially. The UK implemented the Data Protection Act for patient records confidentiality

1999 – Personal digital assistants were used in collecting data from clinical trials with uploads via copper telephone lines

In the 2000s, more integration could be seen with more mobility and cloud computing developing in the IT space resulting in clinical decision support and data and analytics warehousing support (Goldwater, 2017).

2000 – map of the Human Genome was published which served as a huge achievement for big data usage in medicine. The Da Vinci robotic surgical system launched with inferior AI abilities

2007 – the first iPhone was shipped and the word ‘App’ becomes common. Fibit founded

Medical insurance funds of about $17-$19 billion were provided in the US to encourage the EHR technology for hospitals to adopt the technology (Goldwater, 2017).

2014 – venture capital invested more than $3 billion into digital health start-up companies. UK published national health data strategy entitled Personalised health and Care 2020

2016 – around 50% of US consumers possessed wearable technology in some form. PatientsLikeMe.com which was a platform launched in 2004 to connect a specific disease-carrying patient community had over half a million members and more than 2500 other disease listings (Heritage Partners, 2017).

The smartphone has spurred the shift of eHealth to mHealth and tablets are now common and increasedly being used for patient education, storage of reference material and in research projects (Perera, 2000). As manufacturing costs for medical devices and wearables decrease, these will be found everywhere and would be used in the natural rather than artificial environments which would allow for collection of large amounts of data that could potentially lead to groundbreaking discoveries (Tasnim et al., 2018).

Inayatullah (2008) refers to continuous versus discontinuous histories as the first tool required for futures mapping and, when looking at Figure 4-2 below, one can see that there are linkages between the years as technologies progress. This results in the industry moving to more of a machine-based approach rather than labour intensive as well as being more consumer-centric. There is more reliance on technologies to make healthcare service quicker, more affordable, with better quality and being more efficient. When looking at it from an irregular or discontinuous perspective, many more technologies are being churned out in a much shorter time period than previously and have had a much greater impact. This can be linked directly to the emergence of new ITs. This could refer to the ‘jumps’ that Inayatullah (2008) mentions and these aspects create a framework for progress into the future. A convergence of trends is most likely to create discontinuous and abrupt changes in healthcare systems, whether simple or advanced, and is expected to be reactive and costly (Deloitte et al., 2016).

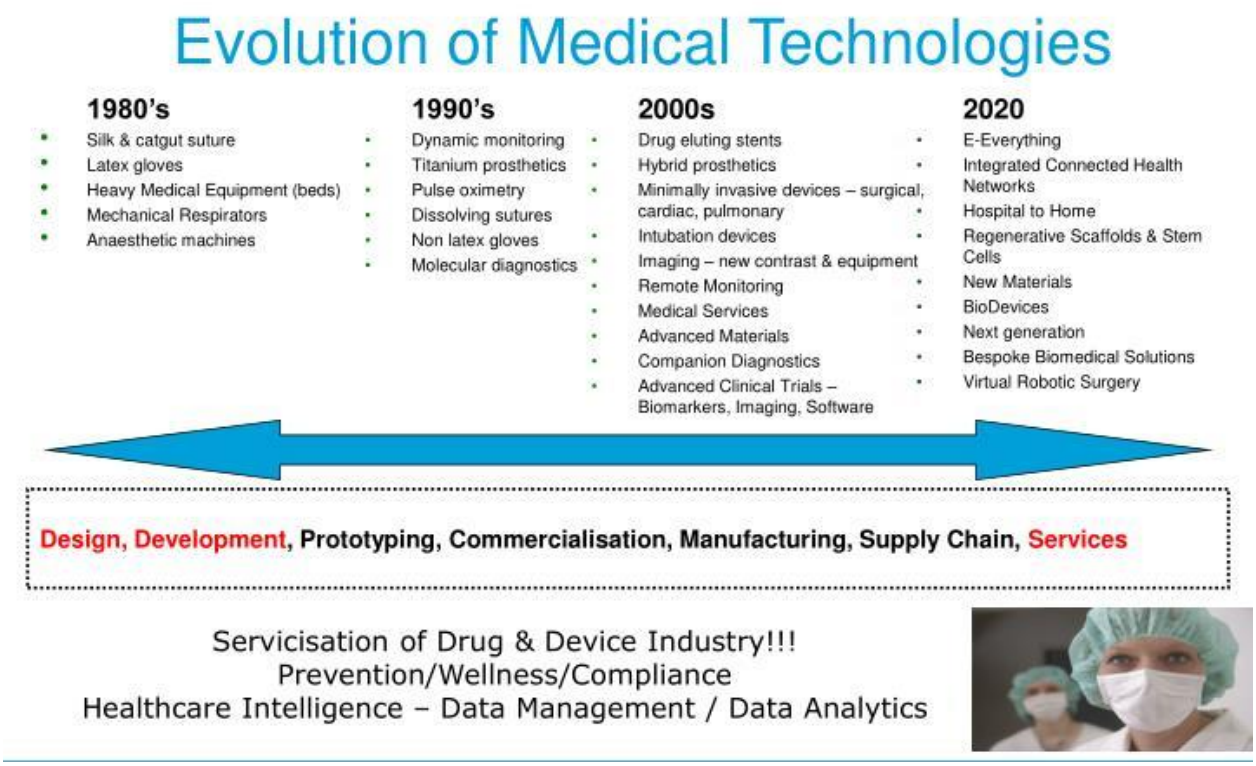

Figure 4-2: Medical Technologies Evolution

Source: O'Neill (2012)

4.3.2. GLOBAL TRENDS IN HEALTH TECHNOLOGIES

ES allows for strategic acumen and assists in the identification of current issues and possible drawbacks that could have an effect on the future of an organisation or industry (Du Plessis, 2016). Trends have been recognised as social patterns from the 1800s, either to explain movement in statistical data with reference to population, for example, or in indicating changes in habits or behaviours (Powers, 2018). A shift later occurred, which identified the value that could be obtained from these trends and forecasters started using this method to identify future possibilities. This was extremely useful in corporate organisations (Powers, 2018). Trends are able to offer a connection between the past and future which enables a conversion from information to knowledge of possibilities (Du Plessis, 2016). Megatrends outline what will define society moving forward and are considered unavoidable, thereby setting

people on new paths (Powers, 2018). In order for businesses to keep up with trends, understanding of trends to define the future is required. Key recent global megatrends acknowledged by prominent publications and organisations for the healthcare industry are available, but for the purpose of this research, they were adapted to be more specific to health technologies and an outline is provided in Table 4-1 below.

Table 4-1: Global Megatrends Summary

Global Megatrends	Source
Discontinuities Politics Demographic Shifts Digitalised Futures Globalised Industries + Commodification	Deloitte
Changes in demographics Chronic diseases and conditions Depleting resources The distrustful consumer The empowered consumer mHealth	PriceWaterhouseCoopers
Rural Healthcare Consumerism in Healthcare Workforce Change Technology Acceleration and Transformative Market Impacts Government: Legislative and/or Regulatory Change	National Center for Biotechnology Information
Immuno-oncology Gene therapy Personalised medicine Artificial Intelligence Wearable digital devices	WEF

Disruption and economic sustainability drive the healthcare revolution The journey to Health 2.0 The next wave of digital innovation will be even more disruptive Fragmentation, adoption and behavior patterns challenge Health 2.0	EY
Biomedical research and innovation Pharmaceutical research entering new era of open science and the usage of converging technologies Digital technologies New public and private R&D Patient groups Low-cost advanced technologies like synthetic biology and additive manufacturing	OECD

Source: Adapted from Deloitte et al., (2016), PwC (2016), Vogenberg and Santilli (2018), Bourla (2018), Ernst and Young Global (2017) and OECD (2016)

Selected global trends are explored to identify drivers and issues with regards to health technologies and will be elaborated upon in the next sections.

4.3.2.1. Healthcare's Digital Future

The healthcare industry has followed other industries with regards to adoption of IT starting with the first wave in the 1950s with the automation of repetitive tasks and the processing of large amounts of statistical data; the second wave in the 1970s was responsible for the integration of processes within organisations. This brought about the electronic health card in Germany and the Health Information Technology for Economic and Clinical Health Act in the US to support health IT. The third wave that is currently in motion allows for the full digitisation of organisations and, in addition, digital products, channels and analytics which healthcare still needs to assume (Biesdorf & Niedermans, 2014). There has been a significant rise in the number of health innovations in the last few years, and this is positive for society at large because most of these technologies were invented for the purpose of improving the quality of life standards and for reducing costs of traditional treatments (Deloitte et al., 2016).

McKinsey carried out a Digital Patient Survey in 2014 and major findings were: More than 75% of patients anticipate using digital services in the future; all age groups of patients are willing and enthusiastic about using digital services for healthcare, but older and younger patients differ between the kinds of digital channels used; mHealth is strongly preferred by younger people but will not be the single most critical health technology; and the most important characteristics that people expect from their health systems include simple things such as efficiency, access to information, integration and contact to a real person if the digital system is unavailable (Biesdorf & Niedermans, 2014). Depending on the technology itself however, uncertainties and caution arises when it comes to adoption as can be seen in Figure 4-3 below. These exponential technologies could possibly disrupt the systems and processes traditionally used in the industry (Deloitte, 2018).

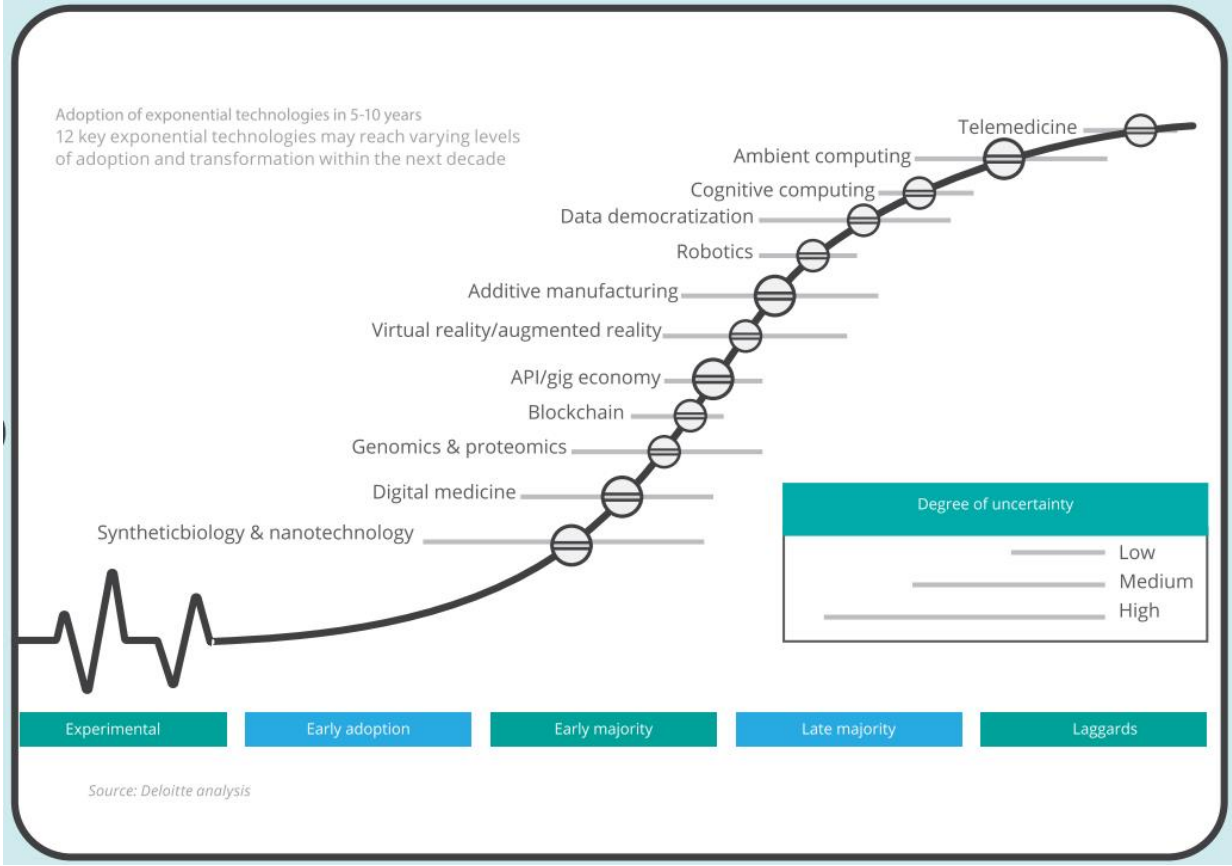

Figure 4-3: Adoption Behaviour of Key Health Technologies

Source: Deloitte (2018)

Healthcare leaders need to build technology ecosystems where collaboration is encouraged with people from other fields and including digital healthcare and analytics as part of improving service offerings (Deloitte, 2018). It is important also to invest in pilot testing of technologies before moving to scale-up but also we need to be agile in altering their strategies to progress (Deloitte, 2018).

Artificial Intelligence

The power of AI is set to significantly decrease analysis and testing times as can be seen from pharmaceutical R&D labs that are utilising AI to improve diagnosis and treatment through the prediction of linkages between biological mechanisms and diseases (Bourla, 2018). Cognitive computing refers to machine learning, deep learning, etc. and is used to formulate statistical algorithms on huge volumes of data and create new models. This is extremely useful since the amount of healthcare data available from wearables, EHRs, medical devices and others, is increasing rapidly which necessitates novel approaches to allow for personalised medicine (Deloitte, 2018). Machine learning may also be used to link data from unrelated sources to form a 360 degree view of a patient (Deloitte, 2014). Internationally, AI is currently being used to optimise healthcare. For example,: Japan is trialling elderly care through robot assistance; China's healthcare providers are making use of AI to assist with imaging diagnosis in lung and skin diseases; a US startup is currently taking data from hospitals and employing AI to deduce how to create efficiencies by freeing up doctors and nurses to allow them to see more patients (Deloitte, 2018). AI and robots will enable caregivers to be more involved in providing care to patients rather than being preoccupied with administrative activities (WEF, 2016a).

Intellectual Property

One should consider that most of the health innovations produced come through privately funded R&D and are protected by IP rights for a certain period of time during which these innovations are quite expensive and mostly inaccessible to the majority of people (Deloitte et al., 2016). However, governments being able to step in and negate the right of patents to provide affordable access can be seen as a waste of time and money and may influence private organisations not to invest in certain

diseases for instance (Deloitte et al., 2016). Due to the increasing move toward global co-creation of value, customary IP challenges are no longer seen as a boundary when developing new technologies (Deloitte et al., 2016).

Ethics

The ethical issues around health technologies are intense, and debates are unavoidable compared to the past where ethics and medicine were working in conjunction with physicians saving lives when possible (Tan & Ong, 2002). Technology now can keep life moving for an indefinite period of time with many questioning the power healthcare providers have. However, Tan and Ong (2002) argue that the same goal of doing the best to preserve life with restricted resources and infinite demands, is still relevant. Policy-makers are concerned with the ethical implications of these health innovations, especially when it comes to genome editing and the like (Deloitte et al., 2016).

Adept human judgement is required to be used in AI results and the US tertiary education establishment, Massachusetts Institute of Technology is churning out AI applications but has also invested multi-millions into ethical standard development which is positive for the field and understanding the limitations of AI (Bourla, 2018).

The Elmina Declaration is a contract between academic institutions in Ghana and the University of Michigan in the US and is a prime example of how ethical challenges can be overcome (Kekulawala & Johnson, 2017). Nine principles that are present in the agreement are namely: sharing of experiences in innovative technology or research among all partners; developing and sharing of all resources efficiently; developing of resources to make use of education and training; improving of infrastructure for ICT and clinical care; expanding of research scope which will result in policy initiatives; to identify and incorporate human resources for healthcare workers where necessary; expansion and decentralisation of education in healthcare facilities; national government research infrastructure to fund health research to be developed and the articulation of principles that work towards a mutually beneficial partnership including trust, respect, sustainability and communication (Kekulawala & Johnson, 2017).

Nordgren (2013) discusses three sets of values that need to be taken into consideration when discussing ethics of personalised health technologies:

1. Practical values: Reliability (providing correct measurements as intended), ease of use (for both patient and heathcare providers) and affordable pricing (economically justifiable);

2. Quality of life values: Health, independence, safety and social contact (which satisfies basic human needs, preference or achieves individual's own goals)

3. Moral values: Autonomy, justice and privacy (these are important values that need to include informed and understood consent; monitoring can sometimes reduce privacy and thus 'privacy by design' should be considered when developing the technology. Should the technology be presented at a large scale in society?)

These are values that are meant to be considered and not the gold standard. Ethical checklists can also be used to generate reflection and provide direction if all their limitations are considered (Nordgren, 2013).

Open Health

Many multinational corporations are concerned about the competition from developing countries and have realised that a change is needed. Large companies have been known to grow by creating products at home and then sell modified, functional versions to emerging markets, but these were frequently too expensive or not suited which led to opportunities for local competitors to enter those markets with lower cost options that met the consumers' needs (Dandonoli, 2013). General Electric then decided to alter their mode of working and invested billions of dollars into healthcare innovation and depended on local teams in China, for example, to lower costs. This improved their quality and access but relying only on in-house expertise and resources in R&D can be slow, creatively limiting and very expensive which is why more organisations are looking towards 'open innovation', a term coined by Henry Chesbrough (Dandonoli, 2013).

Open science/education/innovation has important social benefits that allow for people that would not necessarily have access to certain things, and gives them the opportunity to take advantage of this free knowledge (Deloitte et al., 2016). It refers to the merging of internal and external ideas and routes to market to improve the creation of technologies and limit boundaries (Dandonoli, 2013). IP that was previously safeguarded is encouraged to be shared to create more value through joint ventures, licensing or alternate strategic collaborations (Dandonoli, 2013). Developed countries are now looking to emerging countries' innovations as these generally apply frugal principles and are much lower cost, durable, user-friendly, use less raw materials, are environmentally-friendly and can create huge impact in a high pressure health industry (Dandonoli, 2013).

More open systems should allow better data sharing and higher usage rates of analytics (Deloitte, 2018). Community-based health, peer-to-peer sharing and general health information and innovations relieves certain pressures on providers and they have the potential to relieve governments of financial pressure (Deloitte et al., 2016). However, just as open education requires formal structures within society, so too does the open health cause (Deloitte et al., 2016). Concern Worldwide, which is Ireland's biggest humanitarian agency, has an initiative called the 'Maker Hub', which is attaining credibility as a frugal innovation mechanism through its promotion of collaborative efforts (Figure 4-4) and is being used in various fields with positive results (Dandonoli, 2013).

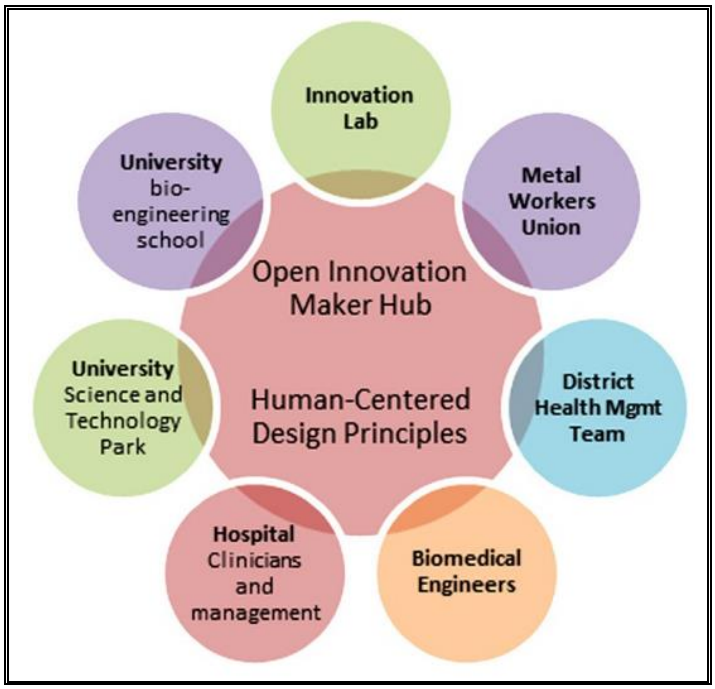

Figure 4-4: Concern Worldwide Makers Hub

Source: Dandonoli (2013)

4.3.2.2. Policy and Regulation

Healthcare policies are generally conservative when it comes to funding, primary care and clinical practice and globally, policies have similar patterns and are mostly reactive (Deloitte et al., 2016).

Most healthcare stakeholders seem tied to the dogma from attitudes and behaviours from the past, but fortunately, the nature of healthcare is moving to a place where these stakeholders become more transparent and there is better access to health and wellness (Deloitte et al., 2016). To enable this systemic shift, change is required at four levels, namely: move to measuring prevention and wellness rather than sickness; change in healthcare nature, at home rather than in the hospital; change in worldview with regards to the deep culture; and a change in the deep metaphor of healthcare with a move from doctors knowing everything to each individual being an expert about their own body (Deloitte et al., 2016).

The future of healthcare is greatly dependent on policies and regulations instituted by governments, but the problem is that government processes that are responsible for development of these are politically and financially risk averse which does not bode well for healthcare to be re-envisoned (Deloitte et al., 2016). Frameworks around the use of big data, wearables, etc. need to be introduced which protect patients and providers as well as faster approval processes to mitigate drug and product developers' as well as investors' concerns (Deloitte, 2014).

SA has an eHealth strategy that was developed in 2012 and delivered a framework to govern and link initiatives that assist digital health. However, there are plans to revise this strategy towards 2019-2023 and start implementation within the next two years (Department of Health, 2018). The National Health Normative Standards Framework for interoperability in eHealth was published in 2014 to back the convergence of data sources (Wolmarans et al., 2015). To ensure that policy, regulatory and legislative territories are steered correctly through the complex field of health technologies and information, the DoH has implemented an integrated programme in a few pilot districts which provides information regarding the difficulties of incorporating interoperability and assists in developing and refining the eHealth foundation (Wolmarans et al., 2015). The National Health Act (2003) and Protection of Personal Information Act (2013) are also in place to assist with compliance, privacy, security and integrity of information going forward (Wolmarans et al., 2015).

Due to the need of the government to gather information in order to make better policies, future studies has grown and is utilised to understand the implications of particular policy decisions and can therefore be regarded as long-term policy analysis (Inayatullah, 2012). Government regulations and policies are required to reinforce healthcare security at a macro level, whereas organisations' executives need to focus on ethics, risk and compliance (Deloitte, 2018).

4.3.2.3. Demographic Shifts

Globally, extraordinary demographic shifts can be seen with health and wellness, the most common being the impact of increase in the ageing population (Deloitte et al., 2016). Other demographic shifts include urbanisation, mobility, increased chronic

care, pandemics, climate change and mental health issues on the rise (Deloitte et al., 2016).

Population changes have a great impact on the future of health and thus needs to be included when setting up strategies with stakeholders from each demographic group being considered (Deloitte et al., 2016). Statistics SA estimated that 36% of the population was made up of the youthful population (14-35 years old) which lends itself to prospects and risks (Kujeke, 2018). SA is much further in its demographic shift compared to other African countries, and if SA can get it right with healthcare, education and employment opportunities initially, a demographic dividend could occur which would amplify economic growth (Kujeke, 2018). The government needs to invest in its youth by providing them with science and technology education avenues as well as implementing the current youth policies correctly and emphasising the need for innovation and entrepreneurship (Kujeke, 2018).

Around 66% of the global population will occupy cities by 2025, and therefore, high urbanisation with a range of income and health levels and high customer expectations can be expected (Deloitte et al., 2016). As global inequity rises and epidemiological shifts occur, cases of depression will rapidly increase as well. Developing countries have tried to close the divide, but unfortunately, the poorest people are most susceptible to disease (Deloitte et al., 2016).

4.3.2.4. Globalisation

Images of sports cars, iPhones, digital revolution, trade and investment potential, free markets and interconnectedness of economies and economic prosperity often come to mind when thinking about globalisation (Ndhlovu, 2012). Due to the slow downturn of economic growth and financial crises, globalisation is also linked with negative implications such as poverty creation, higher inequalities and deteriorated working conditions (Ndhlovu, 2012). Healthcare is one of the global industries that has invested heavily in R&D for competitive reasons and has thus grown much more sophisticated corporations (Deloitte et al., 2016). Technology has had a huge impact on the nature of R&D whereby the convergence of technologies for example, biology and diagnostic sensors blur the lines on what is a medical device, diagnostics or

augmentation (Deloitte, 2014). Healthcare is also exposed to competitive market pressures, product parity and commoditisation of services with the stability of the economy having an influence on healthcare globalisation as well (Miller, 2003).

Globalisation cannot be discussed without entrepreneurship as the former creates new opportunities and hurdles where potential for better productivity, increased markets and thus entrepreneurship can be found (Mutalemwa, 2015). Globalisation generates prospects for SMEs' undertakings and operations and imposes competitive pressures on them which not all of the companies can sustain (Mutalemwa, 2015). Many African countries have seen a dramatic improvement though, with regards to making it easier for local entrepreneurs to conduct business than in the past (Mutalemwa, 2015).

Ndhlovu (2012) argues that globalisation will have a positive impact on developing countries with greater economic integration, minimised inequality, greater governance and a better life for the citizens as well as challenging industries to perform in an above average manner to remain competitive in order to have the chance to play on a global stage. Manufacturing SMEs have been lagging behind when it comes to globalisation and contributing to the SDGs, although sub-Saharan Africa is open to international transactions (Mutalemwa, 2015). The three main causes as explored by Mutalemwa (2015) include: African SMEs lack competitiveness that is driven by flexibility, technology, quality and networking; the journey that these SMEs have to take to reach competitiveness and lastly, dependency on their ability to create export markets which are highly competitive, technology-filled and rapid pace area.

Large pharmaceutical, private health and insurance industries have had significant power over governments but a new age has erupted where democratisation of health, arts, education, etc. are disrupting governments. These old traditions have to make way for a shift in healthcare power amongst stakeholders (Deloitte et al., 2016). Big pharmaceutical companies have to now compete with biotechnology start-ups with more than 50% of novel drug compounds that are in the clinical trial stage having been created by small biotechnology R&D companies (Miller, 2003).

Medical globalisation has been progressing rapidly with the West acknowledging the opportunities in markets that were previously not on their radar. For instance, India has an attractive developing healthcare market with a vast underserved population wherein the government has invested significantly into ICT infrastructure to educate employees (Miller, 2003). Efficient global transfer of healthcare information is where future profitability exists (Miller, 2003). Globalisation of medicine and trade has improved the condition of the world in various ways.

4.3.2.5. Consumerism in Healthcare

Healthcare has developed into a business with a corporate-like commitment to serving its consumers as in other industries and Healthcare is also answerable to market forces and the public or shareholders (Miller, 2003). The patient is considered a consumer in this day and age, and expectations of these consumers have risen with more and more patients working towards prevention rather cure (Deloitte, 2014). Most industries understand the power that their customers yield. However, healthcare has been slow in realising this, but that is why the move towards consumer-centric healthcare is so vital (Deloitte, 2014). Patients now understand the options they possess and will have access to more information to make more informed decisions so as to get the best treatment at a price and time that is suitable in their lives. Healthcare organisations should look at what their patients' digital preferences are and create digital strategies based upon that information for successful incorporation (Biesdorf & Niedermans, 2014).

Health 2.0 is a different model of healthcare and revolves around patients being empowered customers with more information and control. This is in contrast to the traditional passive approach (Schreiber, 2016). Personalised medicine speaks to the unique needs, genetic diversity and lifestyle of individual patients and has the potential to provide less inefficient treatments and improved outcomes with a study revealing that chemotherapy use was reduced by 34% due to genetic testing (Bourla, 2018). Improving the consumer experience is seen as a driver for hospital performance, in that customer loyalty is built, reputation and brand is strengthened and there is an increased use of hospital services through word-of-mouth referrals

(Deloitte, 2018). Other areas that benefit are the decrease in malpractice cases and results in lower staff turnover rates (Deloitte, 2018).

Due to the increase of chronic diseases, systems will move towards understanding and incorporating behavioural change with patients, providers and employers by using behavioural economics in addition to mHealth with which to influence behaviours (Schreiber, 2016). Data collected from wearables is extremely valuable, and these devices are able to capture real-time data with the benefit of patients being able to assess their symptoms with better accuracy and are becoming mechanisms for incentivising healthier behaviour (Bourla, 2018).

4.3.2.6. New Business Models

The business model concept is a cyclic process and takes into consideration the way a company conducts business and what opportunity for exploitation is present in the market (Gomes & Moqaddemerad, 2016). The global economy has brought a more pronounced “for profit” motive to healthcare, with big multinational companies taking higher organisational and financial risks to attain international market advantages (Miller, 2003). Due to the increase of mobile technologies, the internal and external market environments need to be understood by contemporary companies in order to keep up with changes that also hold opportunities and threats that need to be considered to be sustainable (Gomes & Moqaddemerad, 2016).

Stakeholders within the healthcare space have to realise that an individual’s home is now the new hospital and health technologies, expecially those of mHealth and telehealth, make it possible (Deloitte, 2014). In the current highly volatile technology-driven market, a business cannot rely on a single technology to be sustainable and thus needs to be aware of new opportunities to nurture, thereby gaining a competitive advantage and aligning their business model (Gomes & Moqaddemerad, 2016). As can be seen in Figure 4-5 below, supply and demand drivers for health technologies will change how business is conducted and will also give opportunities to entrepreneurs who want to dabble in the space.

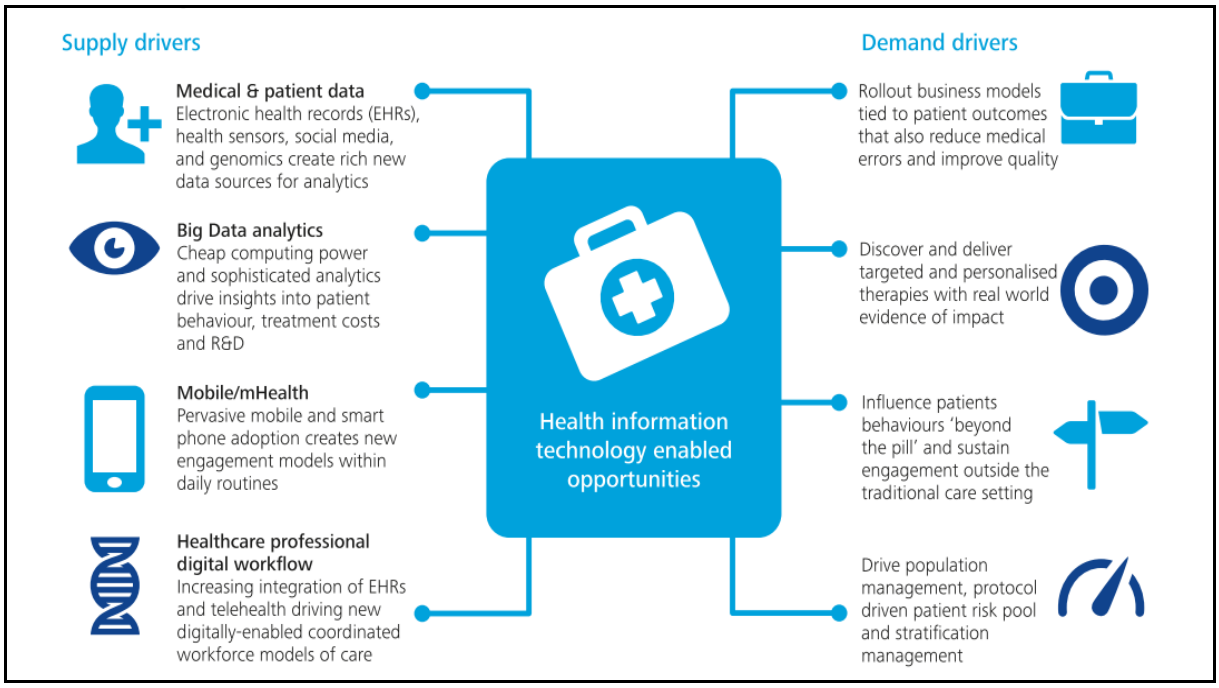

Figure 4-5: New Business Models

Source: Deloitte (2014)

Healthcare organisations are consistently looking into ways of dealing with reducing margins and increasing costs and one of these ways would be to link usual workforce planning with predictive analytics in order to increase efficiencies in labour costs, leverage novel technologies to enhance processes and look into revenue strategies (Deloitte, 2018). The healthcare industry has a huge advantage to create personalised smart solutions and provide a universally accessible database for improved maintenance due to the advent of the internet (Gomes & Moqaddemerad, 2016).

Hospitals in the US are becoming more involved in mergers and acquisitions (M&A) to take adavantage of economies of scale, increase their network of physicians, broaden their geographic reach, and diversify their offerings, which would also lead to more access to capital to use on infrastructure, staff and technologies (Deloitte, 2018). Connections between health and food are becoming more common with M&As in the 'pharma-farm' business providing a strategic advantage (Miller, 2003).

4.3.2.7. Interoperability

Interoperability would allow the integration of data into daily care. This could include a patient's genetic and behavioural information as well as clinical, financial and administrative records that could be held in a secure cloud storage system with restricted access possibly via blockchain (Deloitte, 2018). This is one of the major concerns amongst heathcare stakeholders when it comes to health technologies specifically. To recognise the full potential of these technologies, seamless integration of information across numerous devices needs to be provided for healthcare professionals and patients so as to get an all-inclusive picture (Deloitte, 2014). Convenient data collection, data accuracy and interoperability needs to be offered along with reduction in costs for accessibility (Deloitte, 2014).

Wearables are seen as the technology that can be the main link to collect data and they are envisioned to one day being included as a presecription for monitoring and therefore for providing improved health management (Deloitte, 2014). AI combined with interoperable EHRs has the potential to generate efficiencies and enhance decision making (Deloitte, 2018). However, lack of interoperability is a huge stumbling block for the potential of big data and prevention initiatives, but it is highly promising with regards to cost reduction and enhancing care harmonisation (Deloitte, 2018).

Fragmentation is a difficulty within the healthcare space, and digital health has seemingly amplified this challenge with the spread of data sources (Schreiber, 2016). To attain Health 2.0, the integration of data is required which is a struggle in healthcare where interoperability is restricted and concerns about data sharing and privacy arise. However,with analytics, integration platforms and meaningful collaboration and partnerships, it could work (Schreiber, 2016).

4.3.2.8. Cybersecurity

Personal health data has huge potential but there are drawbacks that need to be considered in moving forward with privacy being the most important, due to the detrimental effects it can have if a patient's data ends up in the wrong hands (Bourla,

2018). Cyber attacks are becoming more common with a recent malware called Decryptor infiltrating Britain's National Health System and major international organisations like FedEx, thus putting emphasis on the issues of cybersecurity and risk management (Deloitte, 2018). Cyberattacks' frequency in the healthcare area is only second to the finance industry in the US, and the average cost of healthcare data breach amounted to USD $3.62 million (Deloitte, 2018).

In Europe, new legislation, (European Commission's General Data Protection Regulation), was introduced to address data access and security which gives people power over their personal data and simplifies the regulatory situation for business (Deloitte, 2018). Businesses in Africa are losing billions to cybercrime activities but still, governments in southern Africa are not prioritising cybersecurity, with SA being particularly vulnerable, having been ranked sixth on the cybercrime predator list of the US Federal Bureau of Investigation (NACI, 2018). South African companies are also estimated to lose an average of ZAR36 million with these attacks and small businesses would be unable to recuperate from such losses (NACI, 2018). In 2012, SA published a national cybersecurity framework but implementation and measures are not clear. SA has been a victim to cyberattacks, and it is crucial for the government to play an active role in increasing awareness and helping protect citizens as it is not just an individual problem but opens up issues for the broader community and is contagious (NACI, 2018). The suggestion made by NACI (2018), would be for the government to develop a behavioural intervention programme that prevents businesses and private individuals from being attacked as well as working with mobile service providers to provide software security updates through trusted conduits.

Patients are becoming more independent and active in their health which implies they will be retrieving healthcare from both public and private sources and in nonconventional areas such as their houses. this complicates quality assurance and cybersecurity matters (Deloitte, 2018). Cybercrime is not going to disappear and governments need to step in to protect citizens with regards to their reputations, incomes and personal information especially in the health industry.

4.3.2.9. Changing Nature of Work

Healthcare workforce struggles are found across the globe with staffing shortages in specialised fields as well as general practice and a lack of nurses to address the number of cases (Deloitte, 2018). Telemedicine is one of the ways that enables technology and people to work together to deliver good quality healthcare virtually to patients who have limited access (Deloitte, 2018). An AI or robotics-integrated healthcare workforce could potentially make better decisions and reduce errors. This however, should not be seen as negative, as it will allow clinicians and other healthcare providers the ability to spend more time on their primary functions which would improve efficiencies and patient service (Deloitte, 2018). The health technologies of the future are already available, but the plan for workforce augmentation is still in idea-stage for most healthcare organisations.

The workforce structure will eventually adapt as health technologies become more familiar and jobs that require repetitive or administrative tasks will possibly be automated (Deloitte, 2018). Inayatullah (2017) mentions a report in Australia that forecasts for 2030: 44% of jobs will be automated; 60% of students are in careers that will cease to exist, and young people will each have 17 varied jobs on average. Professional jobs such as accountants and lawyers are not immune to job insecurity and not only administrative and production workers, but sources reveal that regarding mental and substance abuse, social health workers are least likely to be substituted because they help people and have negotiation skills (Inayatullah, 2017b).

Individuals will require more than just a job as identity and purpose have become significantly important due to heterogenous change wherein we all live in the same world but experience it differently, and future visions are varied as well (Inayatullah, 2006). The future working class would be greatly involved in trying to create a better world through their jobs with higher consciousness, appropriate governance, gender equality and sustainability (Inayatullah, 2006). Outsourcing should continue to increase with companies aiming to outsource as much as possible and work on refining their competitive advantages (Inayatullah, 2006). Retirement will be an

archaic concept with a more flexible approach taken to meet the needs of employers and employees and which will honour experience (Inayatullah, 2006).

Genome mapping can have great consequences with the possibility of us being provided a visual gene map at birth that outlines predisposition to certain diseases, recommended interventions and the possibility of applying for a job with that gene card (Inayatullah, 2006). This would probably elicit an outcry, but government would need to step in to provide legislature on prevention of unjust treatment to people with certain genetic disorders (Inayatullah, 2006).

Education is and should be changing with the incorporation of digitisation and virtual technologies as well as globalisation of education with access to teachers from all across the world (Inayatullah, 2017b). Secondary and tertiary educational institutions need to prepare curriculums for the future and for new jobs along with teaching flexibility becausee many students will endeavour portfolio careers. However, even the ones who stay in one area will create different types of work (Inayatullah, 2017b). Retraining of current employees will be unavoidable and the capability to understand as well as to co-evolve with emergent technologies to be competitively advantaged (Inayatullah, 2017b).

According to Deloitte (2018), the shortage of leaders with strategic, future-minded skills to enable the transformation of patient-centric, value-based healthcare is intensifying the problem. Stakeholders should encourage an augmented workforce where human resources and technological resources (digital technology, robotics, AI etc.) work together rather than against each other (Deloitte, 2018). Safety and security must be a priority when one considers that inequality could increase the inequality problem where only owners of robot technology gains and the rest of the people live in anxiety (Inayatullah, 2017b).

4.3.2.10. Sustainability

The degradation of the environment as well as biodiversity can be linked to other declining resources and loss of lives which harms the development and potential of present and future generations (UNDP, 2018). Due to the rising inequalities,

instability and unsustainable countries, the SDGs are present to assist everyone and for this reason, business as usual approaches will not work in going forward (UNDP, 2018). In line with the definition of sustainability from Brundtland in 1987, ways of preventing undesirable long-term effects that could jeopardise the future generations must be formulated as well as meeting their needs (Riedy, 2009). Sustainability has been tagged as a future-oriented concept and foresight is required to influence and guide policy decisions that are consistent with a sustainable future (Riedy, 2009).

Development of a wellbeing economy is crucial, where quality and effectiveness of human and ecosystem relations are improved as well as supported with enabling technologies without exploiting natural and human resources (Fioramonti, 2017). Overall, promoting preventative care rather than reactive healthcare and access to health information will improve people's health habits and allow for a more sustainable healthcare model (Tasnim et al., 2018). As stated by Penar (2016), renewable energy should form part of national energy plans due to the requirement of electricity for expansion of technology in rural areas, and these are mostly good for the environment and do not necessarily need large-scale infrastructure.

Although health technologies offer great potential for sustainable futures, the risks must be managed and overcome to make sense (Herweijer, Combes, Swanborough & Davies, 2018). Some of the risks involve the lack of trust for such technologies with regards to reliability and security as well as funding access (Herweijer et al., 2018). Blockchain is one of the technologies that is mentioned to have huge potential to to enable technological solutions for environmental difficulties (Herweijer et al., 2018).

4.3.2.11. The South African Landscape

Private Healthcare Sector

The private healthcare sector accounts for 16.2% of the population with most having medical cover and is made up of healthcare professionals who offer services that are usually funded by the subscriptions through any of the 110 registered medical schemes in SA (Jobson, 2015). The private healthcare sector has an expenditure of

about an annual R120.8 billion and are ranked amongst the top four globally (Jobson, 2015). The South African private healthcare sector's leading players are Mediclinic International Limited, Life Healthcare Group, Netcare and Melomed Hospitals (Marketline, 2018a). These few large private players control the sector and have been seen to drive prices up instead of competing with them. Netcare, Mediclinic and Life Healthcare are known to be the three biggest players in SA. The former two have the largest inpatient and outpatient segments and are the most diverse (Marketline, 2018a).

Netcare runs private hospital groups, primary care network and emergency services in SA. Netcare has a strong presence in the United Kingdom with an enhanced financial pull and has an extensive network of hospitals, specialised clinics, pharmaceutical retailers as well as being greatly involved in hospital management through PPPs in SA (Marketline, 2018a). They are involved in four PPPs with provincial governments, covering the construction, refurbishment and management of hospital facilities (Netcare Limited, 2015). The National Renal Care initiative has 12 PPPs guaranteeing public sector patients access to dialysis. The group is consequently dependent on public spending which is increasing. The hospital division within SA is comprised of a multi-disciplinary tertiary institutions, centres of excellence along with same-day surgical units (Netcare Limited, 2015). They provide emergency services through the wholly-owned subsidiary, Netcare 911. The primary care segment of SA offers primary healthcare services and managed care services which include medical and dental provider services through Medicross along with Prime Cure (Marketline, 2018a).

The Triple Aim is an international framework developed by the Institute for Healthcare Improvement and this is the foundation for Netcare's strategy. The goal is to 'optimise the performance of healthcare systems through the integration of three critical objectives: improving clinical outcomes, enhancing the patient experience, and reducing or, at least, controlling the per capita cost of healthcare' (Netcare Limited, 2015). This is also the reason for continuous enhancement of operational processes to guarantee efficiency through the growing digitalisation of business

(Netcare Limited, 2015). They also confirm the value of investing significantly in cutting-edge medical technology to satisfy patients' needs.

Life Healthcare have operations in SA and India but have plans to expand into Europe. They have just acquired a diagnostics service provider, Alliance Medical, that operates in Europe and Italy (Marketline, 2018a). The group has the competitive advantage of forward integration as a health insurance provider in a booming market and also competes directly with Netcare on hospital management and specialised clinics (Marketline, 2018a).

Due to the weak economic growth rate and rising unemployment, most people in SA are unable to afford medical insurance and the burden on government continues to grow with an increasing population (Netcare Limited, 2017). According to Netcare Limited (2017) Annual Integrated Report, the government has been unable to meaningfully involve the private sector and to solve quality and resource problems within public healthcare. It is also mentioned that the current policy is restrictive and does not necessarily support the ideal of universal quality healthcare for all citizens.

As stated by the WEF (2016), the private sector needs to take initiative with support from governments and civilians. Disruptive innovation enables new processes with new business models, and these need to be incorporated in such a way that inclusion is priority and future shocks are avoided. this can only be achieved with these stakeholders working together (WEF, 2016b). According to Stoltz and Wolvaardt (2011), improving poor healthcare in SA relies on PPPs and the NHI seeks to allow for better integration and ultimately benefits the citizens of SA in terms of access and quality. Netcare has also expressed their readiness to collaborate with government to create a sound healthcare system for all South Africans by harnessing the strengths that both of these sectors have as has been done internationally (Netcare Limited, 2017).

Public Healthcare Sector

SA's public healthcare sector is quite large and services more than 80% of the population (Jobson, 2015). It is funded by the government and uses about 11% of the total budget which is exceeds the 5% of GDP suggested by the WHO. However,

health outcomes are poor and inequity is quite prevalent (Jobson, 2015). The public sector struggles with a lack of key healthcare providers with one doctor available for 4219 people compared to 243 patients in the private sector, and SA suffers with other countries eager to recruit South African doctors who have a good reputation (Just Landed, 2014). However, around 1200 medical students graduate annually and are required to serve two years of community service within the under-resourced facilities and the government has made it simpler for foreign doctors to practise in SA (Jobson, 2015).

The public healthcare system is made up of three levels with the first being the primary healthcare clinics that provide first line of access for free. The second is the district hospitals, where people go if they need more elaborate treatments than offered in the clinics and lastly, the academic hospitals where advanced procedures and treatments are offered as well as being used for training providers (Jobson, 2015). The National Health Laboratory Service is the biggest pathology service provider in SA and also offers health research services (Jobson, 2015). Public healthcare facilities in SA are generally well equipped but are overcrowded with patients and the staff are quite indifferent, as they are usually overworked (Just Landed, 2014). South African citizens are required to pay for the services depending on income and the number of dependents, but the charges are comparatively low (Just Landed, 2014).

There is a large divide between the public and private healthcare systems and the former having facilties in deep rural areas with very basic services and there is the complete opposite with private institutions who are at the cutting-edge of medical advances (Just Landed, 2014). This division can be linked to the history of the country with apartheid laws where the healthcare system was mainly focused on servicing the white minority (Jobson, 2015). Medicine and medical technology emphasis was put on hospital care and therapeutics in urban areas for the white population (Jobson, 2015).

The NDoH has a general responsibility for healthcare with a strong focus for the public sector (Jobson, 2015). The South African NDoH has based its performance plan on the NDP 2030 vision and has a strong focus on improving equity, quality

standards and access to healthcare which it hopes to achieve through the implementation of the NHI (Department of Health, 2018). One of the strategic objectives for the NDoH is to enhance management of healthcare facilities through health leadership and management academy interventions. Another objective is to achieve Universal Health Coverage, which is one of the SDGs through the NHI (Department of Health, 2018). The public healthcare sector is trying to improve and will be able to benefit greatly from health technologies meant to increase efficiencies and optimise patient experiences.

Working Examples

Discovery Vitality – In 1992, Adrian Gore founded Discovery with an idea for a health-insurance model that would make people healthier and now, the company is a global player that is able to carry this out by making people aware of their health risk factors and helping them to manage and improve their health (Discovery, 2018). The Vitality programme in SA, UK and China, as well as HumanaVitality in the USA gives people the tools to become healthier and rewards them for adopting a healthy lifestyle (Discovery, 2018). Vitality offers rewards and simultaneously supports behaviour modification with its use of technology and data analytics (Omarjee, 2017).

The Vitality programme has evolved into a comprehensive wellness sytem that is able to track physical activity to nutrition and incentivises people to log their workouts with wearables or apps to gain points that they can use with Discovery's partners and get discounts on the premiums (Discovery, 2018). The cost of claims has been shown to have been reduced by a positive 25% decrease in healthcare costs of the individuals who use the model (Omarjee, 2017). The shared value that is generated for consumers, the company and society is evident, and it is not hurting Discovery's bottom-line. Discovery is quite confident that they have built a core capability that, due to its scale, could not be easily replicated and the flexibility of the structure allows market access where they are not able to take market shares but instead, they partner with the main insurer and scale the Vitality model as required (Gore, 2015). The WEF (2016a) acknowledges the Vitality model as a stakeholder that is able to shape a market as well as to design and deliver a product.

Health Patient Registration System (HPRS) – The NDoH contracted the CSIR to develop a HPRS primary healthcare eHealth programme as the consultative document for the NHI and identified the need for one to plan for the establishment of healthcare facilities and to track the utilisation of services (Wolmarans et al., 2015). The eHealth programme for primary healthcare seeks to move SA to the next stage of maturity whereby patients have unique identifiers and there are patient-based information systems at all facilities which can then be linked to a EHR repository to support access to all records at anytime (Wolmarans et al., 2015). The HPRS will provide a patient registry and index using identification numbers in order to standardise compliance for all eHealth applications (Chetty, 2015). This competence is crtitcal for shared EHRs and will allow for continuity of care in the public health system and there have been over 500 000 patients registered on the system (Wolmarans et al., 2015). The HPRS has also been connected to a standardised filing system which allows for quicker retrieval and storage of files (Wolmarans et al., 2015). The goal is to have 3470 primary healthcare facilities equipped with the HPRS and 60 hospitals maintained with 57 million patients registered on the system (Department of Health, 2018). The flow process for the HPRS is presented in Figure 4-6 below.

Figure 4-6: Health Patient Registration System in SA

Source: Chetty (2015)

RecoMed – This is currently SA's biggest and most rapidly growing local online booking platform for health services and is a marketplace which allows people to reach over 1600 healthcare providers, read their reviews and book appointments (Chowles, 2018b). The idea behind it was to improve the patient experience by preventing long phone calls and queue waiting times thereby adding some convenience to the healthcare model and simultaneously assisting providers with revenues (Chowles, 2018b). RecoMed uses a world-class user interface that has been scaled successfully and has been adopted by several healthcare organisations and is now partnering with another local company GoodX who is involved with medical practice management software. This software includes billing, cloud-based patient portals and so forth with over 5000 customer acorss the country (Chowles, 2018b). They have created a new integration system which streamlines workflows that eliminates double-entries from receptionists and confirms appointments instantly thus saving time for consumers. GoodX is adding a platform into the integration which will allow patients to fill in their medical forms online prior to the appointment (Chowles, 2018b). These two companies are thus working together towards a more digitally inclined healthcare system and making patients have easier access to healthcare services.

MomConnect – This project was launched in 2014 by the Minister of Health in SA. It is a free service that uses mHealth tools and messaging services to generate awareness on health services for babies among pregnant women (Western Cape Government, 2014). It is a collaborative effort among government departments, science councils as well as mobile service providers in SA and is targeted at pregmant women who are literate and have access to a cellphone (Western Cape Government, 2014). The three main objectives are: each pregnancy to be registered at a public health facility; to have stage-based and personalised messages sent to each mother and; for women to be engaging with the health system via helpdesk tools (Western Cape Government, 2014). The messages received by expecting mothers will encourage testing for certain conditions such as diabetes and hypertension. Thereafter, when the baby is born, messages will include advice on

immunisations, breastfeeding, etc. The initiative has provided access to information to over 1.8-million South African mothers and has started using the instant messaging service Whatsapp for delivery (Shapshak, 2017). This has significantly reduced costs for mothers but has also increased the engagement factor (Shapshak, 2017). The Minister of Health mentioned that this project assists in achieving the SDGs and will ensure that mothers are active participants in public healthcare (Western Cape Government, 2014).

Lodox – The Lodox represents the application of innovation and ingenuity that can result in effective healthcare solutions and, in this particular case, looks at the full body X-ray that was designed and developed based on technology created for the detection of stolen diamonds in SA (Lodox, 2018). The system is capable of creating X-ray images in 13 seconds with a minimal radiation dose and simultaneously offering excellent quality images (Lodox, 2018). According to Lodox (2018), there are no alternative solutions globally that match this technology and it was even featured in a popular US medical emergency television series, Grey's Anatomy. The innovation is unique and well-suited for use in trauma hospitals as well as forensic pathology labs (Lodox, 2018). One of the South African government's funding organisations is a major shareholder and continuously supports the R&D and product developments within the company (Lodox, 2018).

Integrated Burn Electronic Record and Registry (iBER) – This is a non-profit organisation that systematically collects a clearly defined set of health data which, in this case, is a record of treatment and management of burn victims as well as demographic data that is stored in a central database for specific purposes (Allorto & AV2 Systems, 2018). They are supported by Molnlycke Healthcare SA who offers effective and kind wound care for burn patients and are endorsed by a professional medical society (Allorto & AV2 Systems, 2018).

Strait Access Technologies – This is a health technology start-up that was founded in 2008 by the University of Cape Town to develop trans-catheter innovations that would offer access to heart valve therapies for patients in the developing world suffering with rheumatic heart disease (SAT, 2018). The company was founded by a small team of biomedical and clinical experts with the goal of producing accessible,

life-saving implantable medical devices to the millions of people (generally poor, young people between 5-15 years old) who are affected by this disease globally (SAT, 2018). Rheumatic heart disease is considered to be a global threat by the WHO and is elicited by bacteria that cause a throat infection. If left untreated, this turns the immune system against the individual's heart and leads to acute inflammation of the heart and valves (SAT, 2018). This is followed by chronic heart disease that damages the heart valves permanently and open heart surgery is the best treatment option which requires scarce skills and facilities in developing countries. However, Strait Access Technologies' innovations remove the requirement for open heart surgery and can be used in general facilities (SAT, 2018). They focus is on simplicity and this has gained them abilities to create superior products that suit developed markets as well (SAT, 2018).

4.3.3. THE MACRO ENVIRONMENT OF SOUTH AFRICA

ES provides information such as external events and trends, that can be used to facilitate future strategies which address external forces (political, economic, technological, social, legal). While it may be futile, being prepared is always better than the contrary (Du Plessis, 2016).

Technological Drivers

Technology is one of the most important drivers for change because of its potentially transformative role both in a positive and negative way in addressing a wide range of development challenges (Adendorff, 2013). A 15-20 year timeframe was used based on the assumption that it is long enough for significant technological change to be plausible and short enough to imagine some prospects for the kinds of technologies that could be developed and applied.

SA has the lowest R&D expenditure (0.8% of GDP) compared to the other BRICS nations and to make matters worse, the R&D expenditure has fallen continuously since 2007 (Marketline, 2018b). However, as government R&D expenditure is low, private expenditure towards R&D is predicted to expand due to their research firms' technological think tanks (Marketline, 2018b).

Around 32% of the software used in SA was unlicensed in 2017, according to the 'BSA Global Software Piracy Study of 2018', However, this was lower than the Middle East and African average of 56% (Marketline, 2018b). Legitimate sellers are losing a substantial revenue due to these high levels of piracy, which is considered a major barrier to the development of the technology market (Marketline, 2018b). SA's IT industry has been praised by international IT majors such as IBM and the Shuttleworth Foundation for using IT standards that encourage interoperability among public sector computer systems and the move towards open source software (Marketline, 2018b). Furthermore, SA has good mobile penetration and network coverage, the number of smartphone users in SA was estimated at 18.48 million in 2017 and is expected to spread to over 25 million by 2022 (Statista, 2018). The presence of research bodies, such as the CSIR, produce an environment conducive to technological development (Marketline, 2018b). The South African government, having finalised a broadband policy referred to as "South Africa Connect", aims to ensure that all South Africans have basic broadband access by 2030 and half of the South African population has access to 100 Mbps speed broadband by 2020 (Marketline, 2018b).

Social technologies have given social interactions the speed and scale of the Internet and companies are using them to reach consumers in new ways. Companies can generate richer insights and form targeted messages and offers (Adendorff, 2013). The technological landscape is outlined in Figure 4-7 below:

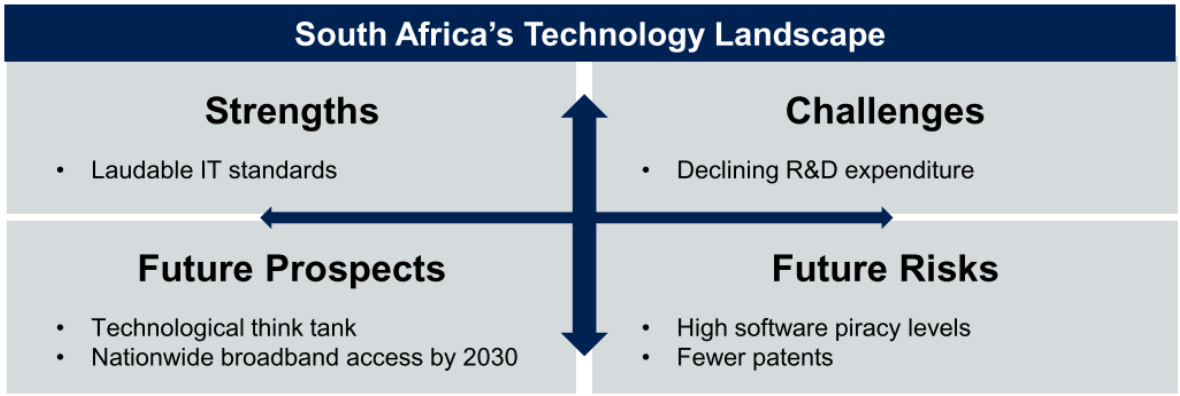

Figure 4-7: South Africa's Technological Landscape

Source: Marketline (2018)

Political and Legal Drivers

Due to numerous allegations of corruption and strong-arming, the former president Jacob Zuma resigned in February 2018 which was two days before he was planned to face a no confidence vote against him in parliament. The African National Congress elected Cyril Ramaphosa as the President who now has to find solutions to high levels of poverty, corruption and inequality (Marketline, 2018b). Corruption is a serious problem, especially in the Department of Police and Department of Home Affairs (Marketline, 2018b). The government will need to take measures to increase transparency and reduce corruption as this has had a significant impact on the country's business environment. As can be seen in Figure 4-8 below, the political landscape of SA is:

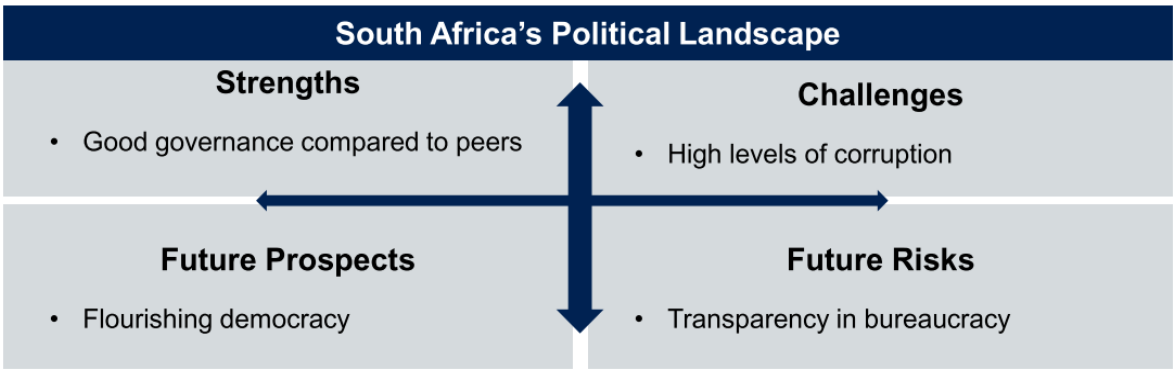

Figure 4-8: South Africa's Political Landscape

Source: Marketline (2018)

The product market regulation in SA fails to generate robust competition. According to the OECD's product market regulation indicator, SA is on par with countries that have high regulation. Even though they are less restrictive compared to other BRICS countries, it is fairly restrictive from a global perspective (Marketline, 2018b). The government has been preparing to reform the healthcare system with a National Health Insurance scheme to be implemented from 2016 but adversities of the South African economy have set back its execution (Marketline, 2018a).

Social Drivers

SA is a multi-ethnic country commonly referred to as the "Rainbow Nation" (Adendorff, 2013). Social movements in SA have developed significantly, engaging in local and national actions such as electricity reconnection and the reclamation of land and homes for those who were forcibly removed or evicted (Marketline, 2018b). Furthermore,In 2010, the United Nations Development Programme (UNDP) added three indices to monitor poverty, inequality and gender empowerment across multiple human development dimensions (UNDP, 2018). SA has a medium human development index as at 2017 and ranks 113 out of 189 countries and moved down two places from 2016 (UNDP, 2018). According to UNDP (2018), the life expectancy of South Africans is 63 years; the Gini coefficient which measures the degree of inequality of SA is 0.63 which is relatively high; the gender development index is 0.98 which is the ratio of female to male Human Development Index values and this shows that there is not too much discrepancy between the two. The report also shows that around 8.2% of the GDP is being spent on health.

The majority of SA's inhabitants are black Africans, accounting for 80.2% of the total population while the white minority makes up 8.4%. The country's overall population grew by 1.1% in 2017, reaching 56.5 million and the population is expected to grow at an average annual rate of 1% during 2018-2025 (Marketline, 2018b). According to the statistics report produced in 2018, around 60% of the population is aged between 16 and 59 years old (Stats SA, 2018). According to Kujeke (2018), as of 2016, the country had 36% of the population belonging to the youth (14-35 years) age group and SA has entered into a period whereby the ratio of the working population to dependents is ideal which should be the case for many decades and will have positive implications for economic growth.

SA has a vast working age population of 66% in 2017 with tremendous potential to thrust the economy into a broad-based growth trajectory but the quality of education provided to the youth is poor and does not prepare them for the job market therefore SA is unable to realise its full demographic dividend (Marketline, 2018b). The available quality of health services to the entire population is unequal and therefore

health status differs considerably between population groups (Marketline, 2018b). The outline of the social landscape is depicted in Figure 4-9 below:

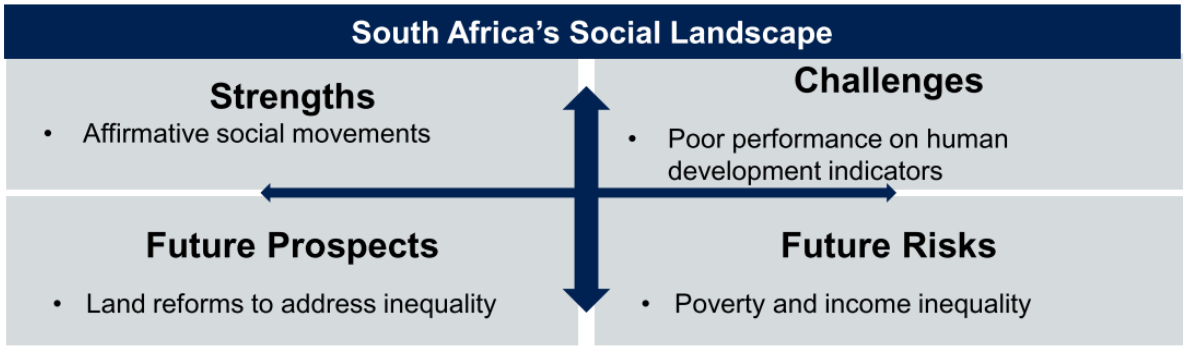

Figure 4-9: South Africa's Social Landscape

Source: Marketline (2018)

Economic Drivers

According to Marketline (2018), SA experienced progress in economic growth in 2017 with the real GDP increasing by 1.3% in 2017, compared to 0.6% in 2016. This can be credited to its robust performance in the export sector which grew by 17.1% in 2017. Private household consumption was raised by 2.1% as consumer confidence improved. The economy is anticipated to grow at an average annual rate of 1.7% during 2018-2020. However, due to the current state of affairs in the country, this prediction looks unsure.

Widespread structural reforms will be required to put the economy on a new growth trajectory, increase job creation and advance inclusivity (Marketline, 2018b). Looking into broadening key sectors such as telecommunications, energy, transport and services to more competition has been suggested by the OECD (Marketline, 2018b). Shortage of skills is another significant bottleneck for the country. SA embraced a National Infrastructure Plan in 2012 to transform the country's economic landscape which aims to create jobs, fortify the accessibility of basic services and support the integration of African economies (Marketline, 2018b). During 2000-2014, the government invested ZAR1tn in infrastructure such as energy, rail, road, ports, transport, healthcare and education (Marketline, 2018b).

SA's general government net debt is projected to rise to 51% of GDP by 2022. In May 2018, Standard & Poor's stated that SA's credit rating was at the sub-investment grade. The rise in public debt might increase funding costs, which would negatively affect ability to raise funds from international capital markets (Marketline, 2018b). The economic landscape is outlined in Figure 4-10 below:

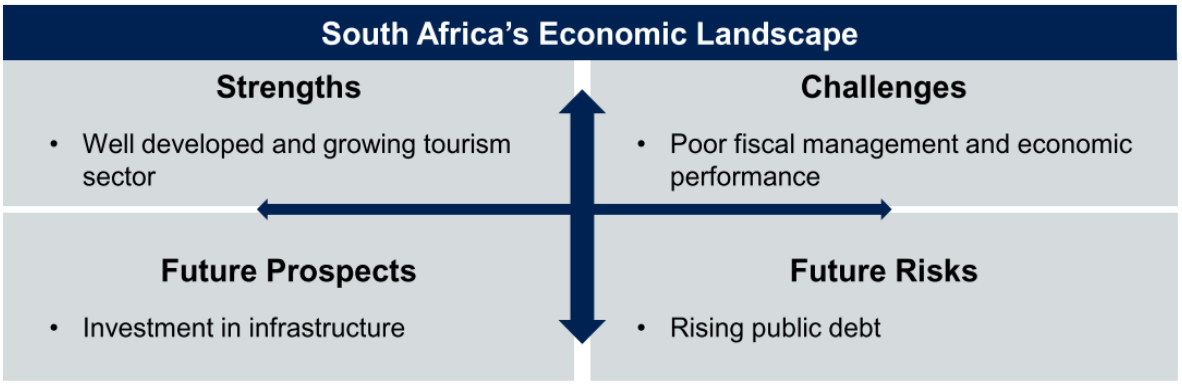

Figure 4-10: South Africa's Economic Landscape

Source: Marketline (2018)

However, according to WEF (2018a), a roundtable discussion was hosted with the current president of SA, Mr Cyril Rampahosa, who issued a call for investment of $100 billion from the business community internationally to repair economic growth conditions and create jobs over the next five years.

4.3.4. THE FUTURES TRIANGLE

Mapping the futures triangle assists in developing a plausible future by presenting and analysing the views of the future today through three dimensions (Inayatullah, 2008). The futures triangle was used to map the pushes, pulls and weights that have an impact on the health technologies industry and was based on environmental scanning, a survey and several pieces of literature. The three dimensions investigated include:

1. Pulls of the future – the images that define where the industry is headed

2. Pushes of the present - the quantifiable drivers and trends that drive the industry forward

3. Weights of history – the patterns or structures that hinder the envisioned transformation and make change difficult (Inayatullah, 2004).

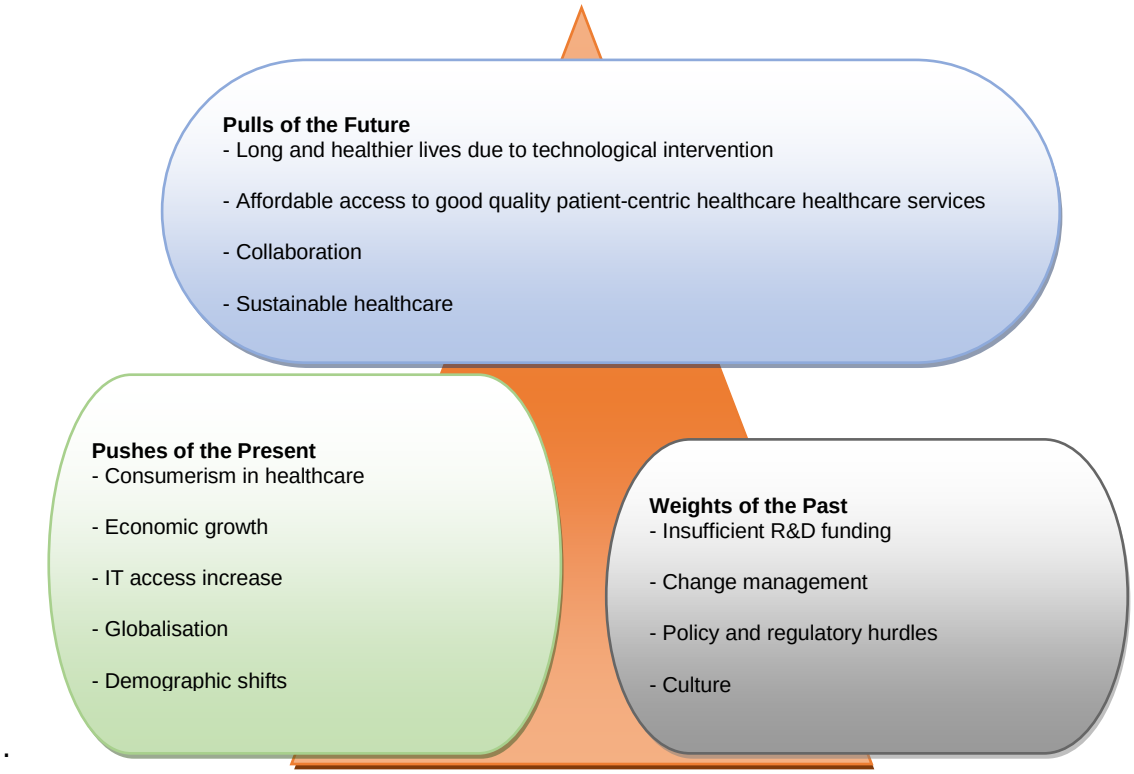

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Figure 4-11: Futures Triangle of Health Technologies

Source: Author's Own Construction

The futures triangle represented in Figure 4-11 above depicts the following: pulls of the future or the vision for SA would include having a healthier population that lives longer due to health technologies. Affordable access to healthcare services of a higher quality and more personalised should be a reality in the future. The goal of the different stakeholders within the system should be to work together and allow for synergies to be harnessed and produce a desired future. The call for sustainability across all industries has been reiterated in the SDGs and will be a requirement if the earth is to accommodate more people and for a longer time. The triple bottom line

(People, Profit and Planet) and shared value are becoming increasingly more relevant and apparent in organisations and how business is carried out.

Pushes of the present include drivers and trends that can be seen to have an impact on the health technologies industry and the biggest one may be that patients are becoming recognised as consumers and more focus is being put onto their needs. Traditional healthcare will not work in the future due to the demographic shifts that are taking place. Africa is said to have a majority youth population in the future. Going forward, economic growth will be a factor that will have an impact on the proliferation of health technologies which is also affected by the population dynamics and macro political factors. SA has plans on rolling out IT infrastructure to more rural areas but will it be enough and in time? Ruwanda has managed to provide their citizens with high quality IT infrastructure and this has created a conducive environment for health technologies. This provides good reason for SA to make sure that this is undertaken in a proper manner and quickly. Globalisation has made the world smaller and competition aggressive for organisations, but it has also made a lot of things possible with regards to virtual treatments and advice in healthcare specifically. The interconnectedness of the world allows for easier knowledge exchange and opens up business opportunities as well.

The barriers that need to be overcome in order to create the desired vision are also important and include both physical as well as mindset barriers. SA currently has numerous challenges with regards to healthcare such as inadequate doctor-patient ratios, inaccessibility, poor patient data storage systems, time-consuming healthcare services, lack of monitoring systems, etc. These are also the reasons that health technologies are needed desperately to raise standards of quality, increase efficiencies and provide low-cost options. The problem is that the government does not allocate enough monetary resources to R&D in the science and technology fields. Although the budget has increased over the years, it is not enough to make a substantial change. However, with collaborative efforts by PPPs, this could not be a huge stumbling block. As invetsments are spread, so are rewards and more people get to benefit. In terms of regulation, SA needs a national e-heath strategy and an implementation plan. This will cover important issues and barriers such as ethics

and privacy matters. Another major hurdle is the change management and culture which has an enormous impact on the adoption of these health technologies within hospitals and clinics. Good leadership is required in order for the roll-out to be successful and for them to get the buy-in from stakeholders. Many nurses and doctors are very traditional and conservative, thus transitioning into unknown or unfamiliar territory is often difficult. The advantages of such technologies have been proven and opportunities are plentiful as people can see beyond their biases.

4.4. FUTURES ANTICIPATION

The second pillar is Anticipation where two methods namely, EIA and the futures wheel are used (Inayatullah, 2008). Bell-weather regions are identified as well as issues that could become expensive and unmanageable along with potential opportunities (Inayatullah, 2008). Information is collected, analysed and assessed via experience thus producing patterns that are used to explain the experiences (Conway, 2015). Through anticipating the future, the emerging issues are determined from the data collected during the mapping phase such as the driving forces and trends (Inayatullah, 2008). Along with possibilities, emerging issues include disrupters as well. Questions like these arise: Will our bodies be pharmacies soon? Will robots be the healthcare interface?

From analysis of patterns perceived in the past, a level of capability to anticipate what could happen in the future is attained (Conway, 2015).

To ascertain how the South African health technologies industry might advance over the next 15 years, it is crucial to reflect and assess the identified driving forces and trends that will play a major role in determining the future direction of the industry and outline the operational environment. A few key questions that are essential for the conception of foresight include:

What does this mean for the South African health technologies industry?

What issues challenge the realisation of the future of this industry?

What can be done about these issues today?

The trends and driving forces discovered during the mapping phase are followed by the identification of the issues and challenges facing the industry. Industry experts who were surveyed in this study were questioned on this and substantiated their views on issues and industry challenges to be:

- Data infrastructure and costs,
- Regulatory issues around privacy and data sharing,
- Lack of technology literacy, governance,
- Distrust of technologies,
- Change management implementation,
- Cost,
- Funding for science and technology,
- Technology adoption by patients and providers,
- Time needed to train healthcare providers,
- Silo mentality and,
- Lack of interoperability.

The emerging issues, revealed by the environmental scan and confirmed by industry experts, are identified as:

Government intervention

Lack of leadership

Insufficient collaboration

Technology adoption

Costs

Anticipation of the future gives one hope that the future possibilities could be far better than what is currently being experienced but also presents anxiety when thoughts of a non-preferred/disowned future unravels instead (Conway, 2015).

4.5. FUTURES TIMING

Timing of the future is the third pillar and searches for patterns in history to provide a linkage to one of the models of change (Inayatullah, 2008). Futurists create maps of time that can be used to comprehend ‘who we are’ or rather ‘when we are’ and thus make better decisions with regards to policies or produce new maps that look into innovation (Inayatullah, 1993). One needs to look at history to observe and decipher what trends were present in order to decide in which of the patterns the future is most likely to follow. The various questions and paradigm one has about the future will influence how it is timed, according to Inayatullah (2008): Is the future open and magical with the possibility of anything happening? If it is a rational with risk analysis and options, is the future based on luck and karma? Or is it predictable and regular? Or is it volatile and frightening?

In his paper, Inayatullah (2012) elaborates on the different patterns which are also outlined in this study in a previous chapter. Based on that information, the future for the health technologies industry can thus be described as following a spiral pattern which represents continuity with change as described by philosopher P.R Sarkar. Some parts are linear and progress-based with certain other parts being cyclical. The traditional paradigms are challenged, but the past is not disowned and is rather used to create a better future. The advent of technology allows for the creation of new economies but requires a creative minority that innovate and who are change agents who imagine a transformed future as well as inspire people to be different. Leadership should be this creative minority as they need to be courageous with foresight capabilities to facilitate and implement change towards a better future for the health technologies industry. ‘Hinge periods’ are those times when the action of a minority make a dramatic transformation, and the previous way of doing things does not work anymore (Inayatullah, 2012).

Timing the future concentrates on the use of macro-, meso- and micro-patterns of change to influence social reality for the better (Inayatullah, 2008). In 1997, Johan Galtung and Sohail Inayatullah defined macrohistory as the study of social systems with isolated trajectories through space and time with the grand patterns used to reconsider the future and permit change (Inayatullah, 2017a). This type of analysis adds weight to futures studies and sets it through historical understanding. The timing of macrohistory uses time as an asset to develop policies and strategies that are more effective and individuals are able to gain insight to have foresight that is plausible (Inayatullah, 2017a). The pendulum is one of the four core patterns of macrohistory and concentrates on movement from one extreme side to another. It refers to the social forces that move towards the extreme pending the primary limits that are reached after which the pendulum reverses (Inayatullah, 2017a). Timing of the future with regards to this pattern implies that patience is required at certain points within an organisation or industry and, specifically, in the health technologies industry, an overnight incorporation of AI, for instance, would not bode well for the future. Sometimes people need more time to change their paradigms but only if this is discussed within an organisation will the leaders know what they are dealing with and how to stage change. Commonly, the pendulum pattern refers to centralisation moving to decentralisation or between government and the private sector (Inayatullah, 2017a).

A linear pattern affecting the healthcare industry would be the increased use of novel technologies. There are four different types of power in organisations: that of labour (worker), coercion (warrior), new or traditional ideas (intellectual) and the creation of storing of wealth (capitalist) (Inayatullah, 2017a). Inayatullah (2017a) explains performing this strategy exercise in organisations where the stakeholders get to play a certain role and understand the dynamics of power within the organisation. This leads to high impact strategies that provide solutions for the greater good. Most often, this exercise allows for the determination of missing leadership aspects and needs to be nutured (Inayatullah, 2017a).

Mesopatterns attempt to transform the futures of organisations in particular and has three conflicting positions of the nature of the change with the first considering how

we view the world and how conscious change will lead to real change; second is institutional change that will occur with a modification in policies and regulations and third, is the change in business produced from new technologies (Inayatullah, 2012). Microtiming refers to the biography of change in that the changes in futures thinking is based on what stage of life one is in and realising the microhistory that frames our life stages. This shapes, in essence, how one visualises one's lifecycle (Inayatullah, 2012).

There are a number of complicated issues with regards to the health technologies industry in SA such as labour, skills, regulation, cybersecurity, etc. but government and private sector stakeholders need to accept that the world is foward in health technologies and we need to become competitive and transform as a country or organisation. Bravery, change management and leadership is required.

4.6. FUTURES DEEPENING

According to Inayatullah (1958) and as mentioned previously in this study, CLA is a futures methodology that creates spaces for transformative thinking and subsequently assists in the generation of alternative futures. CLA is made up of four levels: **Litany** which is everyday life and therefore is an unquestioned view of reality; **Systemic Causes** layer where data of the first level is described and questioned; **Discourse/Worldview** where deeper and unconscious ideological and worldview assumptions are unloaded with stakeholders' views as well. Lastly, the **Myth/Metaphor** level, in which the unconscious sensitive dimensions of the issue are discussed (Inayatullah, 1958). A visual representation can be seen in Figure 4-12 below.

This tool prevents analysis from only one perspective which can produce an incomplete understanding due to the interconnectedness of the layers to allow for vertical movement between layers and horizontal movement in a layer (Conway, 2015). It is important to note that the people responsible for solving the problems vary at each level: Litany level – usually the government or corporations; Systemic level – often a partnership or collaboration between different groups; Worldview level – people or voluntary associations and Myth/Metaphor level – generally leaders (Conway, 2015).

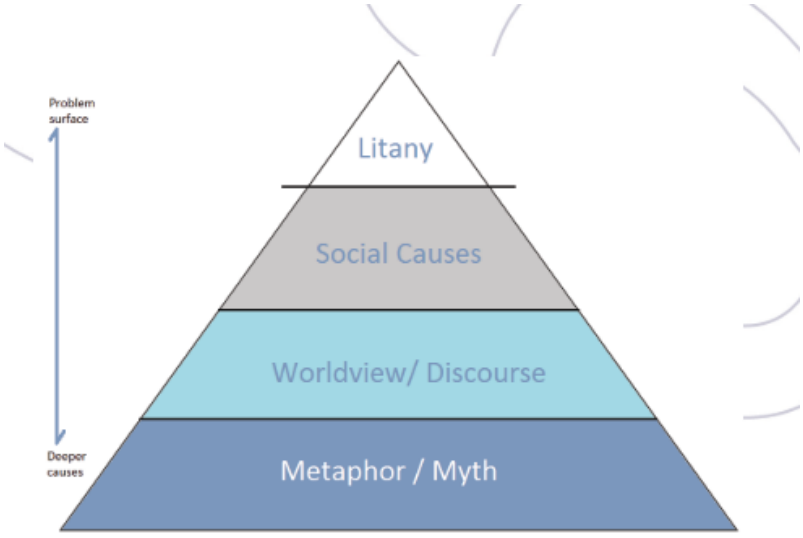

Figure 4-12: Layers in the CLA Tool

Source: Gomes and Moqaddemerad (2016)

Each of the layers can be charted via both individual and world perspectives (Russo, 2003). For personal perspectives to becomeaccumulated is human nature and they areformed by communications from word of mouth to digital media as well as experiences followed by personal storage mechanisms (Russo, 2003). The myth/metaphor layer is deemed to be the most important as it is the foundation for the rest of the layers and gathers together into a worldview that removes systemic and litany out of the image (Conway, 2015). It is considered significant to deepen the future of the South African health technologies industry by investigating the

underlying assumptions, stories, systemic causes, worldviews and metaphors about the future of this industry.

4.6.1. CLA APPLICATION

The application of CLA is based on reviewed literature, environmental scanning as well as some insights provided from key stakeholders within the space to determine alternate future possibilities. The CLA is described based on the four possible scenarios in Tables 4-2, 4-3, 4-4 and 4-5 below:

Table 4-2: CLA Application of cHealth

CLA Level	
Litany	- Multiple health systems working in a complementary and cost-effective manner, a few areas with required infrastructure.
Systemic Causes	- People trained in digital literacy, awareness proliferates, users' adoption rate increases rapidly, national infrastructure available for systems
Worldview	- Collaboration between public and private organisations, policy developed with patient-centred focus, necessary for direct and indirect investment to maintain and modify infrastructure
Myth/Metaphor	- Global '**cHealth'** - SA patients are able to access their healthcare records anywhere worldwide due to successful interoperability

Litany – With better understanding of systems, specifically in the healthcare sector, and how operations function, multiple systems working simultaneously in a complementary manner is achievable. Patients have access to health technologies and are not paying exorbitant prices for data or for these technologies. The infrastructure has been laid out in a few areas.

Systemic Causes – Healthcare providers and patients have been trained in using these technologies and are comfortable with them. Awareness about the benefits and opportunities for health technologies has been spread across societies and buy-in has been gained. Thus, more patients have adopted new technologies to

experience the advantages and the uptake is positive. Infrastructure layout across the country is optimal to ensure interoperability and connecting of systems. Technological advances in other countries, specifically Africa, forms a network that SA can tap into, thus making the knowledge pool much larger. Affordability is possible due to the economies of scale benefit.

Worldview – Personalised healthcare will be accessible and used by all citizens. There is a decentralised system so that bureaucracy is minimised and technologies are commercialised much faster. This leads to patients' benefit in a much shorter turnaround time but without skipping necessary safety checks. Individuals are treated according to their specific genetic make-up, thus reducing adverse side-effects and increasing efficiency of medication. Governments and the private sector work together to achieve this because once resources are combined, synergistic effects are produced, costs are reduced, expertise increased and everyone benefits, especially the patients who are central to healthcare focus. Regulations and policies are in place to assist uptake and implementation of health technologies rapidly and with ease.

Myth/Metaphor – 'cHealth' is a term created by the author of this study, referring to Connected Health which would be defined as the single global platform for healthcare services. A person is able to travel anywhere in the world and will still receive the same type of personalised healthcare they are accustomed to and this will be in line with globalisation imperatives.

Table 4-3: CLA Application of Back to My Roots

CLA Level	
Litany	- Uncertainty about progress being made in SA to fully embrace health technologies
Systemic	- Privacy and security issues – increased bandwidth, lower costs - People do not trust the new technologies
Worldview	- Citizens do not feel safe using health technologies - Cultural mismatch – AI is seen as evil

	- Globalisation vs humanisation - The private sector and the public sector cannot work together
Myth/Metaphor	- Back to my roots is the new way with people reverting to what they know and trust

Litany – There is uncertainty about the embracing of health technologies among the people of SA. Hesitation to a degree is still present as to which healthcare organisations are willing to disrupt their traditional healthcare delivery models by redesigning their models through technology-enabled solutions.

Systemic Causes – Cybersecurity has become a major concern as certain cyberattacks have caused uneasiness, and people are concerned about their personal information being used for detrimental reasons. Hacking is more pronounced due to the increase in connectivity and access as well as lower costs. Parents are fearing for their children's safety and do not trust the systems. Questions about who controls the data and whether it will be used for manipulation are raised. Concerns are raised about constant surveillance and what power that gives certain stakeholders.

Worldview – Citizens feel unprotected, and the government has not provided awareness, regulations or standards that ensure security. A cultural mismatch can be felt when discussing technologies like AI, as people do not trust machines with their health needs. They prefer face-to-face consultations that provide emotional comfort. The government fails to work with the private sector to ensure infiltration of technologies. Thus only the elite have access to these technologies as they have been educated and protected to a certain level. Globalisation is faced with backlash as people prefer humanisation in order to feel safe.

Myth/Metaphor – People go 'back to their roots' because they are familiar with traditional medicines and helathcare services. Medication that has been around for centuries are more trusted.

Table 4-4: CLA Application for a Smart State

CLA Level	
Litany	- Preparation for a high–technology, technologically-infused and uncertain future
Systemic	- Education for the production of competitive advantage
Worldview	- Globalised versus Spiritual versus Bio-utopian
Myth/Metaphor	- Children are the future; Smartness is wisdom and Smartness Evolution

Litany – Increased role of private organisations to ensure high-technology is developed to promote competitivesness. Cyber-education throughout the country is needed to enable students for a high-technology economy and working smarter empowers individuals to prepare and compete for a robust and uncertain future.

Systemic Causes – Government guaranteeing education has a strong science and engineering focus by integrating education with science and technology along with policies. There is a need for the coordination of activities that government, private, international companies and small businesses are involved in so as to achieve a competitive advantage. We need to include citizens in discussions to ensure that a shared and united vision is presented.

Worldview – Globalisation education as a resource to prepare for internet and biotech-led futures which transitions the country to a knowledge-driven economy is needed. Innovation is the key and is required for economic growth and sustainability. All processes should have a ‘smart’ element and continuous learning is encouraged.

The spiritual aspect refers to being ‘smart’ as a mind-body amalgamation with balance at the centre of it. Meditation including mindfulness to create awareness and train attention should be incorporated into the education system and all organisations. Community learning is more important than life-long learning in contrast to the view above.

Bio-utopian refers to genetics and challenges the other views to imagine that smartness would be engineered through gene therapy.

Myth/Metaphor – ‘Children are the future’ which implies that the type of education, whether it be science and technology based or focused on generating more wisdom will determine what the future outcome is. Genetic engineering will change how people think and essentially everyone would be able to become ‘smart’.

4.7. SCENARIOS

The fifth pillar involves the creation of scenarios. Scenario planning is a foresight tool used to deduce information based on a wide knowledge base with a clear understanding of system drivers and trends that allow one to think creatively about the dynamics of a system that could generate different possible futures and how these futures affect present decisions (Cook, Inayatullah, Burgman, Sutherland, & Wintle, 2014). The most famous early corporate use of scenario planning was performed by the Royal Dutch/Shell company in the 1970s (Powers, 2018). The forecasting methods that they had been using showed minimal chance of radical changes but upon utilisation of scenario tools, the company was able to pre-empt increased prices, political changes and also had to pay attention to the social and cultural risks (Powers, 2018). Pierre Wack who was involved in this effort at Shell and published two papers that presented scenario creation, where the foundation had three principles namely: identification of predetermined elements (events that have happened or likely to occur) in the environment; the capability to alter mindsets to perceive reality differently and lastly, the development of a macroscopic view of the business surroundings (Amer, Daim, & Jetter, 2013).

One of the scenario models that was developed by Peter Schwartz (1995, 1996) is organisation focused. The scenario arrangement is made up of four variables: best case (the organisation wishes to move towards); worst case (everything takes a negative turn); business as usual (no modification) and the outlier (a surprise future centered on a disruptive emerging area) (Inayatullah, 2008). According to Amer et

al., (2013), the key benefits of using scenarios are the enhancement of decision making and identification of problems or matters that may occur. Scenarios are able to communicate different elements depending on the audience. these might be governmental agencies, private companies or general citizens (Amer et al., 2013). Despite using various tools to assist scenario development, it is still a highly subjective art and scenarios remain qualitative in nature (Inayatullah, 2008). The five main conditions that need to be fulfilled when creating scenarios for them to be useful and credible are: pertinance, coherence, likelihood, importance, and transparency (Amer et al., 2013).

Schwartz's scenario method has been adopted for the purpose of this study. The scenario structure is composed of the following four variables, **Health Technology Hub**, which is the 'best case' scenario, to which the country aspires; **Medicating Backwards**, the 'worst case' scenario, in which everything turns negative; **Frozen Revolution**, in which no change occurs, making it 'business as usual'; and **Trans-humans**, the outlier future based on a disruptive or emerging issue.

4.7.1. BEST CASE – HEALTH TECHNOLOGY HUB

This scenario represents the preferred future with the health technologies industry being fully embraced and successful implementation thereof in SA by the year 2035. Government and the private sector have learnt how to work together in a synergistic and mutually beneficial manner to provide adequate and advantageous health technologies to the citizens. All people in SA have access to the internet through infrastructure rollout and 5G connectivity. The economy has seen some benefit through the proliferation of innovative health technologies that has seen the industry become highly competitive and they have become pioneers in the global arena. Interoperability has been achieved on a partially global scale with South Africans being able to access their medical data at any hospital within the network of linked hospitals around the world.

R&D has thrived in this field due to the collaborative efforts of private, government and SMEs and SA has one of the healthiest populations in the world with a much longer life expectancy than in the past. Progress in this area has resulted in cures for

diseases such as cancer, HIV/AIDS and diabetes. Sensor technology has now improved dramatically and can be found under the skin to observe real-time unhealthy activities so that proactive measures can be taken. Through these sensors, an individual's medical information such as health records, medical conditions, allergies, next of kin and stress levels will be available. Hospitals will be significantly different in their operations with beds being able to move autonomously with patients to the required operating or radiology room as required. Robots will be used to dispense medication safely and efficiently. Several treatment decisions will be a combination of doctors and intelligent machines with precision medicine supporting these decisions. Drones are used fairly regularly as pharmaceutical/medical supplies transport system. 3D printing of organs has been perfected and successful implants have been performed. Therefore no waiting lists are required for organ transplants. Blockchain is the underlying technology for the health technologies systems and is used for payments as well. Security updates are done frequently to ensure no breaches take place.

Regulations and standards are in place to allow for easy access and the safe use of these health technologies. Transparency is key, and trust relationships have been formed. Government and the private sector have been able to fund health technology research incentives thus creating a robust ecosystem. Awareness is commonplace and buy-in from patients has been received. Healthcare is patient-centric more than ever and continues to focus on their well-being. Inequality has decreased, at least in terms of healthcare access, with everyone being able to get affordable access through government initiatives. Sustainable development is being achieved with more concern for the environment and society being taken. Leadership of the country has changed the way they do things and they have realised the consequences of their actions and the need to serve people.

Technology has not replaced jobs as was originally imagined but augmented jobs are now a reality as well as entirely new professions have evolved within the healthcare space to cater for the technology shift. Healthcare providers have been retrained and upskilled through the support of government and the private sector. Education has shifted with regards to the delivery modes and a major focus on

science and technology has been incorporated into the curriculum. There has been a move towards virtual education and e-learning facilities have increased significantly promoting skillsets that will ensure jobs for the youth. Again, this was facilitated by government incentives and support.

4.7.2. WORST CASE – MEDICATING BACKWARDS

In this scenario, the health technologies industry has become accessible only to the elite few by the year 2035. The technologies have failed to receive the support they require, are highly expensive and only available to the wealthy. A lack of innovative industry transformation due to South African healthcare facilities choosing to maintain their traditional, archaic operational functions and costs with no movements to improving practices. There are reduced opportunities for businesses and SA loses foreign investments and interest. Inequality becomes a bigger issue and affects millions of people in SA. The people who cannot afford health technologies turn back to traditional knowledge systems and nature to find remedies.

The unemployment rate increases due to rough economic times which also decreases health of the population and the high mortality rate rises. Education standards deteriorate as the world moves forward and technology is more abundant, students are not able to adapt and do not have the appropriate skillsets. They are forced to get menial jobs and more poverty arises in SA. Healthcare providers are unable to adopt technologies and become overburdened and underpaid which leads to fewer people joining the industry. Only a few of the professionals can remain unscathed from having to pay for family's medical bills and can enjoy a higher lifestyle. Healthcare professionals start immigrating to other countries as they are frustrated with the operational inefficiencies and are also overworked. This creates a larger skills gap within the country and makes the situation worse.

Government and the private sector refuse to work together and everyone operates in their own silos. Benefits are small, amongst a few people/companies and is short-lived while information is staying in certain groups which adds to the fragmentation and prevent exploratory or integrated R&D.

There is an upsurge of medical and health issues and due to the lack of technological advancement, an epidemic occurs which causes the deaths of millions and the ramifications of such an event are felt for years to come.

4.7.3. BUSINESS AS USUAL – FROZEN REVOLUTION

In this scenario, in the year 2035, the public and private sectors are moving along with no real vision, strategy or implementation plan with regards to how health technologies will be incalculcated into ordinary citizens' lives. There is acknowledgement to a certain extent on the various benefits that health technologies offer, but the action that is required to bring the successful implementation of it to fruition is lacking. Private and public sectors have collaborated on certain aspects but funding and sharing have not been fulfilled to a sufficient level to bring about major change.

Due to the uneasiness and concern raised about incorporating AI into the healthcare space from citizens, government was forced into putting a stop to certain technologies and they enforced strict regulations thus making it impossible for businesses in that space to operate effectively. The concern was largely around ethics, the emotional intelligence of these machines and replacement of jobs. Other African countries have overtaken SA in the implementation and rollout of such technologies and have become competitive players in the global market. Awareness of health technologies is low and plans to broaden the reach of such campaigns have fallen flat.

Technology infrastructure has been constructed in certain parts of the country but connectivity is still an issue and therefore access to healthcare is limited to the few who can afford it. Inequality therefore still exists and continues to escalate due to the economy not doing well and lack of competitiveness of SA. The inadequate infrastructure means that data prices are still high and thus not affordable for the masses. Lower foreign direct investment is also seen and government's regulations do not make business easier.

Due to the lack of major health technologies usage in the country, healthcare does not operate as efficiently as it should and patients still have to deal with

dissatisfactory service. The workforce is slow because of the over burden and people are not gaining anything extra from their jobs. There has been no training provided, so healthcare providers are mostly digitally illiterate and capacity development does not exist in the healthcare space. Students have no better access to education and therefore learn old curricula and are forced into jobs that do not match with the rest of the world. SA thus has to rely on external skills to come in and this costs more. This does not help businesses with their profitability. The healthcare situation in SA has worsened with mortality rates increasing slightly due to the prevention benefit that health technologies provide not being received.

4.7.4. OUTLIER – TRANS-HUMANS

This scenario refers to the outlier that is caused by a disruption. With the advancement of health technologies, people's physical and intellectual capabilities have been augmented to become 'improved' versions of themselves. New transformed humans are thus created and are able to replace normal humans in all tasks as they are superior beings. They have longer, healthier lives due to their genetic coding, are able to take over the country and do not choose to live by the government's laws. This results in disarray as the country descends into unruly behaviour.

Instantaneous gratification is possible due to the developments of technology and people choose to live separately as they do not require anyone else, which creates isolated living conditions. Any new knowledge that is needed can be uploaded. Companies experience the hardship as working conditions change drastically. Very few people obey company rules and productivity declines. Those people who do work change industries and environments as they want, which changes the whole dynamic of companies. Products and services decrease and SA turns into a desolate country with no activity and hardly any life as these trans-humans move away to other countries or die alone.

Life as is it is known is altered with no hope of moving backward and the future looks dim. Technology took over and went too far.

4.8. CONCLUSION

The above four scenarios could possibly occur in the years leading upto 2035 in SA. However, due to the reluctance of people to change and the time it takes, it could be that parts of each of these scenarios could occur by the year 2035. As mentioned, the scenarios are not developed to predict the future but rather give stakeholders an opportunity to see what changes could happen as well as understand the gravity and consequences of their actions in the process of going forward.

The world is becoming quite a diverse and interconnected place with events in certain countries impacting the way in which people live all over the world. By mapping the past, present and future; anticipating future issues and implications; by understanding timing due to grand patterns; deepening analysis by looking into worldviews and metaphors; and by creating alternative futures, one can move into ways to realise the preferred vision that people may wish to live in.

The dawn of the new healthcare space will elicit an ecosystem that is participatory and data-driven in its approach. The three major themes that are consistent in the above scenarios are the inequality issues, global competitiveness and the future of jobs that will be influenced by health technologies. These are issues that will have deep consideration in the construction of the ‘Future vision for health technologies towards 2035’.

5 CHAPTER FIVE: RECOMMENDATIONS AND CONCLUSIONS FOR THE FUTURE OF HEALTH TECHNOLOGIES IN SOUTH AFRICA

5.1. INTRODUCTION

This chapter focuses on the sixth and final pillar from Inayatullah's Six Pillars methodology which relates to transformation of the future. The alternative futures of health technologies in the South African context was explained under the scenarios section in the previous chapter. Possible solutions for the research questions presented in this study were formulated with the aim of addressing the primary research objective. Recommendations and conclusions towards the questions posed in this study will be provided in this chapter.

As SA progresses to a desired and sustainable future up to 2035 and beyond, certain matters included in the development of the preferred future require reflection. The researcher is of the view that a positive future can be realised provided the current actions of stakeholders who have embraced health technologies proceed in a specific manner. Public and private sectors need to choose what adjustment is required and understand consequences of actions to induce the preferred future. Innovative creation and shaping through effective strategies that will secure progress of businesses and reduction of inequalities is the primary goal.

The thinking behind strategic foresight goes back to the 1950s and is now used across disciplines in many organisations to study the resilience of current policies to future disruptions, implications of decisions and create action plans for a desired future (Cook et al., 2014). Since the rate of technological modification has increased profoundly with digital, nano, neuro and genomic innovations being disruptors, having more information allows for better decision-making abilities. This, at the end of the day, allows for increasing of profits (Inayatullah, 2012). Change is now normal and forecasting is one way to deal with it to ensure positive outcomes.

5.2. TRANSFORMING THE FUTURE

Visions are important as they work by giving people something to strive towards, a sense of the possible, and to inspire them to sacrifice in the short-term for long-term benefits and to align their goals with organisational goals (Inayatullah, 2012). There are three visioning methods as stated by Inayatullah (2008) which are incorporated to provide a more comprehensive view of the future: the analytical scenario, questioning and creative visualisation. To enable the creation of the South African health technologies future, strategies and recommendations are suggested to allow for a basis on which to develop the preferred **'Future Vision of Health Technologies in South Africa towards 2035'**. This will allow the relevant stakeholders the confidence to use the tools to create the desired future (Inayatullah, 2008). A few questions that need to be answered to realise the preferred future are as follows:

- What choices need to be undertaken today to assure a lasting and positive effect of health technologies on healthcare in SA?
- What decisions need to be made to safeguard jobs that may be impacted by health technologies in SA?
- What changes need to be implemented to ensure that health technologies are accepted and benefit the citizens of SA?

The preferred vision represents a realistic and attainable future that could allow for the progress of health technologies in the South African context. The previous chapter outlined possible future scenarios of which the 'Best Case' scenario presents a future wherein stakeholders approve and embrace health technologies in SA and advantages are seen by all.

5.3. THE FUTURE VISION

The preferred future of health technologies in SA is achieved through industry transformation and recognition of the potential for these innovations to reduce costs,

create jobs, increase productivity and efficiencies within the healthcare space, sustainable development and national growth. This scenario shows the embrace and full acceptance of health technologies by the year 2035. SA is considered to be at the forefront of innovation in this field and to be a global leader. The public and private sectors has merged forces to produce advanced and beneficial technologies in healthcare to the citizens of the country.

The government and the private sector have invested significantly in infrastructure to support connectivity and thus access to health technologies. SA has gained international appeal through the rise in its GCI rankings and this has led to increased foreign direct investment to supplement infrastructure implementation. SA has also seen the success of the SKA project with big data advancements to provide critical insights and in so doing has elevated SA's standing in this area globally. The management of medical resources has seen a positive effect from this and interoperability has been achieved on a partially global scale allowing citizens access to their medical data at any of the linked hospitals around the world. Interoperability was noted as one of the major challenges that needed to be overcome to see the successful implementation of health technologies.

Due to the successful collaboration between private, public and SME stakeholders, R&D has increased leading to far more innovations coming out from SA. Through the many preventative interventions now introduced, SA is recognised as having one of the healthiest populations in the world with an increased life expectancy. Cures for headline diseases such as diabetes, cancer and HIV/AIDS have been developed on these shores and SA is one of the revered R&D countries in this field.

Biosensor technology has advanced significantly with sensors found under the skin to enable real-time data capturing for preventative measures and has allowed SA to get clinical trial data much more easily. These sensors have also permitted an individual's health records, medical conditions and current conditions to be known. EHRs have been rolled out across the country and improvement of efficiencies have been dramatic. AI and robot technology have been accepted in most hospitals with healthcare providers benefitting from these considerably. Hospitals have changed with automated beds being able to autonomously move patients to where they are

required to be. Robots are being used to dispense medication quickly and correctly. Joint medical decisions are being made between humans and AI systems to ensure that the best possible treatment is provided. Advanced manufacturing has enabled 3D printing of human organs and successful transplants have been performed which relieve stresses for people that require these due to the failing of their own organs. Drone technology has been accepted as an appropriate delivery mechanism with the regulatory frameworks in place to support such activities. Blockchain technology has been implemented as the foundational technology within healthcare, thus allowing for much more secure transactions and distribution of information. Citizens have been made aware of the technology and are comfortable that their data is safe. Security updates are done regularly to prevent cybersecurity issues and protect patient information.

An inclusive and transparent governance process helps in health technologies being able to support sustainable advancement and soci-economic development in SA. Regulations, policies, frameworks and standards are in place to encourage acceptance. Transparency is key and trust relationships between all stakeholders have been formed. This improved governance situation further stimulates investment, capital development and economic growth. Regulatory approval processes have been streamlined to enable much quicker commercialisation of health technologies, which the SMEs as well as private industries have welcomed. The incorporation of the HTA has been successful and has improved efficiencies in the healthcare sector as well. The industry is being directed by transformed, representative, thought leaders who are committed to shared vision principles and improving performance on all levels.They understand and embrace the need for sustainable development, change management, stakeholder engagement and buy-in.

Healthcare has moved towards patient-centricism more than ever, and a well-being economy is being pursued. These health technologies have enabled a decline in the inequalities for access to healthcare in SA. The communities were included in all the stages of deployment of health technologies through mutually constructive and positive cooperation. Public and private stakeholders elicited partnerships with

community members as strategic partners in the implementation of health technologies across the country. Through this collective initiative, a cooperative investment for the participants was formed in contrast to the normal way of technologies only benefiting a few people.

Technology has introduced augmented jobs rather than replacing them and many new jobs requiring new skillsets are being offered. Significant investment from both public and private sectors into education has been made. The level of teaching and delivery mechanisms has changed as well, with a much stronger focus on STEM subjects and e-learning being available at all levels. Students are able to use and navigate their way around technological devices to get more information and learn in a different way. Through the collaboration of private and public systems, education levels have improved drastically which has an impact of the large number of youth that will enter the working world. A skills training programme has been implemented to retrain and upskill healthcare providers who were not digitally literate. The skills learnt are also adaptable to other industries should people want to move around. These intiatives have been shown to have a major impact on the technology adoption rates of patients as well as the fact that people are more comfortable and thus willing to learn and teach.

5.4. CREATING THE VISION

The desired future of health technologies in SA is centred on the collaboration and transformation within the public and private sectors. This is seen as critical to ensure that SA becomes the global leader in health technologies and experiences economic growth. The key elements surrounding the implementation of such a vision are shared purpose with collaboration between stakeholders, infrastructure, innovation, global competitiveness, change management, education upliftment and capacity development in society and the environment. The following sections provide some input as to how SA would go about creating this vision.

5.4.1. SHARED PURPOSE

All stakeholders involved in the health technologies industry are required to agree on the significance of a shared purpose that benefits all South Africans. The rapid growth of technology means that this needs to happen fairly quickly to ensure that the country does not lag behind globally. The preferred vision explained above supports the creation of a sustainable health technologies strategy. The strategy must incorporate societal views on the long term advantages for South African citizens. The main aspects needed to be included are:

- Collaboration, communication and teamwork among all stakeholders,
- Industry issues need to be identified and answers provided,
- Skills shortage determined with mitigation plan,
- Awareness and understanding of SA's health technology space,
- Investment in infrastructure required,
- Culture of R&D instilled in the industry,
- Development of innovative technologies fast-tracked, and
- Partnerships developed with clear deliverables (Putzier, 2017).

Achieving a shared purpose will enable the industry to attack the challenges with confidence thereby seeing results much sooner and learning from mistakes quicker with far less adverse consequences. Through a representative and all-inclusive process, stakeholders are better able to comprehend the system's interdependence and have a better sense of shared purpose.

5.4.2. INFRASTRUCTURE

One of the major requirements to fulfil the health technologies vision in SA is the ability to adequately provide the infrastructure for connectivity as well as electricity. Infrastructure that is planned appropriately can be used by more than one industry along with the public which creates a multiplier effect (Du Plessis, 2016). The rapidly increasing need for electricity is a huge challenge in SA and power generation

entities need to ensure that infrastructure keeps up to speed. Organisations will require sufficient broadband capacity to test, operate and market their devices with broadband connection being vital for storage and security of health records (Tranmer et al., 2018). The SA Connect Policy aims to increase internet connectivity across the country with statistics revealing that 280 000 homes are connected to fibre as of March 2018 (IOL, 2018). Based on the Figure 5-1 below, an increase can be seen with regards to the coverage of the population.

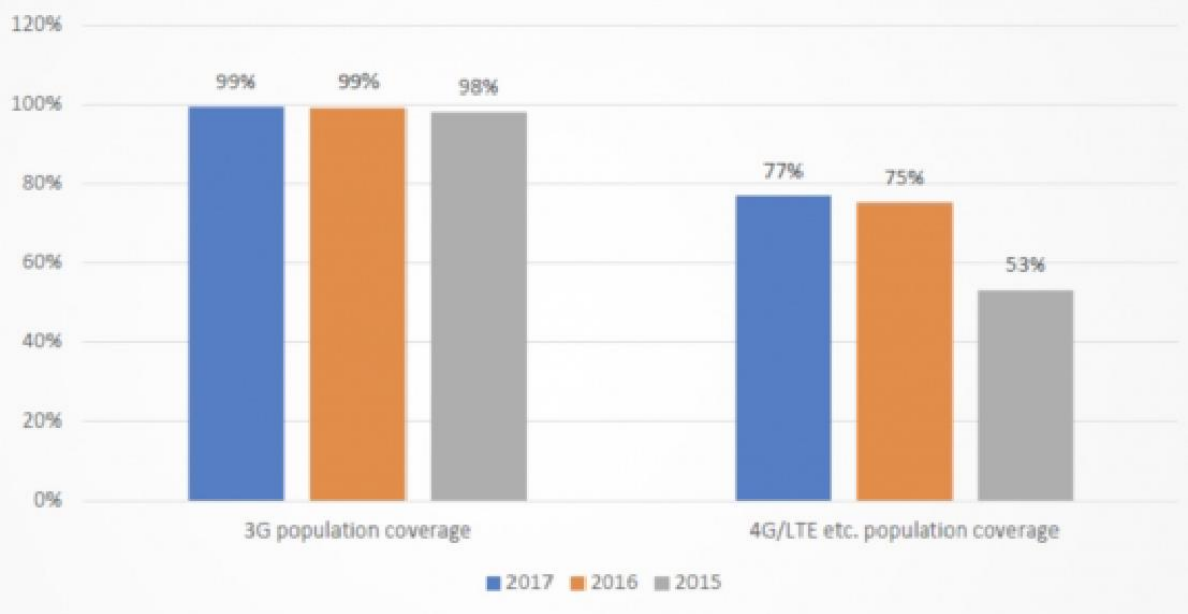

Figure 5-1: Growth of 3G and 4G/LTE Coverage in South Africa

Source: IOL (2018)

At the Wireless World Research Forum hosted this year by the CSIR, representatives from different departments including the Independent Communications Authority of South Africa were present and acknowldeged that regulatory bodies such as theirs should facilitate innovation (IOL, 2018). Opportunities for 5G technologies exist in merging innovations, network infrastructure, regulatory frameworks and business models that would allow for digital inclusion and industrialisation in Africa (IOL, 2018). The CSIR also presented their '5G Research Alliance of South Africa' initiative that will promote research

across all current 5G thematic areas (IOL, 2018). These show that there are motions in the right directions. They just need extra support and action plans.

5.4.3. INNOVATION

The rapid pace and disruptiveness of technological modification is generating opportunities and challenges like never experienced before and are set to increase due to the convergence of digital, physical and biological innovations caused by the Fourth Industrial Revolution (Schwab, 2017). The most important factor is how to unlock their possibilities to benefit the whole country and reconfigure national distributions of income to lead to dramatic transformation. In the desired future of health technologies for SA, the industry's landscape is transformed through the creation of innovative technologies and strategies to support them. SA being a developing country can capitalise on certain disadvantages that the country may experience to create valuable opportunities thus placing SA on a global platform when it comes to innovation in the health sector.

SA will also, as mentioned previously, need to seek out new business models to encourage collaboration between universities, science councils, private companies, etc. to ensure that health technologies find their way to the market. The vision prepares businesses to apply innovation to the operating environment to create efficiencies and increased productivity by incorporating technologies or developing partnerships with other entities who already possess the technologies. Innovative technologies have enabled other developing countries to have locally developed capacity to respond to outbreaks and pandemics, to have the relevant research on infectious diseases and low cost diagnostics, to have molecular typing methods and laboratory-based surveillance systems (Pang, 2018).

The vision also inspires the creation of community collaborations that seek to empower community members through innovation and, in so doing, also breaking down cultural barriers that may exist to see the potential beyond these man-made creations. This is in line with the emphasis on partnership formations and collaboration efforts towards the desired vision.

Innovation is also a concept that will need to be introduced into education so that the youth are brought up with the mindset to innovate and to have paradigm shifts with regards to what they are capable of in the future.

5.4.4. GLOBAL COMPETITIVENESS

The South African health technologies industry will be most valuable when its activities add to the longer-term sustainability for all stakeholders and national growth. The vision sets out aspirations for SA to become a knowledge-driven economy that contributes to the overall competitiveness of individuals and communities through upskilling. The view that current economic approaches are not working towards creating value for people and communities is becoming more pronounced, thus motivating for human-centric models to advance the economy (Schwab, 2017). In developing countries, decreases in poverty and a growing middle class have instigated demands for improved public goods but these have been seen to conflict with slower growth and narrowing of state budgets (Schwab, 2017). As can be seen in Figure 5-2 below, each of the GCI's 12 measures of competitiveness provide guidance for SA's health technologies industry on what to invest when going forward, if they seek to create the preferred vision. The collaboration between public and private sector is critically important to realising this goal.

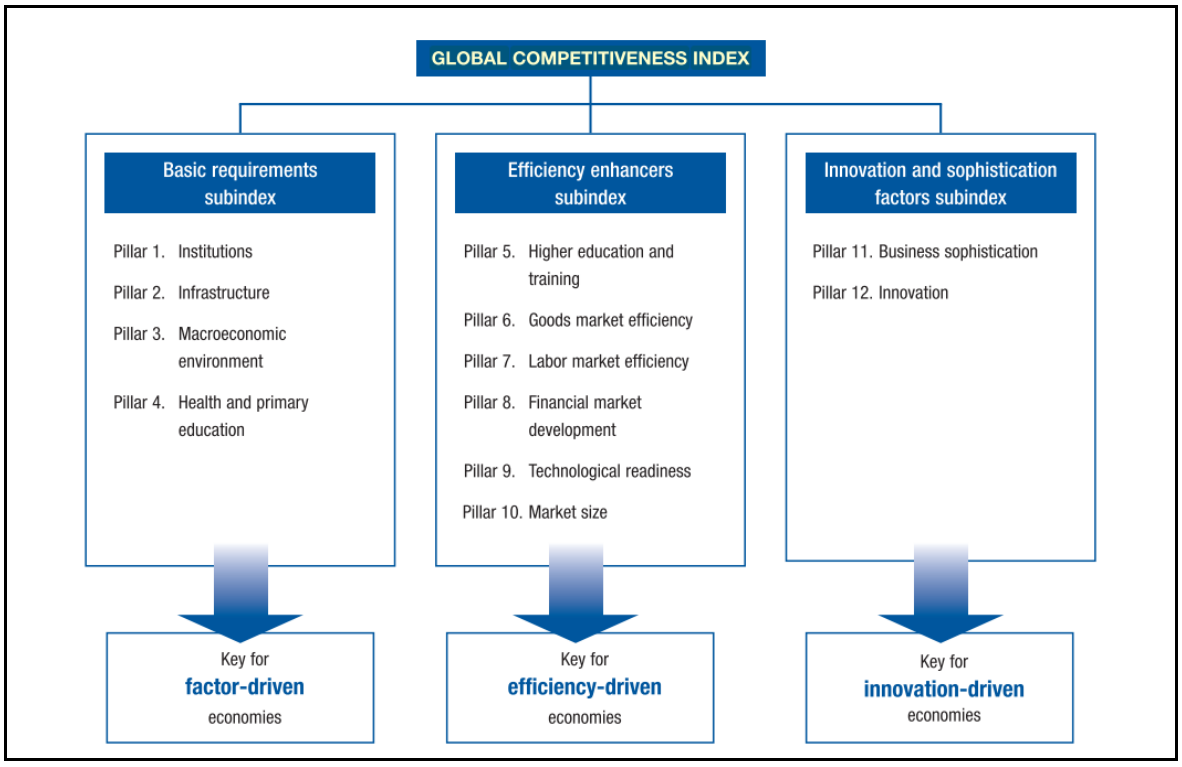

Figure 5-2: Global Competitiveness Index Framework

Source: Schwab (2017)

5.4.5. CHANGE MANAGEMENT

The evolution of healthcare is essentially visualising the development of health in a social and economic investment context, being a driver of growth and provider of circular well-being (among technological companies, hospitals, healthcare providers and patients) (Laurenza, Quintano, Schiavone, & Vrontis, 2018). As the world advances, change management will be seen as a perpetual part of an organisation that is used to improve profits, productivity and their competitive advantage (Al-Ali, Singh, Al-Nahyan, & Sohal, 2017). Change management involves a methodical approach to managing transformation that includes people and resources with linkages to terms such as coordinating or adapting to indicate the significance of a leader and the organisational culture aspects (Al-Ali et al., 2017).

The major terms in the lexicon of currently developing organisational models consists of novelty, adaptability, flexibility, speed and quality which is in contrast to traditional organisational arrangements that have a hierarchical, centralised control

and stable structures (Graetz, 2000). The management of organisational change is generally not conceivable without a change leader, culture and the commitment of everyone involved (Al-Ali et al., 2017). As an organisation makes the technical adaptations required to compete in the digital era, mindfulness of the overall aim to provide value to customers must be constantly present (Shaughnessy, 2018). Dramatic cultural changes are needed for successful implementation of the goal to be ahead of the curve.

Leadership plays an important role in handling resistance to change by using elements to encourage employee involvement in the change process (Al-Ali et al., 2017). With an increased importance on cooperation, communication and collaboration, managers need to develop a completely different set of leadership skills (Graetz, 2000). Changing the status quo and developing a change readiness mindset involves: inspiring a shared vision; being transparent, generating sponsors at various levels to build loyalty; empowering others to act by building teams and providing required resources; using recognition to attain support, being a role model and personally showing senior management participation and commitment (Graetz, 2000). Research has found that leaders were required to adopt transactional as well as transformational leadership styles to guarantee productivity and active change management (Al-Ali et al., 2017).

Due to the preferred vision requiring healthcare providers to have high adoption rates, change management is needed to effect this change as there is likely to be some pushback due to cultural change within the organisations. This will need to be managed appropriately as the adoption of patients depends on it and therefore the success of the industry as well.

5.4.6. EDUCATION UPLIFTMENT AND CAPACITY DEVELOPMENT

The modifications to the education system to realise the vision for health technologies towards 2035 cannot be stressed enough. The significance of enforcing a STEM-focused curricula towards creating an improved workforce in the future is critical. This requires the collaboration of public and private sectors yet again as the difference between the current two education systems is vast. New types of jobs

requiring different skillsets due to the Fourth Industrial Revolution will be offered and students need to be able to acclimatise themselves to ensure they are ready for the future. A knowledge-based economy will require the youth to be more involved in innovation and R&D. Transferable skills need to be developed so as to minimise the effect that automation and mechanisation will have on certain industries.

Africa needs to start developing and producing their own medical devices by their own biomedical engineers but other elements are required as well such as well-equipped laboratories for experimentation, funding to support prototype development, manufacturing infrastructure and appropriate regulations to ensure safety (Douglas, 2017).

As stated by Gionet (2017), the nurses of the future could very well be the future application developers, coders and AI experts. Simulation labs and high-fidelity mannequins have been introduced in healthcare providers' training facilities around the world and this needs to be considered quickly in SA to complement current practices. Healthcare workers need to be retrained and equipped with the applicable skills to perform better at their jobs. The vision includes optimal augmentation of jobs that will mean a harmonised working condition of both machines and humans. One of the ways to realise this is to empower these workers to be digitally literate and know what can and cannot be done. Educating them on the potential benefits and advantages of these health technologies will be crucial in obtaining buy-in. The shared purpose of doing this for the betterment of South African citizens should be reiterated. A highly skilled local workforce will also reduce the need for international experts that come at a high price.

5.4.7. SOCIETY AND THE ENVIRONMENT

The desired vision seeks to create an influential technology industry that promotes a more robust and healthier country. The importance of developing policy frameworks to support the industry is emphasised along with the role that public and private sectors need to play in enabling sustainable development. There is a global consensus among healthcare stakeholders that current healthcare systems are not sustainable and that reforms are required with the introduction of innovative

technologies that could make processes more effective and efficient (Laurenza, Quintano, Schiavone, & Vrontis, 2018). Sustainable action involves a convergence of technology, human and social capital with core values of equity, supported by local decision-making as well as bottom-up approaches, partnerships that are respectful, commitment, trust and local ownership (Pang, 2018).

The SDGs for 2030 have major implications for health and healthcare and is applicable to countries at all levels of development (McKee, 2018). Sustainable healthcare is supported by three imperatives namely:

Moral – to allow human beings to suffer in a world that has the means to alleviate their condition is considered unacceptable;

Political - much broader recognition of the contribution that modern healthcare can make to preventing premature death and alleviating suffering combined with treatments should be accessed by those in need leading to UHC; and

Economical – research has seen that poor health acts as a brake on a country's development.

The industry looks to align economic advantages with social and environmental issues in order to satisfy needs of future generations. The social environment improves through the trust and collaborative efforts seen by all stakeholders including community members. Capacity development through training programmes have empowered individuals and can reduce unemployment rates thereby decreasing poverty levels.

Diminishing waste in international organisations is necessary, thus encouraging the use of tools to measure, improve and control process quality which require business process management principles (Laurenza et al., 2018). In other industries, this model is used regularly to improve competitiveness via processes that provide value and gain cost efficiencies (Laurenza et al., 2018). The use of IT in the healthcare industry needs to be looked at in terms of the advantages gained towards sustainable development.

5.5. ADDRESSING THE PROBLEM STATEMENT, RESEARCH QUESTIONS AND RESEARCH OBJECTIVES

The problem statement in this research study revolved around the potential for health technologies to create major positive impact in SA where health is a major issue and the risk of SA not being sufficiently prepared or, alternatively, the challenges experienced being too large for SA to ebrace in these innovation for the benefit of the citizens and the sustainability of the country. The study aimed to create new insight into the future of health technologies in SA up to the year 2035 through scenario development.

Inayatullah's Six Pillars of future studies was used as the methodology for the research process with an emphasis on the generation of alternative futures scenarios for the health technologies industry towards 2035. CLA was also applied to deepen the future horizontally and vertically, and create a transformative space through various perspectives.

The primary research question was to investigate the readiness of the private and public sectors in SA within the healthcare space for health technologies through the development of possible scenarios. This question was answered through the primary objective which consisted of creating a desired future vision up to 2035 and the establishment of strategies for both the public and private sectors to work together to accept and implement health technologies. Practical yet enlightened ideas on attacking the challenges for successful implementation of health technologies have been provided as part of this study. The research questions were stated, incorporated and addressed to ensure that the research objectives were achieved.

Usage of the Six Pillars methodology provided a comprehensive view incorporating driving forces of the state of health technologies in SA's uncertain future. The scenarios developed described possible alternative futures and the implications of not embracing health technologies in SA. This presents the stakeholders with plausible futures and gives them insight for decision-making.

In the **'Future Vision of Health Technologies in South Africa towards 2035'**, SA has been transformed and is based on:

- Improved communication and cooperation among all stakeholders;
- A better society and environment through the execution of innovative technologies leading;
- Promotion of a competitive and knowledge economy in SA;
- Greater productivity and efficiencies in healthcare due to technological innovation;
- The introduction of successful change management and leadership to provide the required industry changes;
- Increased access and less inequality regarding healthcare services due to cost reduction and infrastructure improvements;
- Establishment of improved labour environment through training and development programmes;
- Better governance reinforced by viable legislation and functional environments; and
- A healthier country with a patient-centric healthcare system.

Therefore, the primary objective of the research study has been accomplished.

5.6. CONTRIBUTION OF RESEARCH

Health technologies are becoming increasingly popular globally due to the experienced and potential benefits of such innovation for the healthcare of a country. The relevance of this study can be ascribed to highlighting the importance of health technology adoption to South Africans. The research study contributed in the following ways:

Theoretical value - The study enabled review and analysis of several literature resources on the processes and Six Pillars of futures studies, scenario planning, CLA and strategic visioning. A goal was to provide a distinctive contribution to the current level of knowledge with integration of futures methodologies.

Methodological value - The research study presented the future of health technologies in SA using the Six Pillars approach and structure of futures studies. A set of scenarios relevant to this future was generated along with a vision of the preferred future for the industry.

Practical value - The scenarios built will provide stakeholders with insights into several interpretations of the possible roads in the future of the health technologies. The scenario development enabled the creation of the 'Future Vision of Health Technologies in South Africa towards 2035', providing the private and public sectors a foundation for the industry to seize and utilise the opportunities to realise sustainable growth.

5.7. STRENGTHS AND WEAKNESSES OF THIS STUDY

A comprehensive environmental scan inclusive of an extensive literature review was embarked on to uncover driving forces and trends that would impact the future of the health technologies industry. The ES was also enhanced by a survey of a small sample of industry experts which included their views and recommendations. Challenges and uncertainties were also extracted from the collected information.

Unfortunately, many of the changes including a low quality education system along with a weak innovation ecosystem that is required for the desired vision to become a reality rests in the hands of the private and public sector and is based on history in SA. It is sometimes a challenge to get things moving at the pace that is needed. As stated, change management and leadership is required across the board so as to enable transformation. Collaboration between the private and public sectors has always been a challenge but, with some stakeholders mentioning the necessity of it, this lends the idea that change could be afoot.

The study was motivated by the potential benefit that South Africans could receive along with the economic progress of the country. Literature regarding health technologies in SA and strategies is also limited which prompted this research undertaking.

5.8. OPPORTUNITIES GOING FORWARD

The challenges to fully embrace the desired vision for health technologies are not going to disappear overnight, but this study has aimed to provide motivation towards reaping the benefits that these technologies yield for SA and elucidate consequences if they are not implemented. It is highly recommended that the health technologies industry monitor the implementation of the future vision towards 2035 to ensure outcomes are achieved.

A practical framework is needed for all stakeholders to be able to quantify the results of interventions. An outcome-based structure with clearly defined milestones and deliverables should be utilised. Strategic coordination is required to undertake all the activities inclusive of technical support, policy research and a “think factory” for implementation of the vision. A strategic management is required to oversee the process.

5.9. CONCLUSIONS AND RECOMMENDATIONS

Scenario planning and creating a desired vision has enabled additional insight and knowledge on the industry and its range of futures. The goal has not been to predict what will happen, but to prepare for what might happen. Enormous investments are being made globally into new health technologies and future innovations have huge potential for benefitting SA. Foreseight methods are able to reveal stumbling blocks and appealing opportunities. Focus is needed on different actors, agencies and institutions when performing these techniques to understand the complete picture.

Managerial implications that have emerged consist of the reality that innovation is vital for enabling the sustainability of healthcare systems; IT will play a significant role in healthcare by supporting the management of medical data, administrative duties and cooperation between other organisations; prediction and prevention initiatives of diseases will allow for an improved quality of life; home-based healthcare will proliferate allowing hospitals to save costs; and efficiencies due to health technologies will aid in productivity and, hence, profits. Health policies need to view the contribution of ICT as essential and a core component as opposed to it wll be an add-on service option. The use of new technologies can shift companies from trying to use cost-effective automation towards leveraging technologies to enhance the human workforce, but this will only be realised if all stakeholders work together.

Health technologies are driven by ecosystems of innovation and entrepreneurship and parties involved in economic development in SA need to acknowledge that creating an enabling environment physically and through policy will allow entrepreneurs to develop pioneering technologies. Challenges experienced by start-ups involve lack of access to resources to meet regulatory requirements and funding but these present opportunities for stakeholders from different areas to partner and build products that enter the market much faster.

Patients no longer need to be in a passive position but are able to provide feedback and change service providers if they so wish. Patient engagement enhances compliance which subsequently improves patient outcomes and as the healthcare industry advances toward a values-based environment, patient satisfaction makes good financial sense. However, companies must view regulation as an opportunity to build trust and without this critical trust component, new technologies will fall flat.

As reiterated through this study, collaboration is essential among the different stakeholders, especially across public and private sectors. Governments are urged to upgrade education levels and develop local capacity to be able to adjust and prepare accordingly for the technological future that is upon us. Governments are also advised to employ systems thinking to work together rather than in silos.

Health technologies applied to make healthcare more accessible, affordable and manageable with a shared vision and exceptional leadership will ensure that the '**Future Vision of Health Technologies in South Africa towards 2035'** is established for more a prosperous future. In conclusion, a statement by the late Stephen Hawking:

"The past, like the future, is indefinite and exists only as a spectrum of possibilities".

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APPENDIX 1

Timestamp	Name	Designation	Organisation	What do you understand by the term health technologies?	How important is the usage of new technologies in healthcare to South Africa?	What do you think are the driving factors influencing uptake of health technologies?	What challenges does South Africa face when it comes to implementing these technologies?
9/30/2018 8:09:29	[redacted]	CEO - Dynamic Body Technology	Private	The integration of technology to improve the flow of data relating to healthcare. These tools empower stakeholders to make more informed decisions relating to healthcare policy / treatments	South Africa is widely recognised as on of the most unequal societies in the world and there are few places where this is more obvious than in the healthcare sector. The National Health Insurance (NHI) initiative is likely to be one of the most emotive issues facing the sector and it is important that we use reliable and quality data to make informed decisions to drive policy.	I would argue that this is a 2-part question. Over the last 5 - 10 years, consumers have become more aware of their health status and have (to some degree) been proactive around measuring their health and activities (Driven by medical insurer rewards initiatives). To this end, the medical insurers have made a concerted effort to drive awareness and encourage the use of wearable technology and integrating to mobile phones. Clinicians - in my experience - themselves have been less keen to adopt technology in their practices (either govt. or private practice). Partly I think this has been driven by the recession and 10 years of little to no economic growth in SA. I think a breakaway factor which could drive further technology adoption in the next few years is actually a by-product of the Fees Must Fall protests from 2015 / 2016 / 2017 where enormous damages were inflicted on places of learning. The education system was already under financial strain and the cost of reparations is easily estimated at R1bn. The introduction of technology-based learning initiatives such as the eZone at Wits is a way to build capacity in skills and share information quicker. As these clinicians graduate, they have a stronger grounding in technology. As a follow-up to this, there is valuable IP sitting inside of the universities who are now being driven to commercialise this as govt. funding comes under pressure and student abilities to pay fees remains under pressure.	Data. 1. The issues around our costs of mobile data are well documented and probably don't need to be further discussed but this has a negative impact on the way that a clinician goes about utilising technology / mobile health / tele-health technology in their practices. 2. More importantly (in my opinion) the data architecture system in SA is inverted with all the focus aimed at empowering medical insurers to invest in health data gathering. Clinicians are at the frontline of the process and should be gathering data to grow the body of knowledge rather than simply to empower the pricing ability for medical insurers. 3. We need to remember that the implementation of POPI and GDPR are likely to drive policy around data collection and this might have an impact (positive and negative) around using health tech.
10/1/2018 9:06:50	[redacted]	Senior Lecturer	Government	Hardware , software, systems that have an impact on health education, training and healthcare delivery	It is critical - aocess to information as it is needed improves decision making. Efficiency in systems improves patient care (even down to the 4GB RAM vs 16GB computer to ensure the pharmacy turnaround time is better).	Upskilling of health professionals in the available technology | Funding not only for implementation but for maintenance and support | The tech support that can get to a system in reasonable time-frame.	Our generally inadequate infrastructure! Our nurses have generally poor digital literacy (particularly those who have college diplomas and have worked for many years). Fear of depending on a technology and then it fails (possibly due to electricity, maintenance, network bandwidth etc). Generally poor health systems governance. If we can't even feed patients at some hospitals....
10/2/2018 13:27:35	[redacted]	President & CEO	Government	innovation for health e.g. diagnostics, devices, vaccines, drugs etc	Critically important	Human Resources, usability, reliability	understanding change management and the support thereof
10/2/2018 13:50:38	[redacted]	Mr	Private	Evolving tech influence in healthcare	Extremely	Cost, Infrastructure Adoption Skill set	Cost Gatekeepers
10/18/2018 8:40:49	[redacted]	Prof	University	products that are used for diagnosis and treatment, may include software	V important	self-care, better diagnosis and treatments	funding, low investment into general STEM education

10/19/2018 15:01:39		Project Manager Technology	Public Research Institutic	Any technology which can be applied within the health sector, to improve overall health of a population	Very important. New technologies need to be integrated into the healthcare system in South Africa, to increase access and affordability of healthcare to all	New health technologies are often able to provide a certain aspect of healthcare at a lower cost than the previous technologies, increasing the chances of uptake. Technologies that target the largest disease burdens in South Africa (HIV, TB, Maternal and Child Health) are more likely to be adopted both by private and public sector due to the large impact.	One of the biggest challenges is that most new technologies need the health system to be changed for adoption of the technology and this is not an easy task, especially in the public sector. Irrespective of how good the technology is or what an impact it might have, getting it adopted within the health system is the biggest stumbling block. This includes procurement systems (for example, needing to procure a different diagnostic is not easy, etc), training of healthcare workers (new device that needs training), extra time of healthcare workers spent on new technologies as opposed to previously.
10/26/2018 16:24:19		Consulting analyst	Private	Existing or novel solutions/systems/methods/devices developed to address targeted healthcare challenges.	New technologies are critically important.	Weakened health systems in need of improved efficiency, limited healthcare resources that require the support of valid/effective technologies, the need to analyze and share large data sets etc.	Limited funding, lack of expertise, low rates of uptake, lack of awareness of the benefits, limited infrastructure/connectivity etc.
11/10/2018 5:12:21		Medical Doctor Founder of Novitech Digital	Private	Any software or hardware that is used at some point within the health value chain with a direct impact on patients or healthcare service providers. My definition is broad as i believe things like cellphones and computers in and of themselves form part of health technologies in 2018	I feel it is pivotal. The nature of healthcare in south africa means we need to look at novel ways to harness technology (both new and old) to deliver access and convenience to the general public	Historically access to such technology was the problem, then infrastructure to enable the use of these technologies. These two factors are largely overcome nowadays, the challenges we now face are to do with interoperability, integration into existing systems and widespread knowledge of these systems	The major problem is innovation in silos and lack of interoperablity. Standards need to be set and upheld to allow these systems to operate in a meaningful fashion

Do you know of any health technologies that have been implemented successfully in South Africa and can you elaborate?	What are the opportunities that this field could have for South Africa?	What would be the best case scenario for South Africa in terms of implementation of health technologies	What do you think the private sector could do to assist the country in developing this field to its full potential?	What do you think the public sector could do to assist the country in developing this field to its full potential?	What is your view on Artificial Intelligence and Robots in the healthcare space?	What assumptions do you think are made when considering implementing health technologies in South Africa and how do we dispel these?	Anything else that you may want to add to assist in this research project?
Discovery Vitality is (in my opinion) still one of the best Health Technology examples out there - data driven, seamless in its integration.	Improving the quality of discussion around the National Health Insurance discussion. We need reliable data to start informing policy or we will end up going down the populist route which will hurt the most vulnerable.	South Africa has a scale and skills problem. We don't have the skills to cope with the demand for healthcare in South Africa and if we can improve the ability to scale: - Sharing healthcare education - Sharing healthcare data - Commercialising highly valuable intellectual property inside of the universities and creating a culture of private sector investment (think about the energy that has been driven into "Fintech" initiatives) If we can get these issues right, then we have the chance of improving access to quality tools	Public Private Partnerships between the universities and initiatives like The Innovation Hub are critical to building capacity and scale. The reality is that the Public sector is cash-strapped through years of mis-management and it's critical that the private sector is able to help unlock some of the potential here. There are major challenges around the commercialisation process in respect of Intellectual Property restraints but where there is a will, there is a way.	I think the public sector actually does a very good job with a very limited set of resources. There are probably 2 areas - and both relate to leadership - where I think the public sector needs clarity: - Is the purpose of the public sector (university) to educate AS MANY people as possible or provide the set of skills that the economy needs. Under the current political leadership, I think this is very much an overlooked factor where the focus has been on quantity over quality of skills. This is an idealogical thing from a political leadership perspective but at some point we need clarity - The universities need to embrace technology as a tool to help scale their education offering. If knowledge can reach more people, more effectively, then we have the recipe for an improved skills base. But this requires buy-in from education leadership	Again I revert to the question around data architecture. We can invest as much as we like into AI and robotics but if the right data is not acoessible to the clinicians then we're starting at the wrong point. We need to be realistic about the costs of this technology coming into the marketplace in emerging markets (like SA) vs. developed markets.	I think one of the big unanswered questions is around "Who will pay?" - While the consumer might implement health tech indirectly through an app on their mobile phone, they are cost-sensitive and in markets like SA where inequality is rife, there is very little buying power for technology. The next argument would be that the medical insurers will pay. Again they are interested in the data to help them price risk, but their mandate is arguably different from the clinician.	
RedCap as is data system used for Biomedical research - Longitudinal studies and epidemiology. (Wits) MomConnect - the SMS maternal health care message system I know there is a system linking the full ECG's and other tests from some of the government hospitals to the specialists to access from anywhere (even overseas). I recently broke my collarbone - the ER doc simply whatsapped the X-ray to the ortho for treatment advice.	Improved health care particularly to rural South Africa. Reduced burden of care on family members. Reduction of mortality rates. It all depends on what technology and how it is used....	There needs to be a unified drive towards using technology. At the moment it is very "lighthouse" based...	Keep developing new robust tech at affordable rates. Invest in University research. Form Public-Private Partnerships.	Improve the skills development. Ensure all hospitals and clinics have the infrastructure : Power, Broadband etc	It is already happening - we need to embrace it to improve health care delivery	There are so many, but they all depend on the situation - What happens in a top private hospital surgical theater is very different to managing an emergency in a township. If those using the technology see value and success they will adopt it - especially if they are made to feel confident in their skills in using new tech.	
EDL, gene-expert, HIV testing, TB register	having information that is usable to optimize treatment outcomes	that it is used and not redundant	they could help augment innovation, co-fund, and develop innovation	need to understand the barriers to implementation and develop strategies to overcome this.	they are critical to advancing health in RSA	the assumption is that the health care worker will buy into the innovation and adapt to use the innovation in practice, that they understand and know how to use innovation.	NA
Patient management software	Various and immense	Government buy in	Form PPP	Engagement private role Players	The paradigm shift needed	Cost Training	No
no	Vast opportunities	support of local entrepreneurs	partner with enrepreneurs	Clearer regulations	good for improved outcomes	Not enough knowledge and competition. Market is price sensitive	

Lodox is an imaging (X-ray) equipment manufacturer in South Africa which has implemented their equipment in South African hospitals, as well as globally. MomConnect is a cell phone messaging platform from the National Dept of Health for pregnant women in the public health system. Vula Mobile is a platform where healthcare workers are able to access specialists for advise and referrals. The Essential Medicine List (EML) app was also developed in South Africa and is being used successfully by healthcare workers for queries on treatment, medication, etc...	The digital health space is growing rapidly, mostly due to its lower timeline for development and implementation and lower cost for development. Implementation of digital health solutions could have a large impact. Medical devices is also a big opportunity for South Africa, considering most medical devices used by the South African Dept of Health are imported. The regulatory hurdles and development timelines are lower for medical devices than they would be for therapeutics.	Health technologies that would make impact in the public health system would be important for South Africa, however for these to be profitable, they would also need to ensure market penetration in the private health sector	The private health sector could assist by procuring locally if available (consumables, equipment, diagnostics...). It is very difficult for local health technology companies to perform R&D in South Africa and enter the local market.	The public health sector could assist by adopting these technologies within the system or change the system to include new technologies (procure local products). The regulatory approval system (SAHPRA) should also be streamlined and capacitated to ensure speedy regulatory assessments and approvals for new technologies.	It is an inevitable event, and so they should be utilised to improve the quality of healthcare as well as to ensure access to more people utilising these technologies. AI has wide applications in healthcare, especially in diagnosis, precision medicine...	One of the assumptions is that if a needed technology which can have a lot of impact is developed, the South African Dept of Health will implement it in the public health sector. It is very difficult for the DoH to implement new technologies within their existing systems (including procurement) and so when technologies are being developed, engagement with DoH should be happening in parallel, to ensure the procurement systems and health systems needs are taken into account by the company developing the technology.	
Yes. The RecoMed patient booking platform serves both patients and healthcare professionals in streamlining scheduling of appointments and reducing administrative load. Strait Access Technologies (a healthcare start-up stemming from UCT) have developed a novel TAVI (trans-catheter aortic valve implantation system) to address the alarming incidence of RHD (rheumatic heart disease) in developing, underprivileged regions. This technology is set to save millions of lives across South Africa, Africa, and the rest of the world.	Opportunities present themselves in the form of rising NCD rates, consistently high infectious disease rates, and the low number of healthcare human resources.	The best scenario would involve streamlined collaboration between the public and private sector, with the public sector leveraging the expertise, infrastructure, and financial stability offered by the private sector (including continued interest and investments by multinational players).	The private sector could contribute opportunities to grow the healthcare workforce and offer high-quality training/educational opportunities. Additionally, the private sector could offer support in the form of access to world-class facilities and expertise.	The public sector must eradicate corruption and maladministration in addition to rejuvenating its facilities and workforce in order to successfully implement the NHI that will serve each and every citizen. Cooperation with the private sector is also critical to the success of the public sector.	These factors will play a key role in the healthcare sector in coming decades. For example, AI will improve the accuracy of medical diagnoses and will help predict the risk of adverse health conditions in order to prevent unwanted health outcomes and unnecessary expenditure. Robotics will enhance patient treatment strategies among other benefits.	The primary barrier is the cost of implementing technology and ensuring continued adherence/maintenance of technologies while eradicating corruption associated with healthcare expenditure. Educating end-users and decision-makers on the remarkable return on investment (ROI) offered through implementing technology is a critical part of mitigating the aforementioned barriers. Furthermore, ensuring that the correct expertise and advisory teams are in place to oversee the correct use and maintenance of health technologies is essential.	Robust public-private partnerships are vital to drive investments into innovative health technologies in order to strengthen local health systems.
http://iber.co.za/ The Burns record and registry held in Edendale KZN. This helps to keep a unified record of treatment and management of burn victims in Kzn Patient who sustain burns are catalougued and referred to tertiary institutions using this system	Technology and record keeping enable a patient to carry their medical record, this creates an activated patient who can then participate in their own helathcare - too many South Africans are spectators when it comes to their health no idea what medications they are taken what procedures they have undergone and why What diagnoses they currently suffer from All these lead to higher cost, repitition of tests, inefficiencies in health provision	I think there needs to be a standard for interoperability from a security and technical standpoint, no one facility should house and cordon off their own data as truly the data belongs to the patient	There are already private public partnerships that are beginning to change the face of healthcare in South Africa, we need to nurture these. The public sector is typically sluggish at rolling out innovative ideas in a managed format that is monitored and iterated upon, the private sector is typically better at this as they don't have to consider ramifications as wide as the public sector does and also they generally have better internal processes.	There needs to be a department within the government that focuses solely on innovation in healthcare. A single point to make it easier for those from the private and even the public sector to find audience for their innovative ideas. This will prevent expensive duplication and foster a culture where partnership can be made easier	Love it :) From an accessibility and diagnostic perspective this can really revolutionise healthcare. Teaching a computer to recognise what is normal, the varying degrees of normal and than to flag what is not normal would alleviate a lot of burden from the under-resourced health sector and that is just the beginning of what becomes possible	Everybody wants to own and be the "one service" that solves all the problems in south african healthcare. We build for exclusivity and that is not in the best interest of the patient or the country. We need to strongly push the message that meaningful collaboration is the only way forward.	I will gladly avail myself for any further questions or discussion around this. My perspective is from that of a young startup as that is what I know - but hopefully studies and reviews of the current healthcare setup similar to what you are doing can make for enduring change