THE READINESS OF THE SOUTH AFRICAN PRIVATE AND PUBLIC SECTOR FOR THE FOURTH INDUSTRIAL REVOLUTION

By

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Research proposal submitted in partial fulfilment of the requirements for the degree of Masters of **Business Administration (MBA)**
in the Faculty of Business and Economic Sciences in the Graduate School of Business at the Nelson Mandela University

Supervisor: Professor Christian Adendorff
Degree of confidentiality: A

December 2017

Declaration

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NAME: Mark Ludwig Putzier

STUDENT NUMBER: 18803705O

QUALIFICATION: Masters in Business Administration

TITLE OF PROJECT: Readiness of private and public sector South africa for the Fourth Industrial Revolution towards 2035.

DECLARATION:

In accordance with Rule G5.6.3, I hereby declare that the above-mentioned treatise/ dissertation/ thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

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Acknowledgements

My sincere thanks go to all those who, in one way or another, contributed towards the completion of this study. In particular, I would like to acknowledge the following:

- I am eternally grateful to my Creator, who gave me the strength and wisdom to complete this journey on which I embarked.

- To my wife Claudia, thank you for the patience and love shown during yet another of my academic expeditions. I know it has been lonely sometimes, but I promise to make up for lost time.

- To my Mom and Dad, thank you for the solid upbringing and grounding that you have given me, as well as showing and teaching me to never give up and always chase my dreams.

- To the rest of my family and extended family, thank you for the encouragement and words of motivation.

- To my MBA group – Jehan, Ryan and Stephen, thanks for making the journey an enjoyable one, and thanks for the strong work ethic you guys displayed over the course.

- To my supervisor, Professor Chris Adendorff, thank you for all the years of pushing and motivating me to aim higher than I thought possible. I may never have started this journey if you had not planted the seed in the first place. Your friendship is, indeed, valued.

Abstract

The exponential growth of technology over the past few years led to it being given prime slot at the World Economic Forum held in Davos in January 2016, with Forum founder and executive chairman Klaus Schwab coining this potentially disruptive phenomenon as the 'Fourth Industrial Revolution'. Since then, the term Fourth Industrial Revolution (FIR) has gained ever increasing relevance and importance. Schwab (2016) emphasised that the world is on the edge of "a technological revolution that will fundamentally alter the way we live, work and relate to one another"; and that in the pure "scale, scope and complexity, the transformation will be unlike anything humankind has experienced before". What is certain is that the FIR is predicted by many to impact significantly on jobs in the world as robotics; automation and artificial intelligence become more prolific. This shift will have a direct bearing on South Africa as well. With the challenges facing the country, such as infrastructure constraints, frequent industrial actions, rising costs and shortages of skills, the loss of further jobs should be of concern for government and the private sector alike.

The outcomes of the in-depth analysis of future studies practice and theory in this research study give credence to the argument that the manner in which planning for the future of the FIR in the South African context is taking place requires profound adjustments. The development of fresh insight through the application of futures studies is essential to this planning process, as is progressively evidenced in the tendency for present day business to make collaborative decisions and strategies that are founded on and informed by futures studies.

This research has tried to gain insight into the possible future of the FIR in South Africa through the creation of four scenarios towards 2035. These are outlined as follows: The Fifth Element, which is the 'best case' scenario, to which the country aspires; Terminator, the 'worst case' scenario, in which everything goes bad; The Matrix, the outlier future based on a surprising, disruptive, emerging issue; and The Day the Earth Stood Still, in which no change takes place, making it 'business as usual'.

The research furthermore endeavoured to discover the preferred future for the FIR in a South African context, as a basis for the Future Vision of the FIR in South Africa

towards 2035. All through this study, Inayatullah's (2008) pillars of futures studies were applied as a guide in mapping the present and future, further deepening and broadening the future through the development of scenarios, and, finally, transforming the future by narrowing it down to the preferred. It is up to the South African public and private sectors to determine which path is to be followed in the decisions surrounding the embrace and acceptance of the FIR as the country moves towards progress and sustainable development. Through a novel and innovative methodology, the creation of an atmosphere of trust, and the sharing of purpose, values and benefits, a national Future Vision of the FIR in South Africa towards 2035 is attainable. All stakeholders have to commit to working in co-operative partnerships, with government, society, local communities and labour striding boldly together into a world of technological, commercial, environmental and social innovation.

Keywords:

Futures studies, scenarios, fourth industrial revolution, progress, sustainable development, singularity, artificial intelligence, robotics, disruptive.

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List of acronyms and abbreviations

AI	Artificial Intelligence
ARC	African Research Cloud
BD	Big Data
BER	Bureau for Economic Research
CLA	Causal Layered Analysis
DNA	Deoxyribonucleic Acid
EV	Electric Vehicles
ES	Environmental Scan
EnS	Energy Storage
FDI	Foreign Direct Investment
FIR	Fourth Industrial Revolution
FTA	Future-orientated Technology Analysis
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
ICT	Information and Communications Technology
IDC	International Data Corporation
IDIA	Institute for Data Intensive Astrology
IoT	Internet of Things
IP	Internet Protocol
IR	Industrial Revolution
ISEA	Institute for Spatial Economic Analysis
IT	Information Technology
LED	Light Emitting Diode
L-i	Lithium-ion
NPC	National Planning Commission
NDP	National Development Plan
OECD	Organisation for Economic Co-operation and Development
PC	Personal Computer
R&D	Research and Development
SKA	Square Kilometre Array
STEM	Science Technology Engineering Mathematics
UK	United Kingdom

US	United States
USA	United States of America
USD	United States Dollar
VR	Virtual Reality
WEF	World Economic Forum

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THE READINESS OF THE SOUTH AFRICAN PRIVATE AND PUBLIC SECTOR FOR THE FOURTH INDUSTRIAL REVOLUTION

CHAPTER 1
THE RESEARCH PROPOSAL
"THE STORY LINE"

1.1 INTRODUCTION

The procession of scientific breakthroughs and new technologies is unrelenting, unfolding on many fronts (Manyika, 2017), bringing about changes in the manner in which people work, and progressively allowing machines and software to replace human intervention (EY, 2015). The significance of the Fourth Industrial Revolution (FIR) as a potential game-changer for the world was highlighted at the World Economic Forum (WEF) in Davos in January 2016, at which it was allocated a special slot on the agenda. Schwab (2016) emphasised at the annual meeting that the world is on the edge of a technological revolution that will profoundly change "the way we live, work and relate to each another"; and that in the pure "scale, scope and complexity, the transformation will be unlike anything humankind has experienced before". Features setting the FIR apart from its predecessors are **speed** (where whole industries will be transformed or created in years rather than decades), **scope** (as "nobody is going to be left untouched" by these impending changes) and, more importantly, the need to take a **systems approach** (as the changes will be far more extensive and deeper than those of the past) (Moavenzadeh, 2016).

EY (formerly Ernst & Young) (2015) points out in the report **"Megatrends 2015: Making Sense of a World in Motion"** that the world we live in is in perpetual motion and that capital, goods and labour are traveling the globe quicker and moving in more innovative patterns than ever before. Technological innovation is altering all industries, as well as the way in which humans manage their lives. In this realm, the ever increasing speed of change is one of the few constants (EY, 2015). Technology can be viewed both in terms of possible economic influence and its capacity to disrupt, which means these effects go hand-in-hand and both are of vital importance to leaders (Manyika, Chui, Bughin, Dobbs, Bisson & Marrs, 2013). There is uncertainty as to just how the FIR will develop, however one thing is clear: the critical reaction must be

comprehensive and integrated, encompassing all stakeholders of the global society, from the private and public sectors to the academic world and civil society (Schwab, 2016c).

The repercussions for nations and businesses that do not embrace and adapt to this wide sweeping development are ominous (Pretorius, 2016). Only a few global investors and leaders have thus far noted and reacted to the revolution and have already reaped the benefits; it is time now for all business leaders, educators, economists and investors to recalibrate and adjust to this phenomenon, in order not to be left behind (Beck & Schwab, 2016). Beck and Schwab (2016) call this phenomenon a revolution of networks, people, platforms and digital technology that is "*blurring the lines between physical, digital and biological spheres*" (Beck & Schwab, 2016). The overwhelming convergence of evolving and ubiquitous technological innovations overlays an array of comprehensive fields from artificial intelligence (AI), 3D printing, nanotechnology and biotechnology, to the internet of things (IoT), robotics, autonomous vehicles, quantum computing, materials science and energy storage (EnS) (Paine, 2016).

From an African perspective, Mtongana (2016) draws attention to some of the challenges impacting the African continent's involvement in the FIR, including infrastructure restrictions such as access to broadband and electricity and a lack of education – implying that Africa is always 'playing catch-up' and never setting the pace in technological innovation. In an attempt to counter this, substantial investments will be made in new and innovative technologies led by the private sector and assisted by the international community (Kende-Robb, 2016), with venture capital funds being made ready and waiting to increase investment across Africa, ultimately reflecting the symbiosis of public and private sectors and assisting them to conclude deals as swiftly as possible. Disruptive technologies have the latency to solve real problems around the inequality and poverty found in growing African cities and to fundamentally drive structural transformation (Mtongana, 2016).

South African Minister of Trade and Industry Dr Rob Davies acknowledged, when speaking at the 'Investment Dialogue' session of the 2017 Investing in African Mining Indaba conference in Cape Town, that the FIR will offer fresh opportunities through

which to realise inclusive and sustainable growth by fast tracking market integration in Africa through regional and various industrial corridors. Furthermore, Davies added that the effects of the FIR will not be limited to the manufacturing arena, but rather would similarly extend to service sectors, including the accounting and legal professions, as well as e-commerce, and warned that South Africa will need to start preparing its response (Medupe, 2017). The FIR cannot be ignored and will affect business and labour models alike (Pretorius, 2016), potentially resulting in greater inequality and thereby creating a massive challenge in South Africa, where the gap between the poor and rich is among the highest in the world. Indeed, a recent World Economic Forum (WEF) report, **The Future of Jobs**, (World Economic Forum, 2016), projects a net loss of 5 million jobs globally by 2020 – as a consequence of technological changes.

While the FIR is a little more complex to understand than its forerunners, as Moavenzadeh (2016) admits, it does expand on the digital change originated by the third industrial revolution. The term refers to the influence of a convergence of dissimilar evolving technologies, from large scale digital platforms and smart sensors to synthetic biology and nanotechnology, 3D printing and advanced robotics. Digital platforms have now become ubiquitous and shifting consumer outlooks are of increasing importance. Along with the first generation of youngsters to have grown up in a world full of computers, the internet and digital communication is coming of age right now; these users bring with them “different consumption habits and different ideas about the purchase and use of products and services” (Moavenzadeh, 2016). This marks the rise of a new generation of disruptive businesses, eager to develop completely new industries for themselves or to take profoundly different approaches in established areas.

1.2 PROBLEM STATEMENT

Like all revolutions, the FIR is about disruption, not only for individuals but for business as well (Ofir, 2016). Production was automated in the first industrial revolution; electric power for mass production was used in the second; and, in the third, information technology was used to automate production (Falcioni, 2016). Now, this fourth revolution is characterised by its exponential evolution and, unlike the three previous

industrial revolutions (IRs), it is not purely linear (Bloem, Doorn, Duivestein, Excoffier, Maas & Ommeren, 2014). While the increasing use of technology can be seen daily, the FIR's bearing on other aspects of the economy have to be critically assessed. In the paper, **Impact of Technological Innovations on the Social Structure** (Dmitriev, Kalinicheva, Shadoba, Nikonets, Pogonysheva, & Shvarova, 2016), the authors highlight the negative consequences of innovations which could lead to the displacement of human labour by automated systems. The challenge and responsibility to manage the FIR's potential and advancing effects on economic policy and society lie in the hands of governments and the private sector.

In 2015, United Nations countries adopted a set of 17 global sustainable development objectives aimed at protecting the planet, ending poverty and ensuring prosperity for all. The specific sustainability targets include poverty, health, energy, education, hunger and food security, water and sanitation. Technological developments will contribute and assist in achieving these global goals (Burda, 2015) so, although the FIR is about technology, Coleman (2016) proposes that these technologies can equally be used to accelerate access to energy, food, water, healthcare and education (Coleman, 2016).

The FIR poses risks to the political, economic and social fabric of the country – it will mean significant changes for governments, businesses, civil society organisations and the media. Davis (2015) indicates that one of the most intense impacts of the FIR will be on the jobs people have and the skills that are necessary for success. From a South African perspective, this is of particular concern considering the high level of unemployment in the country. Any further job losses will have a severe impact on tax revenues; pension funds will be affected, and it is probable that the social damage as a far reaching result of lost taxes, lost employment and lower GDP will increase (Burda, 2015). In order to gain a competitive advantage in this fast changing world, it is imperative that government and business embrace the FIR which, according to Nayyar and Forum (2016), **should provide within it some of the solutions to such challenges, in the form of increased effectivity of the value chain via technologies like data analysis, sensors, robotics and 3D printing**.

There are other benefits to be derived from the FIR too, including economic growth, foreign direct investment, increased exports and first mover advantage. Kakuru (2016) asserts that the change will bring about an end to wasteful means of production, the transformation of the education system, and also incentivised trade among different communities (with the consequential effective elimination of trade bottlenecks). These and other transformations will be seen in e-commerce, improved transparency and governance, and will also lead to the dawn of innovative industries. The FIR is set to transform the way we work and learn across the entire African community (Kakuru, 2016).

Lack of vision or buy-in by government and industry vis-à-vis the importance of the FIR could lead to South Africa being left 'out in the cold' while other countries, including those of the African continent, embrace the new marvels. Pretorius (2016b) implores the South African government to show similarly courageous leadership in ensuring effective and well-organized education and healthcare systems, as well as addressing restrictive labour market practices (Pretorius, 2016). Meanwhile, the positive view imparted by Schiessl (2016) indicates that if there is one certainty in the midst of this flux, it is that the pace of change is accelerating and that the economies that adapt and the governments that are flexible will most certainly emerge as the winners in the end (Schiessl, 2016).

Another possible cause of the local challenge is that the **South African information technology (IT) infrastructure is not up to standard**, as the FIR is reliant on a backbone of an advanced technology. In the view of Schiessl (2016), while a large portion of technology and IP may have originated in developed economies, it is perhaps in emerging economies that the changes will be most extreme (Schiessl, 2016). A poor technology infrastructure, the manner in which people share data and access information, education, and an overall deficiency of maths and science skills are some reasons that have been cited for Africa's inability to participate in the FIR movement (City Press, 2016). Furthermore, a robust telecommunications infrastructure is critical to enhancing efficiency, effectiveness and transparency in institutional and trade activities which, in turn, results in direct improvements to trade efficiency (Bankole, Osei-Bryson & Brown, 2014).

Another challenging issue lies in the **lack of skills** that are required if a nation is to take advantage of the FIR. A key strategic drive identified by Pretorius (2016b) is that companies across all industries need to be actively and urgently investing in the reskilling of current workers as part of their transformation and future labour force planning efforts. Pretorius (2016b) further mentions that businesses can no longer be reactive in their upskilling of the nation's labour force; as such, they require a change in mind-set that will simultaneously address societal needs (Pretorius, 2016).

An additional potential origin of the problem is that government's current economic policies are restrictive and hamper its ability to adapt timeously to the FIR movement. Balkaran (2016) highlights that the South African government needs to dispel many of its own myths about the public sector and the opinion that it has remained unscathed by the **technological and digital improvements and resourcing** levels. Frustrations around bureaucracy across the public sectors, the failure of senior management to understand the logistics of efficient service delivery, as well as the corresponding lack of resources (Balkaran, 2016) can no longer be ignored.

The last aspect to consider is the **widening inequality gap**, both from one country to another, as well as between the inhabitants of individual countries. Pretorius (2016b) argues that this revolution may result in increased inequality in South Africa, where the gap between the poor and rich is among the most extreme in the world, which creates a huge challenge. A further reality is that this technological revolution will disrupt employment markets (Pretorius, 2016), and Balkaran (2016) warns that policymakers may be required to intervene to confront the widening inequality gap resulting from the introduction of new technologies, as the affluent stand to gain more from any advancement than the poorer sectors of society (Balkaran, 2016) .

Based on the context and background established above, the formulation of the main research problem for this paper is as follows: **Despite the growing importance and possible major impact of the FIR on global economies, South Africa's challenges put it at risk of not being adequately prepared to participate in and benefit from this event, which is likely to have a consequential harmful impact on the economy and socio-economic system in the country.**

1.2.1 Primary research question

The primary research objective to be addressed in this study is: **To investigate the extent and impact of the readiness of the South African private and public sector for the FIR towards 2035.**

1.2.2 Secondary research questions

The main research problem is further supported by the secondary research questions presented in Table 1.1.

Table 1.1: Secondary research questions	
RQ_1	What are the factors to be considered in determining the readiness of South African business for the FIR?
RQ_2	What are the potential implications and impact on the South African labour market as a result of the FIR movement?
RQ_3	Which industry sectors will be most impacted by the FIR?
RQ_4	What are the consequences to the South African economy of not embracing the FIR?
RQ_5	Which role-players should be involved in the determination of skills shortages and does South Africa have the capacity to overcome these shortages?
RQ_6	What are the potential implications and impact on the South African socio-economic system as a result of the FIR movement?

1.3 RESEARCH OBJECTIVES

1.3.1 Primary research objective

Based on the main research question, the primary research objective is therefore to investigate the **readiness of private and public sector South Africa for the FIR by developing a series of alternative scenarios, and including identification of the desired future for the South African private and public sector in the period up to 2035**; in other words, the creation of the **"Future Vision of the FIR in South Africa towards 2035"**. The primary objective will be achieved through the establishment of

innovative and sustainable mechanisms and strategies through which both the public and the private sector can implement the FIR.

1.3.2 Secondary research objectives

To support the primary research objective, the secondary research objectives were identified and are listed in Table 1.2.

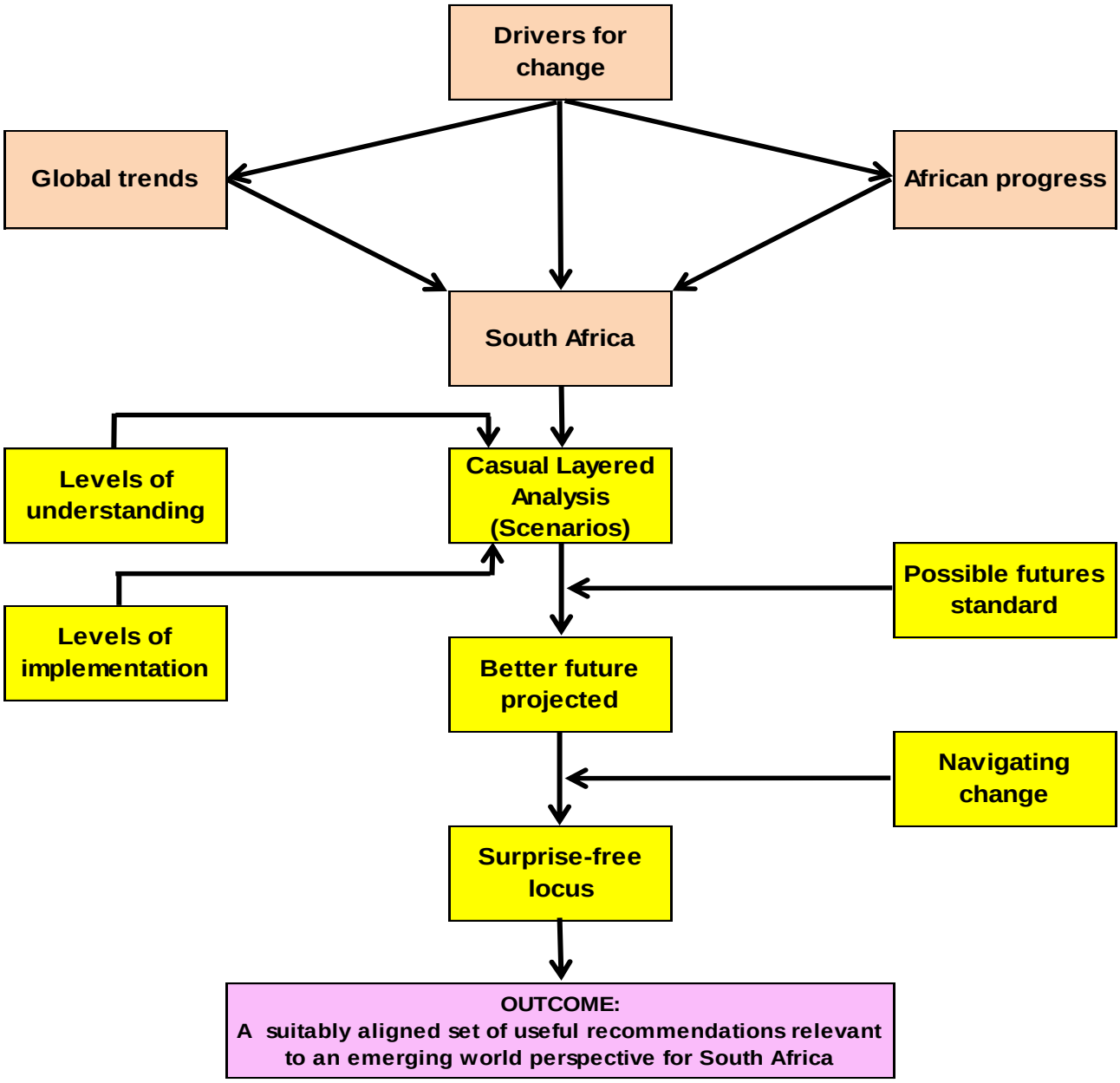
Table 1.2: Secondary research objectives	
RO_1	To conduct an in-depth analysis of FIR in South Africa and establish whether or not the private and public sectors are taking note of the phenomenon
RO_2	To consider emerging threats and opportunities that will influence the future of FIR in South Africa by plotting various alternative futures in accordance with specific drivers
RO_3	To inspire dialogue throughout all industries, at all levels of stake holding, to develop an inclusive, consistent strategic plan to embrace the FIR
RO_4	To gain a better understanding of the best possible future for South Africa, the nature of development and failure in the African context will also be explored
RO_5	To analyse South Africa's progress and failure in terms of the FIR
RO_6	To develop a simple yet practical set of recommendations to address the main factors that inhibit the possible implementation of the FIR, with the aim of improving the level of technology management in South Africa

1.4 CONCEPTUAL RESEARCH FRAMEWORK

To better understand the purpose of the research, a conceptual framework was developed and aids as a foundation for the research (Baxter & Jack, 2008). A conceptual framework serves a number of purposes:

- recognising who will and who will not be involved in the study;
- defining relationships that may be present based on theory, logic and/or experience;
- providing the researcher with the opportunity to collect general constructs into logical "bins" (Miles & Huberman, 1994).

Figure 1.1: Conceptual research framework



(Source: Author's own construction, 2017)

The above design describes the extent to which the variables that influence the FIR are understood. It also aims to identify the drivers for change, global trends and standards, the nature of technological development and progress in an African context, and the development of ideas for a better future, as factors determining the route of change for South Africa (Osmond, 2015).

1.5 RESEARCH DESIGN AND METHODOLOGY

The preferred method of futures research in this paper, to analyse the past, present and future theoretical perspectives of futures studies and the social sciences, will be 'causal layered analysis' (CLA). Derived from theories of poststructuralist discussion, and developed by Inayatullah (1998), CLA provides a basis for evaluating the social hypothesis of the 'real' and proposes a layered approach with which to analyse the results from the key focus areas of the research (Inayatullah, 1998). The CLA method assumes four levels of analysis:

- The 'litany' level, which is the official public description of the issues;
- The 'social causes or systems' level, at which some underlying systemic causes are revealed;
- The 'world-view or paradigm' level, in which the analysis is concerned with challenging the deeper assumptions behind the issue; and
- The 'myth/metaphor' level, where the perspective is rational and the method attempts to discern the irrational (Inayatullah, 1998).

These four levels are used to find the full array of stories, including the conscious, unconscious and emotive views of the issues. CLA's capacity to create new ways of knowing by interpreting and re-interpreting issues and their solutions provides a rich method for the analysis of scenarios and case studies (Gould, 2008).

Futures research and perspectives are critically important to strategising and decision-making in the creation of alternative futures, adding to conventional wisdom (Du Plessis, 2014). Futures research can focus on large or limited problems, in the near or distant future and it can project desired or possible conditions. The methods can be highly qualitative or quantitative (Du Plessis, 2014). Scenario planning is, additionally, offered as a methodology to increase the understanding of possible futures and to reinforce educated decision-making in a decidedly unclear environment. When appropriately executed, scenario planning provides the means for superior strategic choices and corrective activities, effectively linking the vague world of 'what-ifs' with useful and realistic decision-making. Furthermore, it requires the cooperation of all role-players in the construction of a promising alternative to the existing state of affairs (Oosthuizen, 2013).

According to Inayatullah (2005), CLA is best employed prior to the scenario or strategy development phase because it ‘opens up’ a vertical space for constructing scenarios of differing categories. Benefits of this methodology include the following:

- CLA encompasses and enriches the scenarios to be used in the selection;
- The intellectual process of ‘deepening’ the future leads to different dimensions of knowledge for the contributors involved;
- Its non-textual and almost artistic expression in the futures process appeals to a broad range of people;
- It layers participants’ opinions and positions, both the harmonious and the conflicting ones;
- It moves away from back-and-forth discussion and debate, beyond the shallow and obvious to the far-reaching and profound;
- It caters for a range of transformative activities;
- CLA leads to the formation of policy activities derived from alternative layers of analysis; and
- It re-establishes a vertical form of social analysis, drawing from postmodern relativism to global ethics (Inayatullah, 2005).

To further re-inforce this study, an interpretivist approach will be taken and a qualitative process will be followed in order to gain an advantageous understanding of the issues and of the strategies and actions that management should follow to solve the problems highlighted above. The nature of the research process will focus on available case studies to further understand the phenomena. Furthermore, a broad literature study will be completed through a variety of sources, which will include books, local and international journals, material on the internet, and other local and international publications.

1.5.1 Quantitative research

The positivist paradigm is linked with quantitative methods of analysis, as it is based on the statistical analysis of quantitative data (Collis & Hussey, 2014). The positivist paradigm of observing social reality is grounded on the philosophical thinking of the French philosopher Auguste Comte, according to whom reason and observation are the best ways of understanding human actions. True knowledge is built on familiarity of senses and can be gained by observation and experimentation. At the ontological

level, positivists assume that certainty, and therefore knowledge, is both objective and quantifiable using properties that are independent of the researcher's instruments. Positivistic intellectuals embrace scientific methods and organise the knowledge gathering process with the assistance of quantification to improve precision in the narrative of parameters and the connections between them. Positivism is concerned with finding the truth and presenting it by empirical methods (Thomas, 2010), while quantitative research enables separation from the subjective viewpoint of the researcher (Wahyuni, 2012). Within the methods of quantitative research, measurement is an essential element and it is thus important to ensure the accuracy of that measurement (Collis & Hussey, 2014).

1.5.2 Qualitative research

The alternative to the paradigm of positivism is interpretivism. This paradigm is embedded in the principles of idealism and is linked to qualitative analysis methods (Collis & Hussey, 2014). The appeal of qualitative exploration is that it enables the researcher to conduct in-depth studies about an extensive array of themes, expressed in a plain and everyday manner. Additionally, according to Yin (2015), qualitative research allows greater flexibility in choosing topics of interest, whereas other research approaches are likely to be inhibited by:

- the failure to form the necessary research environments (such as an experiment);
- the absence of a satisfactory data series or deficiency of coverage of appropriate variables (for example, an economic study);
- difficulty in obtaining an acceptable sample of respondents and achieving an appropriately high response rate (as in a survey); or
- other restrictions, such as being enthusiastic to study the past but not ongoing events (as in a history) (Yin, 2015).

The ontological assumption of interpretivism is that social reality is subjective and socially fashioned, thus implying that several realities exist (Yin, 2015). The epistemological assumption is based on the interaction of the researcher with the occurrence under study and therefore knowledge is resultant from the contributors' subjective evidence. Thus, qualitative research accentuates quality through the depth and richness of primary data collected (Collis & Hussey, 2014).

1.6 THE IMPORTANCE AND BENEFITS OF THE STUDY

The initial review of the literature identified a dearth of information and studies conducted on the FIR and its impact in the South African context. Globally, however, the FIR has already been embraced by many countries and so it is increasingly clear that there is a widening gap between those countries accepting the influence of the FIR and those that are still trying to understand how to fully implement its ubiquitous nature. The following critical aspects will be considered in this study, along with any additionally identified gaps in the understanding of this phenomenon:

1.6.1 Infrastructure and the response to change

Since the widely acclaimed final report of the German Academy of Science and Engineering's 'Industrie 4.0 Working Group' in April 2013, academia and industry experts have struggled to fully grasp the impact of the FIR on manufacturing, especially as it relates to manufacturing IT systems. Almada-Lobo (2016) states that manufacturers could begin to define their target manufacturing models and ultimately plot a transformation roadmap. However, in spite of the hype around the subject, the exact implications for manufacturing operations, or when these will happen, remain unknown, aside, that is, from the clear belief that the later-movers will in all likelihood be forced out of the market (Almada-Lobo, 2016). These inconclusive findings represent a gap that will be investigated by this study.

1.6.2 Skills and jobs

The technological changes happening in all of the digital domains, including robotics, big data and connectivity, will have a far-reaching impact on the employment market. Borg (2016) cites estimates from Oxford University's Carl Benedikt Frey and Michael Osborne that 40% to 50% of all jobs will either undergo transformation or cease to exist in forward-looking economies. Post the 2008 global financial crisis, the number of jobs added have not been traditional, full-time jobs with full social benefits. Instead, seasonal work, self-employment, part-time employment and short-term contracts have dominated and the impact has undermined job security (Borg, 2016). In the WEF's 2016 'The Future of Jobs' report, it is estimated that the FIR will eliminate approximately 7.1 million jobs over the period 2015 to 2020 (World Economic Forum, 2016). What should also be noted is that, as Dmitriev et al. (2016) point out, the FIR

will create fewer new jobs in new sectors than the previous three IRs (Dmitriev et al., 2016). Inconclusive findings or incomplete information concerning how this challenge will affect the South African environment create another serious a research gap that will be covered in this study.

1.6.3 Less tax and reduced revenue

The effects of the FIR on fiscal policy will be particularly complex. If robotics and digitalisation are indeed going to disrupt job opportunities, as Borg (2016) contemplates, this will clearly have a negative effect on tax revenues. If computers and machines replace jobs, then the capacity to tax labour earnings will be reduced on a longer term basis, which will likely mean that the social expenditures of taxes relative to lost employment and reduced GDP will increase. Taxes are expected to return lower revenues, which, in turn, will lead to even costlier negative side effects for society (Borg, 2016). This is further corroborated by Burda (2015), who suggests that the long term sustainability of an economic policy would be weakened by an erosion of taxes and the need for higher outflows, thus necessitating the urgent action on a number of issues, including a significant cut in the spend on social security, solving the problems of social framing the great number of migrants and refugees, and finding a speedy solution for youth employment (Burda, 2015). In the South African context, there is little information available that can assist with the decisions required from such challenges, and they therefore present an opportunity for further research in this current study.

1.6.4 Lack of government effectiveness and adaptability

Balkaran (2016) provides evidence that previous technological revolutions occurred as governments undertook bold missions to maximise innovation without focussing on minimising government failure. The introduction of technology in any sphere means that the work conditions are transformed and the environment is altered. It demands the corresponding revision or possibly even new creation of policies, practices and regulations to ensure their validity and appropriateness for the new environment. "*The most significant driver of change, across all industries, is the changing nature of work itself. The public sector has little choice but to improve the way it operates online. To do so, it needs to take its digital revolutions deeper, past the delivery of online services via e-government portals, into the expansive business of government itself. That*

means looking for opportunities to improve productivity, scale, cooperation, process efficiency and innovation" (Balkaran, 2016). There does not appear to be sufficient information available that indicates that the South African government is completely ready for the FIR, hence this is another research gap identified for further analysis under this study.

1.6.5 Inequality

Dmitriev et al. (2016) highlight a recent study by Oxfam which shows that inequality has accelerated over the last few years and that its current maximal level is significantly higher than previous levels. In the USA, for example, with the largest economy in the world, the number of beneficiaries of food stamps increased from 27 million to almost 50 million under the Obama administration. Income inequality in both developed and developing countries received attention at the WEF conference in Davos in 2016, and a number of other significant reports have analysed the problem of inequality in economic, gender, racial and other terms (Dmitriev et al., 2016). The subject of inequality in the South African scenario, however, requires further investigation as the potential impact of the FIR has not been appropriately analysed.

1.7 STUDY OUTLINE

CHAPTER 1: The research proposal ("The story line")

Chapter 1 includes the introduction to the research, the problem statement, and the demarcation of the study. It introduces the Fourth Industrial Revolution (FIR), considers the challenges and concerns faced by the public and private sector, and further indicates the research objectives and questions. The importance of the study and the research limitations are similarly defined.

CHAPTER 2: Research design and methodology ("The score")

Chapter 2 will set the scene and deliberate on the research design and logic for the research process being followed, along with an assessment of the design criteria to ensure an adequate, 'surprise free' research outcome. Various concepts of scenarios and scenario planning will be introduced as a methodology. The futures for an African and South African vision will also be presented and expanded upon.

CHAPTER 3: Literature review (“The cast”)

Chapter 3 will involve a literature review, considering and expanding on the global trends and consequences of the FIR on the South African public and private sectors and also examining the disruptive technologies currently shaping business and economies.

CHAPTER 4: Six pillars of future studies (“The plot”)

Chapter 4 will see the six pillars of futures studies being reviewed along with causal layered analysis (CLA) as a methodology. CLA and scenario planning are utilised in this paper to present alternative, plausible futures and to deepen insight into the future. Lastly, the context-related theories of progress and sustainable development in the FIR industry will be considered.

CHAPTER 5: Transforming the future (“Epilogue”)

Chapter 5 will offer an ideal, realisable future for all South African stakeholders within the context of the FIR, through a **“Future Vision of the FIR in South Africa towards 2035”**. This foresight will be presented along with a set of contextually-aligned, practical recommendations, and, finally, an overview of the research and a summary of its findings and conclusions.

CHAPTER 2
RESEARCH METHODOLOGY AND DESIGN
"THE SCORE"

2.1 INTRODUCTION

In Chapter 1, the various concepts and parameters that relate to the research study, including the definition of the primary research objective and research questions, from the perspective of the FIR in South Africa, were introduced. Additionally, Chapter 1 introduced the proposed research methodology as well as an assessment of the design criteria to guarantee a satisfactory and 'surprise free' research outcome.

Chapter 2 will apply the research methodology approach to encompass those areas that apply to the research questions. Furthermore, Chapter 2 will examine the global views of the FIR, looking particularly at the growth, drivers for change, standards and global trends that have been the catalyst for the phenomenal explosion and growing importance of the FIR to the public and private sector. Thereafter, the impact of the FIR on Africa will be analysed to determine the continent's progress in its acceptance and implementation of the movement. Finally, from a South African perspective, a detailed review will be undertaken to establish what impact, if any, the FIR has had on the country and what possible options are available to ensure that it is not left behind the rest of the global economy. Lastly, this chapter will also cover the various 'strategies' put forward from the CLA and their applicability in the real world for South Africa. "*CLA is based on Sohail Inayatullah's future-orientated methodology, which seeks to accentuate the issue of the current future-orientated thinking, exploring the assumptions, worldviews, ideologies, statements or even policy-orientated futures*" (Osmond, 2015).

2.2 SETTING THE SCENE

Adendorff (2015) contends that the future does not exist, except in our imaginations, and therefore there is no single future for which to plan. Instead, we need to plan for the variety of ways in which the future could unfold (Adendorff, 2015). Since ancient times humans have been mesmerised by predictions of the future and have attempted

to recognise and to shape future developments. Literature from time immemorial contains a treasure trove of proof that the ancient Romans and Greeks, along with many other cultures, shared this intrigue (Kreibich, Oertel & Wölk, 2012). Indeed, the beginnings of future thinking can be mapped over the centuries from philosophers and intellectuals such as Plato, Thomas More, Heraclitus, Francis Bacon, Augustine and many others (Irmak, 2003). Mankind has also attempted to understand the future through astrology, the main of which was originally to assist people to escape dangerous situations by providing an early warning system through its predictions (Inayatullah, 2010a). Through these and other belief systems, people of all ages and cultures have undoubtedly assumed that knowledge about future happenings would give them valuable advantages, enabling them to impact that future or encourage desired outcomes (Kreibich et al., 2012).

According to Kreibich et al. (2012), during the eighteenth and nineteenth centuries, as technology accelerated and spread during the IR, future opportunities became progressively critical for decision-making in the present. The IR was a vital historical milestone en route to the establishment of today's industrial society (Irmak, 2003). The phenomenal growth of technological infrastructure, industry and new, scientifically armed practices began to alter living circumstances at a hitherto inconceivable rate, particularly in rapidly expanding cities and industrial areas (Kreibich et al., 2012). Irmak (2003) states that even though the history of future thinking is virtually as old as the steps of the intellectual advance of man, parts of futures studies as a field of study is connected with the swift pace of change in the IR, which supported the awareness of the unevenness, contradictions and discontinuities of social change. The future of each being and of society as a whole looked far less like the past or the present than it ever had before, and those who did not want to deal with the opportunities that the future presented were at a higher risk of being either left behind or pressed in the direction of possible futures they neither preferred nor had chosen (Kreibich et al., 2012). When building possible futures, it is essential to also give the past its positive dues, no matter how unconnected to the future that past may possibly seem to be (Dator, Boulding, Galtung, De Jouvenel, McHale, McHale & McHale, 1993).

2.3 FUTURES STUDIES

The future can never really be known, but it always exists through our perceptions (Wilenius & Kurki, 2010). Lombardo (2008) presupposes that the awareness of time is grounded in the awareness of events – of things happening and the associations amongst these events. People may be unaware, but we all develop through the passage from childhood to adulthood and, in a variety of ways, philosophise about the future even though perhaps we are not consciously aware of it. Futurists anticipate, assess and forecast future events by using a variety of empirical, rational and scientific techniques (World Future Society, 2004). Besides science fiction, the other key modern-day thread of futuristic thinking is future studies, but whilst science fiction is usually just an entertaining tale, future studies is usually non-fictional and non-narrative in its approach and format (Serradelpino, 2007).

Futures studies is the methodical consideration of probable, possible and preferable futures, which includes the myths and worldviews underlying each future. In modern futures studies, inquisitive and divergent opinions are not only integrated, they are essential to the resilience and robustness of the constructs (Inayatullah, 2010a). One role that a futurist plays is to present, in an engaging way, some of the forces, elements and components in the past and present which most powerfully influence the future (Dator et al., 1993). Learning to deal with the future necessitates the embrace and management of uncertainty (Bishop & Strong, 2010). These elements influencing future studies certainly do embrace features like continuity, familiarity, change and novelty but, without doubt, the new and unfamiliar will noticeably outnumber the tried and true (Dator et al., 1993).

The first countries to posit important questions regarding the future within the framework of economic consultation, science and politics were the Scandinavians, whose goal was to influence the economy, society and the environment in various ways (Kreibich et al., 2012). Irmak (2003) concurs that the origins of today's futures studies were shaped by numerous philosophers and thinkers a long time ago, so a mankind's certainty in creating metaphors of the future is nothing new. In Germany, it was similarly obvious that the most relevant concerns of the future were defined by the effects of economic and technological development (Kreibich et al., 2012). Some

examples of this are the glaring global economic, social and ecological inequalities, the possible concerns of nuclear, chemical or biological weaponries of mass destruction, and the power disparity between developing and industrial nations (Kreibich et al., 2012).

2.3.1 Purpose of futures studies

The purposes of futures studies are to ascertain or create, examine, assess and, in addition, to recommend possible, plausible and preferable futures; as futurists seek to know what can or could be (the possible), what is likely to be (the plausible), and what ought to be (the preferable) (Bell, 1997). Thus, with its theoretical background and formerly defined objectives, futures studies does not try to predict a single future but instead attempts to make people cognisant of the fact that there are several futures that may be fashioned by our outlooks (Irmak, 2003). Kreibich et al. (2012) allude to the fact that present-day futures studies accepts that the future is not totally determinable, that diverse future advances (futures) are conceivable and that there is possibility for design, based on the realisation that there are actually a number of possible futures and they are not haphazard (Kreibich et al., 2012).

When studying probable futures, futurists may become creatively tangled in fashioning images of the future for persons, organisations or complete societies, which may well interpret the world in novel ways and guide human effort in different directions (Bell, 1997). As the world becomes progressively perilous - in observation, if not in fact - futures studies has been enthusiastically accepted by executive management teams and planning divisions in institutions, organisations and nations globally (Inayatullah, 2010a). Kreibich et al. (2012) conclude in their work that futures studies is aimed at clarifying:

- multi-layered, dynamic processes and systems;
- significant and/or global relationships and effects;
- medium and long-term time frames, viewpoints and potential measures in the future;
- medium and long-term effects of measures, decisions and actions from the past and the present;
- interconnected discontinuities, uncertainties and outcomes of higher orders;

- sector‑spanning issues, problems and strategies; and
- notions about future growths and the effect on current and future behaviour (Kreibich et al., 2012).

2.3.2 Futures studies time frames

Inayatullah (2010) describes time frames that in the futures approach as being longer term, from between five to 50 years (or even 1 000 years), instead of just one to five years, and connects horizon three (20–30 years) with horizon two (5–20 years) and horizon one (the present to five years). Kreibich et al. (2012) concur in saying that humans generally focus on futures of 20, 50 or 100 years, specifically when referring to infrastructure, yet, in doing so, nations create longer-term problems for future generations to manage, many of which are permanent and caused by human actions. These include the depletion of natural and fossil resources, as well as the extinction of complete species (Kreibich et al., 2012). According to Bishop & Strong (2010), transformation occurs in three timeframes or time horizons, namely short, medium and long-term. These are outlined in more detail as follows:

- Short-term transformation (termed **tactical**) is what is dealt with daily. This time horizon is measured in hours, days and perhaps a few weeks.
- Medium-term transformation (termed **operational**) takes longer as it includes transformation in the processes that are used. The time horizon is measured in a few months to a few years.
- Long-term transformation (termed **strategic**) takes the longest. This time horizon involves a number of years. Paralleling the global environment, long-term strategic transformation seldom enters day-to-day thought (Bishop & Strong, 2010).

The futures approach is dedicated to the creation of reliable alternative futures in which each **scenario** is essentially different from the other. When economic forecasters and planners use scenarios, they frequently involve mere deviances from each other (Inayatullah, 2010a). A scenario is a story with possible cause and effect that links a future situation with the present, while demonstrating events, key decisions and effects throughout the narrative (Glenn, 2006), and can also be seen as a means of exercising our foresight capabilities (Bell, 1997). Furists similarly advance the idea of scenarios as an exceptionally suitable way to consider the future, and not as a prediction claiming to state categorically what will occur in the future; instead a scenario is a fictional,

though plausible and realistic explanation of events that could possibly happen in the future (World Future Society, 2004). Perhaps a vital characteristic of scenarios is that they are hypothetical, as the future is innately unknown and hence none of the scenarios will necessarily develop as imagined (Puglisi, 2001). Scenarios have been created and utilised to:

- ascertain what is unknown that should be known, before making decisions;
- demonstrate what is likely and what is not likely;
- appreciate the importance of uncertainties;
- recognise what strategies may possibly work in a range of possible scenarios;
- make the future more real for decision makers to engage original thinking and new decisions; and
- establish what has to be evaded and determine new prospects (Glenn, 2006).

The view of Kreibich et al. (2012) is that societies need to deal with strategic planners, conceptual intellectuals and policy makers in politics and business who claim to comprehend that the world is moulded by globalisation and long-term trends, yet the policies and programmes that are applied tend to be speculative and do not provide the answers required by government because of their narrow-minded, short term mentality (Kreibich et al., 2012). Consequently, phrases such as ‘a science and knowledge society’ or ‘sustainable development’ are commonly used (Kreibich et al., 2012).

2.3.3 Future technologies consideration

Adendorff suggests that technology is undoubtedly one of the most important drivers of revolution because of its potentially transformative role, with both positive and negative repercussions (Adendorff, 2015). Major advancements in science, technology and society have been witnessed in recent years (European Commission, 2014), frequently accompanying societal paradigmatic changes which alter the fundamental logic, structures and values upon which the systems are based (Wilenius & Kurki, 2010). Bishop and Strong (2010) indicate that the current most significant driver of change is the swiftness with which data is able to travel around the globe. The digital revolution has put the capacity to create and diffuse data into the hands of far more people and at greater distances than ever before. Ease of access to the burgeoning world of information is powering the speed of technological change

(Bishop & Strong, 2010). Right now, the exciting sectors that are utilising future technologies include nanotechnology, biotechnology, micro- and nano-electronics, new materials, photonics and a myriad innovative manufacturing technologies (Briseno, 2016). This discussion will be expanded upon in Chapter 3, when the detailed literature review is performed.

Future-Oriented Technology Analysis (FTA) includes strategic foresight, technology assessment and forecasting, where the concept of technology can be assumed to include a body of objects, a practice, as well as a body of understanding, all of which co-evolve with each other over time (European Commission, 2014). New technologies (some which have the potential to disrupt the status quo) and scientific breakthroughs are changing the way people work and live and lead to the development previously unimagined services and products. Consequently, societies and policy makers need a clear understanding about the manner in which technology might alter the societies, as well as the global economies, of the future (Giyose, 2014). From this viewpoint, technological systems are best understood as comprising both physical technologies (i.e. in the form of collective systems, infrastructure and components) and social technologies (i.e. organisations, in the form of limitations, social patterns and mechanisms of behaviour, such as customs, laws, social norms, standards and economic incentive instruments) (European Commission, 2014).

Kreibich et al. (2012) cite the following list, created by Coates (2001), in Scapolo & Porter (2008), of powerful challenges and changes for FTA:

- “Changes in the nature of ‘technological change’ with increasingly science-based innovation;
- Shift in the prime drivers of technological innovation from the more narrowly technical concerns of Soviet-American Cold War military systems to industrial competitiveness concerns requiring inclusion of socio-economic contextual influences;
- Renewed attention to societal outcomes (and sustainability);
- Opportunities to exploit electronic information resources to enrich FTA;
- Better capabilities to address complexity in technological innovation” (Kreibich et al., 2012).

According to the European Commission (2014), FTA approaches make use of quantitative and qualitative methods to develop new visions, acquire information and data, explore ideas, negotiate solutions and clarify situations. Inayatullah (2010) questions whether new technologies promise a transformation of the world we have known for the last five hundred years, and whether they have the capacity to readjust the obvious risks generated by industrialisation, materialism and the Western way of life. Futures studies technology forecast and technology assessment form the basis of future-oriented technology analysis; consequently the methodological approaches show considerable similarities (Kreibich et al., 2012). These similarities remain consistent in terms of the understanding of challenges and risk associated with future technologies (Kreibich et al., 2012).

Recently, the information technology industry has offered opportunities for FTA and has begun to transform the nature of the industry and its activities (European Commission, 2014). A substantial number of information technology tools have become more widely available to consumers, which has transformed the way FTA activities are designed, structured, managed and applied (European Commission, 2014). This can be seen as a direct result of the new possibilities created in terms of retrieving, gathering and analysing large volumes of information and data, at the same time facilitating new ways of engaging FTA communities and enabling the sharing of intellectual property with the public (European Commission, 2014). Consequently, the need to innovate and advance cutting-edge FTA approaches should receive continuous consideration (European Commission, 2014).

2.3.4 Future of sustainability development

Rapid development and technological improvements in information and communication technology, bio- and nanotechnology, and energy technology fields are known to exert a massive impact on economies and societies (European Commission, 2014). It is thus not surprising that globalisation, which includes the technologisation and economisation encompassing all areas of life, has unleashed feelings of anxiety, incapability and incredulousness regarding the resolution and progress of the associated ecological, social and cultural distortions perceived by many people (Kreibich et al., 2012). According to the European Commission (2014), severe social and economic volatility has been witnessed as a result of ubiquitous

events such as climate change, economic recession, shortages of fresh water, food and energy supply, regional conflicts and respective population movements. Governments must create an environment in which a nation's inhabitants can continue to thrive, even as emerging technologies disrupt their lives (Giyose, 2014). In such a rapidly changing environment, it becomes crucial to develop "cutting edge FTA approaches" to provide strategic intelligence for strategy, policy and decision makers (European Commission, 2014).

Kreibich et al. (2012) are of the view that even the positive effects of globalisation and economisation - which include the opening of the global job market, the proliferation of import and export prospects, the integration of world markets and accompanying competitive prices for services and products, and the improved entry to worldwide information and knowledge - remain fairly restricted to most people in their everyday lives. Wang and Noe (1998) suggest that future research should continue to examine knowledge sharing from a social exchange viewpoint, in order to provide an understanding of those ideas that have yet to be examined. The accountabilities that connect us to future generations implicate future thinking to be handled in more reliable, mature and sensible ways (Puglisi, 2001). Future studies employing a generalised social discussion and the theory of social problems may assist in increasing the understanding of the circumstances under which information sharing is likely to take place (Wang & Noe, 1998).

The notion of 'sustainable development' is primarily established as a response to the necessity of maintaining the basics of production and existence, both globally and on a long-term basis, and to allocate the incomes of natural and scientific technological wealth more equitably (Kreibich et al., 2012). Planning for sustainability necessitates new ways of deliberating about the future, and it calls for decision makers, governments and other planners to produce a clearer understanding of relationships between present and future actions (Puglisi, 2001). Sustainable development implies that every generation strives to protect and preserve the natural resources in a manner that does not jeopardise the basis of survival for future generations and which allows all individuals to continue to live together in potential social and economic stability (Kreibich et al., 2012). Sustainability principles require planners to consider alternative possible scenarios and future advances for a period longer than the customary five,

ten or even twenty years, with the aim of guaranteeing that natural resources will be conserved for future generations (Puglisi, 2001). Therefore, sustainability, particularly in the light of challenges such as climate change, calls for society to become more actively futures-oriented (McGrail, 2011). The longer outlook is essential in ensuring that a concern for inter- and intra-generational equity is built into planning methodologies (Puglisi, 2001). A sustainable society would demonstrate foresight, have a futures-responsive culture and would be determined and prudent in the creation of its futures (McGrail, 2011).

2.4 FEATURES OF FUTURES STUDIES

Futures studies is not an attempt to 'predict' the future, in the sense of dictating exactly what will happen to a country, organisation or individual, before it really happens; most futurists forecast a wide assortment of 'alternative futures' rather than trying to predict 'the future' (Dator, 1998). Robinson (1990) observed that even if the future could be predicted accurately, the incorrect question would in all likelihood have been addressed. Futures studies is effectively a vessel through which the future can be decolonised and in which leading images can be confronted and alternative images created (Inayatullah, 2013). The most likely future is, more often than not, the most appropriate or desirable result and it therefore becomes imperative not simply to deliver good predictions but rather to hint at the alternate futures that are available and their likely characteristics (Robinson, 1990).

Features of futures studies include a wide range of factors, some of which are essential to the understanding of futures studies (Osmond, 2015). One such common feature is the prediction of the most likely future state of the system under study. Indeed, predictive objectives underlie much of the long-term socioeconomic forecasting and are embedded in the economic alignment of many of the models used for such purposes (Robinson, 1990). An additional factor to recognise is that there is never one single future, but always a number of alternative futures (Inayatullah, 2013). Grounded in the intense study of social, economic and technological changes, and their associations and effects on each other, futures studies further aims to explore three primary "alternative futures, namely the possible, the probable and the preferable" (Irmak, 2003).

The next pivotal principle is that of disruption, mapped through emerging issues analysis (which was conceived by Graham Molitor in the 1960s), in which these emerging issues may be found to be predictive, but still do assist people to rethink their creation of a 'normal' world (Inayatullah, 2013). Dator (1998) expounds that "*just as futures studies does not look to predict things to come, so also futures studies does not attempt to study the future, as the future does not exist to be studied but what does exist, and what futurists can and often do study, are images of the future in people's minds*".

Instead of predicting the future, futures studies aids individuals to visualise and formulate the future, not with the aim of creating a probable outline, but rather to provide a sense of control and direction on the supposition that soon after heading towards a preferred future, one will create new ideas, experience new things about a new preferred future and then dispose of the old one (Inayatullah, 2013). Inayatullah's (2013) view of the role of a futurist, or a futures-orientated 'thinker', can be understood as the ability to challenge the actual future and through that create a space for alternative futures to be acknowledged. Glenn (2004) elaborates that futures research should be adjudged by its capacity to help decision makers in their immediate policy-making, rather than by whether a forecast was wrong or right, as futurists can certainly make a forecast that is anticipated to be proven wrong.

2.5 FUTURES STUDIES METHODOLOGIES AND TECHNIQUES

It is scientific discovery and technological innovation, forces of nature, and social and political dynamics that essentially determine the future, however, it is mankind's choices that progressively shape it (Glenn, 2004). While future-oriented work is concerned about learning and looking at new insights to achieve a variety of different ends (Iversen, 2006), the purpose of futures research is to help inform insights, choices and alternatives concerning the future (Lang, 2000). Society cannot entirely regulate the future, but it can influence the path of history and so make the effort to consider the balance between what we want and what is possibly meaningful (Glenn, 2004). Predicting the future is difficult and risky (Alkhatib, Faraboschi, Frachtenberg, Kasahara, Lange, Laplante, Merchant & Burgess, 2014). Glenn (2004) explains that

the intention of futures methodology is to systematically explore, test and create both desirable and possible future visions which can assist in the creation of long-term policies, plans and strategies, thus helping to bring likely and desired future situations more closely into alignment.

It is important to note from the outset that a wide range of methods have been developed for use in futures studies (Puglisi, 2001). Possibly the most generally understood purpose of futures methods is to aid in identifying what you don't know, but must know, in order to make more intelligent choices (Glenn, 2004). Frequently, the use of technology is a key driver of change and there is often a strong focus on the possible use and progress of technology in a scenario examination (Iversen, 2006). Lang (2000) contends that science and technology, particularly the new developments in microbiology, biotechnology, physics, computer science, ecology and engineering, are the primary significant drivers of future events and, accordingly, are principal areas to be observed. Technology embodies innovative ways of doing things and, once grasped, creates enduring change, which corporations and cultures do not easily ‘unlearn’ (Giyose, 2014).

While the different scientific methods of creating strategies for the future have not been limited to particular issues, a strong weighting has traditionally been placed on the questions surrounding science and technology (Kreibich et al., 2012). Since the commencement of digital computing in the mid-1940s, the world has beheld a historic revolution in the acquisition, communication and processing of data, one which has altered every single facet of society through its ubiquitous access to information, automation and global human networking (Alkhatib et al., 2014). Kreibich et al. (2012) state that it is noteworthy that present-day futures studies have become increasingly conscious of the risks and consequences of the dynamic forces of technology and industry.

Societies and policy makers have to get ready for future technology and to prepare adequately will need a clear grasp of how technology might shape worldwide economy and society over the coming years (Manyika et al., 2013). According to Kreibich et al. (2012), developed and developing societies are currently informed by two guiding models, namely the ‘**science**’ (or knowledge-based) society and the ‘**sustainable**’

society. The science society is predominantly driven by the mega trends of ‘scientific and technological innovations, knowledge transfer, qualification and education’ (Kreibich et al., 2012). These new science-based technological, social and economic values find their strongest demonstration in modern, highly-efficient data and communication technologies, especially the internet, and, combined with cultural and social innovations, enable a hitherto unimagined increase in the efficacy of production procedures and services, along with their global interconnection (Kreibich et al., 2012).

One essential objective of futures research is the methodical generation of an understanding that can assist in addressing future tests and predicaments. Foundationally, foresight is an interdisciplinary task, requiring a methodology reliant on distinct disciplines and incorporating them, at the same time, into a common reference framework (Kreibich et al., 2012). Iversen (2006) expands on the work done by Hudson in 1967 in his test and measures of intelligence, in which he recognises two apparently different forms of thinking (or skills): convergent and divergent thinking. Both these skills can be drawn upon when applying futures studies, especially in scenario setting.

- **Convergent thinking** is fundamentally about old-fashioned problem solving. It usually brings to bear material from a number of sources in a manner that produces the ‘correct’ response to a problem. This kind of thinking is especially suitable in the fields of maths, science and **technology**, since it includes reasoning, observation, description and/or prioritisation in relation to a given problem.
- **Divergent thinking** is a talent generally linked to the creative expansion of ideas and encouraged by a motivation. Such thinking is conventionally better suited to artistic pursuits and studies within the humanities (Iversen, 2006).

Kreibich et al. (2012) argue that the application of most methods of futures research has not been adequately systemised. They delineate four rudimentary procedures of futures research:

- **Explorative empirical-analytical** method: This approach is accomplished by gathering a wealth of knowledge, including new data, facts, trends, possible and probable developments, that are then systemised according to precisely

determinable conditions and assumptions, and analysed according to precise rules. This approach can be presented in both quantitative and qualitative form.

- **Normative-prospective** method: With the use of creativity and imagination in futures projects and futures studies, and data that is empirically-analytically obtained, a combined vision of the future or future-preferable projections can be created.
- **Communicative-project** method: Both knowledge and experience are utilised for practical application in this method, when defining futures strategies and goals so as to support decision-making, communications and implementation processes.
- **Participative-creative** approach: This involves the use of actors from social areas, which increases the content for future knowledge, and introduces aspects of the desired futures. In this way, a scope for design and implementation, and more specifically the research and design process, is established (Kreibich et al., 2012).

Every day, humans all proceed with life, whether individually or collectively, based on their perception of the future, or the image of the future that they want to create for themselves, despite growing unpredictability and the constraints of the environment and of the past (African Futures and Phylos IPE, 2002). There are three elements of analysis common to all futures studies that should be considered when reviewing the characteristics of futures-study methods. These include the analysis of the past and the present, the changes in the environment, as well as the plans of the stakeholders concerned (African Futures and Phylos IPE, 2002), as illustrated in Figure 2.1 below.

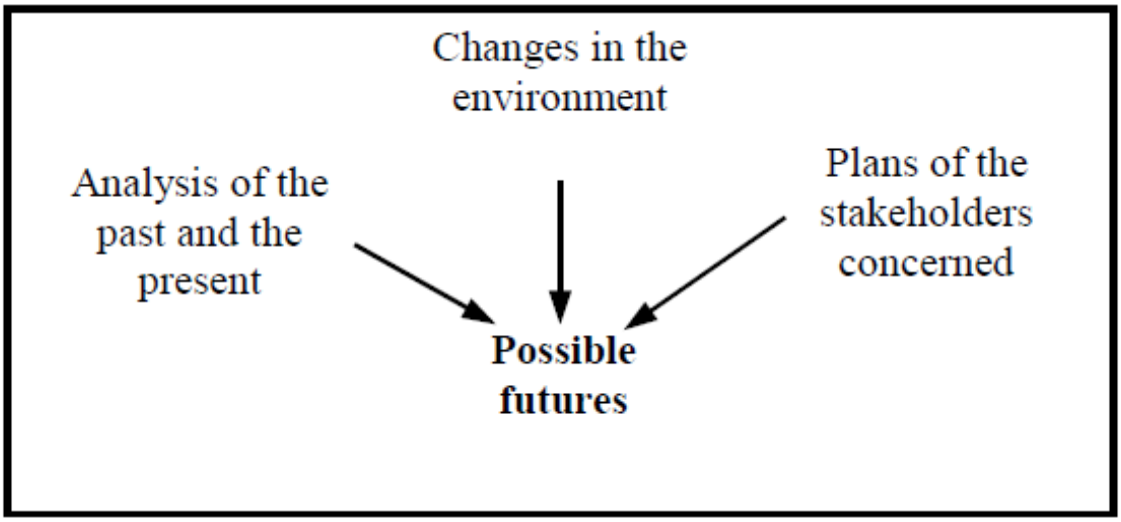


Figure 2.1: A multidisciplinary approach. (Source: African Futures and Phylos IPE, 2002)

Hugon and Sudrie (1999) propose the classification of futures-study methods into four categories as follows:

- **Scenario methods**: describe possible futures which are determined by long-term changes in key factors;
- **Predictive methods**: are based on building formal models to describe the actions of the different stakeholders involved;
- **Methods based on a linear view of history**: use strong historical trends which are not necessarily continuous; and
- **Methods based on tracing the common thread of a "driving force"**: used to determine the likely futures (African Futures and Phylos IPE, 2002).

The first three abovementioned categories study the weight of the past in different ways and consider the vision of the future by allowing for long-term alterations in key factors or discontinuities in strong historical trends. The fourth type of method places more emphasis on the driving force, or motivation, and the vision of the future that generally underlies it (African Futures and Phylos IPE, 2002). Hugon and Sudrie (1999) concede that this classification is somewhat theoretical, but stress that in practice it has been shown to obtain solid answers to the questions they have asked and therefore suggest that researchers apply a blend of these methods (African Futures and Phylos IPE, 2002). Puglisi (2001) believes that all futures methods acquire different meanings during application, a characteristic that owes more to the aims of their application than to their methodological characteristics.

2.6 THE SIX PILLARS OF FUTURES STUDIES

Inayatullah (2008) distinguishes six fundamental concepts of futures thinking: the used future, the disowned future, alternative futures, models of social change, alignment and the uses of the future. Furthermore, a number of diverse methodological techniques and approaches to enable the imagination and exploration of probable, possible, plausible and preferable futures have been developed over the years (Roney, 2010). Additionally, futures questions are summarised according to fear, alternative futures, hidden assumptions, will, preferred future and the next steps (Inayatullah, 2008). These six pillars of futures studies offer a theory of futures thinking

that is linked to their tools and methods, and developed through practice.These six pillars are listed as follows and unpacked in more detail below:

- Mapping;
- Anticipation;
- Timing;
- Deepening;
- Creating alternatives; and
- Transforming (Inayatullah, 2008).

Mapping

Past, present and future are mapped in the first pillar, as it is through mapping time that it becomes more clear where mankind has come from and where we are going (Inayatullah, 2008). An environmental scan (ES) of the impact of the FIR in South Africawas performed to uncover the existing trends and driving forces influencing the future of the industry. Environmental scans deliver strategic intelligence through the identification of situations, emerging issues and possible pitfalls that could affect the future of an organisation or industry. External environments that might effect an organisation may be grouped into a variety of categories, including regulatory, political, technological, social, industrial and economic (Choo, 2005). Inayatullah (2008) describes the elements of the futures triangle (as illustrated in Figure 2.2) through three dimensions:

- the image of the future that **pulls us forward**;
- the **pushes of the present,** which are quantitative drivers and trends with the potential to change the future; and
- then there are **weights,** which are the barriers to the change humans wish to see. Each image may having differing weights (Inayatullah, 2008).

By evaluating the relations between these three forces, the futures triangle helps to advance a plausible future (Inayatullah, 2008).

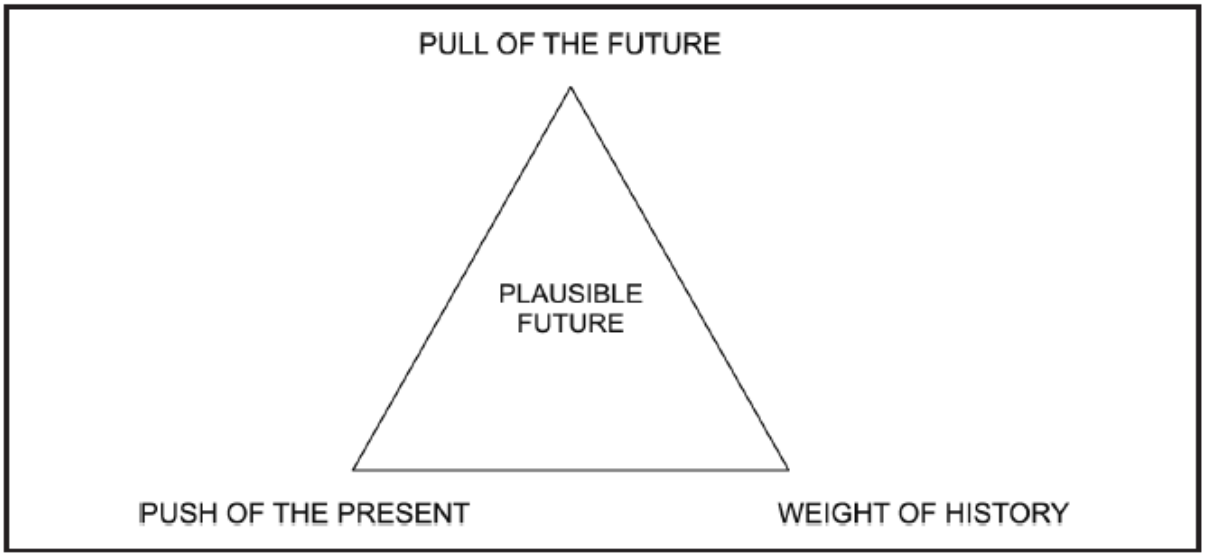


Figure 2.2: Futures triangle (Source: 'Six pillars: futures thinking for transforming'; Inayatullah, 2008)

Anticipation

Data gathered during the ES in the initial mapping phase may be understood in this pillar of futures thinking, when an analysis of the emerging issues and drivers is performed to identify regions in which social innovation can begin. In this study, critical questions about the FIR in South Africa were considered during this phase, in accordance with the guidelines recommended by Horton (1999), who considers the response to these important questions vital to the process of foresight creation:

- What does this mean for the FIR in South Africa?
- What are the consequences for the stakeholders?
- What are the concerns that challenge the realisation of the future?
- What can be done about it today?

Timing

The third pillar is timing the future. This is the examination of the grand patterns of history and the recognition of each of the models of change. Mankind can either resign itself to the providence of history, or trust that change may come from inner reflection and spiritual practice; or, alternatively, is it, as Inayatullah (2008) asks, really technology that counts most of all, as new economies are crafted and pressures result when societies fall behind and power relations do not adjust to technological change? These questions, in turn, engender wider speculation, including: how is the future

timed? Is the future a planned, coherent action created by selection and risk analysis, or is the future completely open and anything probable? Macrohistorians and grand thinkers have been grappling with these questions for milenia and, from their thinking, certain central but divergent ideas have arisen:

- The future is linear, good, progressive and attainable through commitment and hard work.
- The future is cyclical, with ups and downs; those at the top will one day in the future find themselves at the bottom. While they are on top, they are powerless to adapt to the changing world and their success is therefore based on their mastery of past environments and conditions.
- The future is spiral-shaped; bold leadership with foresight can create a positive spiral by taking ownership of the past and incorporating it in the roadmap of an ideal future.
- New futures are frequently driven by a creative few, thus challenging the idea of a used future through political, spiritual, cultural, social or technological innovation.
- There are pivotal periods in human history when the actions of a few can result in a spectacular transformation. Conventional means of behavioural management are no longer effective during these periods (Inayatullah, 2008).

In this approach, as Sahtouris (2002) suggests, conscious evolution is vital, because the world is a multifaceted, adaptive system in which, as soon as a future is mapped, it changes. Thus, while humans do need a vision of their future, they do not require a blueprint (Inayatullah, 2008).

Deepening the future

Pillar four addresses a deepening of the future, for which two methods are critical: the first is **causal layered analysis** (CLA) and the second is **four-quadrant mapping**. CLA has been selected as the primary research methodology for this study and will therefore be unpacked in greater detail in Chapter 4. Nevertheless, four-quadrant mapping is of equal relevance to this approach and worth brief elaboration here. Fashioned originally by Richard Slaughter and Ken Wilber, four-quadrant mapping develops the inner dimension of CLA (Slaughter, 2005) by investigating the following four features:

- the **inner-individual** – the meaning given to the world that must be altered;
- The **outer-individual** – the conduct;
- The **outer-collective** - the approved strategies undertaken by businesses; and
- The **inner-collective** – the internal map of organisations (Inayatullah, 2008).

Most policies tend to concentrate on the outer-collective and pay little attention to the innermost collective. Consequently, CLA and the four-quadrant technique go hand in hand and, as so, the latter may be considered to be an inner CLA. After the future has been deepened, it can then be broadened using the fifth pillar (Inayatullah, 2008).

Creating alternatives

The fifth pillar addresses the creation of alternative futures. During this phase, the future is expanded by means of scenario construction, a valuable method of establishing the extent of uncertainty, clarifying the present, and then presenting alternatives (Inayatullah, 2008). Scenarios are the instrument of preference for futures studies and valuable in revealing the present, suggesting alternatives, outlining the array of uncertainty and, even better, crafting predictions. There are several scenario techniques: single variable, double variable, organisational, archetypes and integrated (Inayatullah, 2008). Using four scenarios, one can articulate how an organisation may appear in each alternative future (Inayatullah, 2008). The **organisationally** focused model, developed by Peter Schwartz of the Global Business Network, will be employed in this study, as will be decribed in Chapter 4. There are four variables in this structure:

- **best** case (towards which the establishment wishes to move);
- **worst** case (here the whole lot goes bad);
- **outlier** (a surprise future grounded on a disruptive developing problem); and
- **‘business as usual’** (no alteration) (Inayatullah, 2008).

Scenario planning is built on the observation that an educated strategy may be implemented across a number of possible futures, in which the main objective is to recognise the forces pushing the future in various directions (Du Plessis, 2016).

Transforming the future

The last pillar is that of transformation. Here, the future is narrowed toward the favoured future, the one that people want or that cities desire. This desired future can flow from scenarios or be fashioned by a process of inquiry. The emphasis is on revealing win-win solutions without withdrawal or compromise. Such a preferred future can also be determined through a method of creative visualisation (Inayatullah, 2008). Sustainability is employed as a guiding principle throughout this phase.

2.7 QUALITATIVE AND QUANTITATIVE RESEARCH

A research paradigm is a "*philosophical framework that guides how research should be conducted and, in turn, philosophy is the use of reason and argument in seeking truth and knowledge, especially of general causes and principles*" (Collis & Hussey, 2014). Collis and Hussey (2014) emphasize the two main research paradigms of positivism and interpretivism. **Positivism,** originating in the natural sciences, rests on the hypothesis that social reality is objective and singular, and is not impacted by the act of examination; hence this kind of research comprises a deductive process with a view to supplying explanatory theories through which to understand social singularities. Positivism is allied with quantitative methods of analysis (Collis & Hussey, 2014). In contrast, according to Collis & Hussey (2014), the **interpretivist** paradigm was formed in reaction to criticisms of positivism and rests on the supposition that social reality is in our minds, that it is multiple and subjective, and is consequently impacted upon investigation. Hence, this research paradigm encompasses an inductive method with a vision of providing an interpretative understanding of social sensations within a particular context. Interpretivism is allied with qualitative methods (Collis & Hussey, 2014).

2.8 FUTURES STUDIES FOR AN AFRICAN VISION

"*People in the West are fundamentally uneducated about Africa and it's not only the people in the street, even the educated classes know little about the continent and that's why companies and institutions systematically underestimate the potential of Africa*" (Grosskurth, 2010). At a 1990 conference on Africa, organised by the Netherlands government, held in Maastricht and attended by African governments and

aid agencies, there was agreement that, contrary to past assumptions, Africa's development could not be realised by means of economic actions alone, and that even though sound economic policies were essential, these had to be supplemented by changes in behaviour and in cultural, political and social structures. The delegates also agreed that these changes would not occur without a vision of the future – a view fundamentally shared by all the peoples affected (African Futures and Phylos IPE, 2002).

Discovering the future of the world is an interesting challenge. The many reports and books that debate likely solutions to futures questions tend, for the most part, to ignore Africa – and, where Africa is included, the dialogue is often based on stereotypes or broad assumptions (Grosskurth, 2010), yet the countries of Africa are evolving rapidly in an equally fast-changing world (African Futures and Phylos IPE, 2002). A large number of future-oriented technological ambitions in Africa are focused on their transformation into fully industrialised countries with technology structures that are similar to those found in Western, or Westernised countries (Grosskurth, 2010). One major obstacle to technological innovation encountered in Africa is the absence of power, with approximately 620-million Africans living without access to electricity; and yet Africa is a continent of creativity and innovation, so technology is itself assisting to break down the obstacles to energy supply (Kende-Robb, 2015).

Grosskurth (2010) further points out that there are number of commendable motivations to include Africa when attempting to appreciate global futures:

- **Economics and population**: Economic and demographic progress will strengthen the global impact of the continent.
- **Food**: Global food harvests are under pressure from soil erosion, extreme weather conditions, as well as the struggle to obtain arable land for food and non-food agricultural production, such as for cotton and biofuels. Africa’s immense expanses of arable land, much of it still unfarmed, have the potential to feed billions and thereby alleviate the pressures on the rest of the world.
- **Climate change**: Africa is at the epicentre of climate change effects and will likely have an impact on other world regions.

- **Energy**: There is a global necessity to decrease fossil fuel reliance, but still guarantee energy supplies. Africa has the potential to become a source of renewable energy through the harvest of wind, solar, biomass and water sources, which are substantial enough to supply locally and to export significant volumes.
- **Social**: Africa's fragile health status and structures appear to limit the prospects of attaining the minimum objectives set out in the Millennium Development Goals. The risk of global pandemics, along with local knowledge systems and progress made in bio-prospecting, offer old and new potential as governments realise the need to invest in adequate care for the societies they govern.
- **Resources:** 21st-century technological devices are heavily reliant on African rare earths and metals for their development and manufacture. There is a bit of Africa in every laptop, car, iPhone and other modern electronic device.
- **Global conflicts**: Africa has been, and probably always will be, a battleground for global vested interests (Grosskurth, 2010).

Giyose (2014) suggests that many forecasters have overlooked the changes occurring in developing countries, specifically in Africa. According to African Futures and Phylos IPE (2002), expansion efforts in large parts of Africa and almost all the countries in sub-Saharan Africa have been a failure, yet African societies are going through extreme changes and, as the world continues on its swift advancement despite escalating and widespread conflicts, it is increasingly necessary to reconsider African futures (African Futures and Phylos IPE, 2002). The prospects of African countries are dependent on the actions taken tomorrow (African Futures and Phylos IPE, 2002). African futures studies can certainly benefit from applying a wider array of futures methodologies, which can even further advance the studies if African researchers are to develop new methods, relevantly tailored to the continent's particular situations (Grosskurth, 2010).

2.9 FUTURES STUDIES IN SOUTH AFRICA

The National Planning Commission (NPC) (2011) states that key forces shaping South Africa's future are both external and internal, but that South Africa belongs to its people and the collective future of the country is in the hands of the people. One such force

in the NPC's current 2030 focus is the short-term impact of the global economy, driven by the downturn that continues to affect South Africa's larger trading partners in North America and Europe. However, over a longer period it is likely that a significant shift in global economic influence will spur rapid growth in the four BRICS countries (Brazil, Russia, India and China) and other middle-income countries, and that these changes will have a major direct implication for South Africa's economy as well as the greater African region (National Planning Commission, 2011).

Choosing a desirable future and strategising to achieve it are eminently political acts, necessarily involving government authorities or political parties (African Futures and Phylos IPE, 2002). Political change brings no guarantee of economic, social or, indeed, political improvement and through history a number of empires, countries and civilisations have experienced deep decline rather than growth after such change. Some of the indicators of which South Africans need to be most cognisant, and which could even be a preamble to decline, include:

- increasing corruption;
- poor economic management;
- the failing of civil society and state institutions;
- politics dominated by short-termism, factionalism or ethnicity;
- the flight of capital and skills; and
- deficiency in the maintenance of infrastructure and reduced standards of service (National Planning Commission, 2011).

Futures studies launched formally in South Africa in 1974, when a 'Unit for Futures Research' was established at the University of Stellenbosch's Bureau for Economic Research (BER) with the backing of private sector funding; the initial objective was that the new research unit should focus on long range economic forecasting (Spies, 2004). When it comes to studying potential futures for a human community in a complicated, changing world, no single scientific method can be suggested as perfect for all circumstances (African Futures and Phylos IPE, 2002). One of the tasks of futures studies is to research the factors driving change, to support a dialogue on the future, to stimulate awareness and consciousness regarding the reasons and implications of change, and to develop suitable proficiencies in the management of change (Spies, 2004).

For South Africa, the elements of energy transitions (which include rising energy prices and a desire for energy security), food security (with the rising demand for food and consequently higher food prices globally), climate change and new technologies will continue to drive changes in the way societies work (National Planning Commission, 2011). Aside from their direct influence on South Africa, these drivers will have a deep impact on both society and the economy, offering opportunities as well as posing threats, thereby implying that beyond the evolution to new energy technologies, additional developments, such as the convergence of information technology, biotechnology, nanotechnology and cognitive science in new configurations, will certainly reshape societies, lifestyles and economies as we know them today (National Planning Commission, 2011). South Africa needs to be prepared for these influences.

2.10 ETHICAL CONSIDERATIONS

Ethics, widely accepted to be "*moral principles that govern a person's or group's behaviour*" and often also referred to as 'morality', is that branch of knowledge that deals with moral principles (Akintan, 2014). The need for ethics in research as well as in general business is of growing importance (Polonsky & Waller, 2011). Ethical contemplations are crucial to futures research and futures teaching; there can be no pretence of splitting the deliberations of good and bad, beauty and ugliness, right and wrong, or other core values from academic analysis into the future (Dator, 1998). Values are essential; they need to be clearly debated upfront and in every stage of futures study and consultation (Dator, 1998). Akintan (2014) provides guidelines for futurists to consider when formulating a professional code of ethics:

- As with all professionals, futurists are required to embrace values such as honesty, respect and trustworthiness when carrying out their roles;
- Futurists should accept accountability for the promotion and development of mankind's common ethical codes (such as those of sustainable development and democracy) and should furthermore participate in work that assists humanity in general and the public interest;
- As in academia, futurists are obliged to search for the truth and to test ideas empirically and logically as far as possible before reporting on their research works; and

- Futurists, as consultants, should avoid unethical behaviours, such as placing self-interest above the interests of the client, padding expenses, withholding information and violating confidentiality. They should adopt the emerging code of ethics for policy analysts as a serving guideline for their occupied roles (Akintan, 2014).

Most universities around the world have developed rules surrounding ethics in research, making use of independent ethics committees that serve to evaluate the work of students, researchers and staff to ensure the adherence to all basic ethical principles as well as compliance with the universities' codes of conduct (Polonsky & Waller, 2011). It is, therefore, imperative for futures studies practitioners to have an understanding of their university's ethics methodology from the outset (Osmond, 2015).

2.11 CONCLUSION

This chapter has dealt with the research design and methodology to be followed in this research to guarantee a successful outcome. This includes narrowing down the FIR in South Africa and the country's preferred future, grounded in alternative plausible scenarios that will be presented. The research process has five stages: a review of appropriate literature, knowledge creation, foresight, value creation and reflection. The following chapter will present a summary of the available literature, as well as a look at the trends and disruptive technologies that comprise the FIR.

CHAPTER 3
LITERATURE REVIEW
"THE CAST"

3.1 INTRODUCTION

The term 'industrial revolution' is used to refer to the transformation of the social and technological economic systems in industry, focusing in particular on changes in living conditions, circumstances of work and economic wealth (Dombrowski & Wagner, 2014). The first industrial revolution mechanised production, the second one used electric power for mass manufacturing and the third used information technology to automate production; it seems the fourth will distort the lines between the digital, the physical and the biological realms (Falcioni, 2016). While the earlier IRs were driven by swift developments in connectivity and automation, beginning with the technologies that launched the first Industrial Revolution in eighteenth-century England, through to the exponential increases in the computing power of modern times, the FIR is similarly driven by the same two forces - automation and connectivity (Baweja, Donovan, Haefele, Siddiqi & Smiles, 2016).

The first force, extreme automation, is the result of the rising prominence of AI and robotics in private life, commerce and government. The second, extreme connectivity, serves by conquering the hurdles of time and distance, facilitating deeper and faster communication than previously believed possible between and amongst humans and machines (Baweja et al., 2016). According to Schwab (2016a), this revolution comes on the back of a number of transformative technologies, but it is, at the same time, much more than the sum of all those technologies. Technologies are intensifying and merging across the digital, physical and biological worlds; intense shifts are being observed across all industries through the disruption of their incumbents, the development of new business models, and the reshaping of the systems of consumption, production, transport and distribution (Bloem et al., 2014).

It is evident that technology is the central component of the FIR and, at this juncture, it is necessary to consider and understand the various definitions attached to technology. Business Dictionary's definition of technology is "*the purposeful*

application of information in the design, production and utilisation of goods and services, and in the administration of human activities. Technology can be defined in the following ways:

- *Tangible: blueprints, models, operating manuals, prototypes;*
- *Intangible: consultancy, problem-solving, and training methods;*
- *High: entirely or almost entirely automated and intelligent technology that manipulates ever finer material and ever powerful forces;*
- *Intermediate: semi-automated partially intelligent technology that manipulates refined matter and medium level forces; and*
- *Low: labour-intensive technology that influences only coarse or gross matter and weaker forces*" (Business Dictionary, n.d.).

A further definition of technology is that of a frame of knowledge dedicated to processing activities, creating tools and extracting materials. The term 'technology' is extensive and each individual has their own way of understanding its meaning. Technology is used daily to achieve various tasks; it can be described as processes, products or organisations and can also be used to improve people's abilities, making individuals the most vital part of any technological system (Ramey, 2013). As Ramey (2013) further points out, while technology is used in science to solve a problem, technology and science are different functions, working hand-in-hand to achieve a specific task or solve a specific problem. Therefore, in the researcher's view, technology is about not only the tangible, tools such as computers, robots or smartphones, but also the intangible, in which processes are improved or designed, and where human ingenuity is applied to find efficiencies and generate new ideas, which may, in turn, need the tangible technology to bring these ideas to reality.

In the FIR, specific technologies will be significant but the material changes will be to the economic and social systems that form our lives and the way we live (Schwab, 2016a). The influence and impact of the FIR 'web' on government, corporates and the ordinary man in the street is extensive and all encompassing (as can be seen in Figure 3.1 below). Falcioni (2016) stresses that opinions differ when it comes to measuring the overall impact of the FIR. There are some concerns about the decline of the 'tech boom', as a recent drop in private and public valuations of technology firms suggests; however, there are also those proponents who consider the emerging revolution and

technological innovation as a way of securing long-term gains in productivity and efficiency, more effective supply chains, as well as bigger profit possibilities.

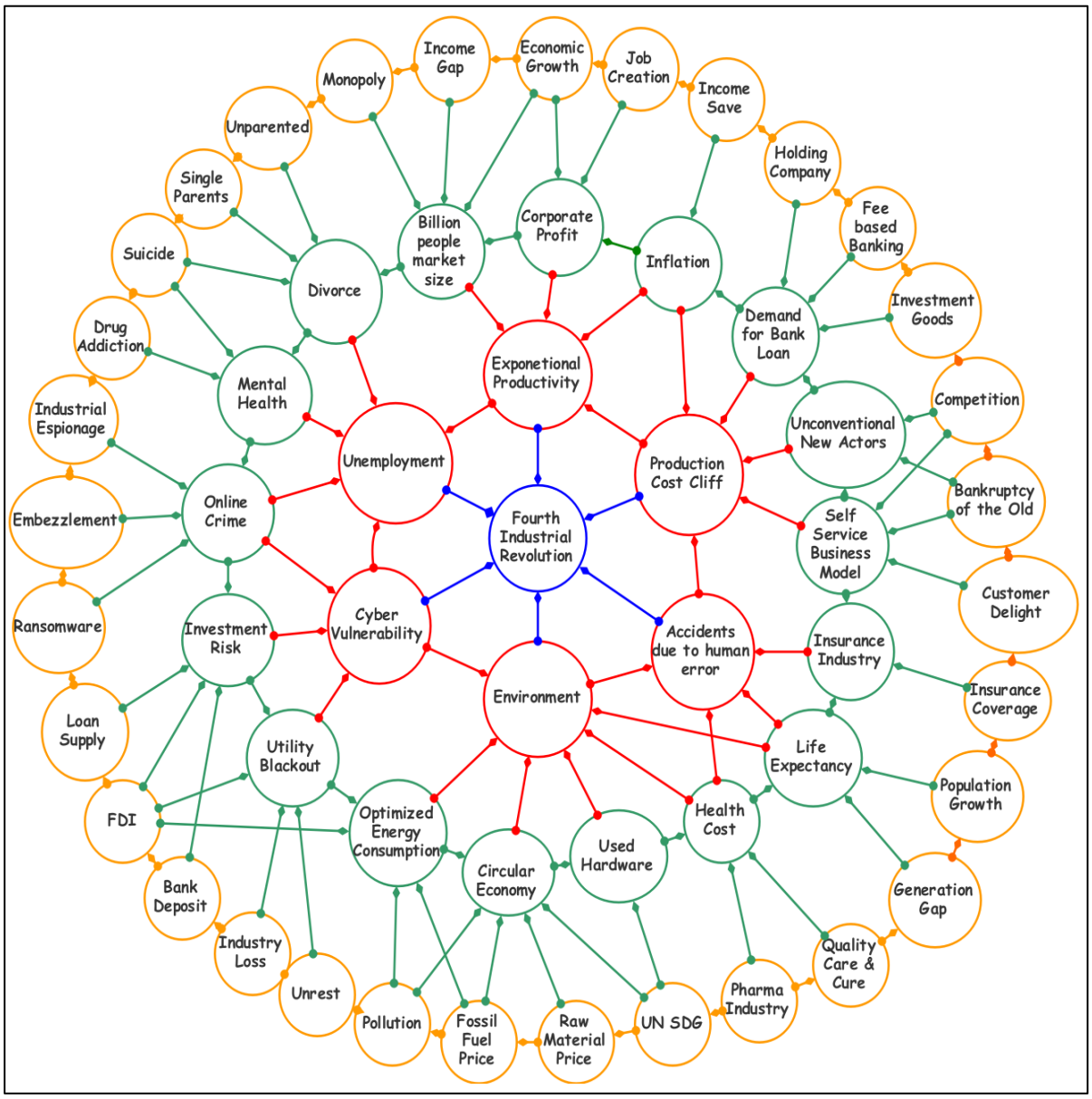


Figure 3.1: The FIR 'web' (Source unknown)

The FIR is a global trend that will result in new ways of creating value; novel business models will involve increased collaboration between several different partners in international networks of value creation (Sendler, 2013). Its impact on the workforce still needs to be determined (Falcioni, 2016), although, according to the World Economic Forum, digitisation has boosted global economic output by €142 billion and created six million jobs over the past two years (since 2015), and the changes and

challenges brought about by digital technologies are certain to continue (European Commission, 2016). Benioff (2017) asserts that businesses are incredible platforms for change and every business leader can have a direct role in creating economic opportunity for millions of people by investing in education and training programmes for existing and potential talent.

The skills and quality of the labour force will be a critical feature in gaining competitive advantage (Lapthorne, Crafts, Evans, Green, Harris, Hughes, Lowe, Mughal and Sterling, 2013). In their report, "**The Future of Manufacturing: a new era of opportunity and challenge for the UK"**, Lapthorne et al. (2013) identify the crucial need for UK policy makers to concentrate support for research, apprenticeship schemes, the supply of skilled workers and the supply of skilled managers. Furthermore, they urge companies to pay additional consideration to building multidisciplinary teams to develop progressively multifaceted products and possibly innovative business models (Lapthorne et al., 2013). Companies are great 'universities' for educating the workforce of the future; an investment in the training of employees, interns and apprentices not only drives growth and innovation, but frequently amounts to a level of specialised instruction and hands-on experience that cannot be obtained at even the most prestigious universities (Benioff, 2017).

3.2 GLOBAL TRENDS OF THE FIR

"*We are living in a time of extraordinary change. In this FIR, every individual, business, industry and government is being impacted by breakthroughs in computing power, connectivity, AI, biotechnology and other innovative technologies - this is a revolution without boundaries spreading across the world with incredible velocity*" (Benioff, 2017). This new crisis will be fundamentally different from the previous three and will simultaneously affect people in every corner of the world, not only the industrial working class but also the many white-collar workers who see themselves as 'middle-class' (Craven, 2017). Whatever the point of view, the FIR is here and it is real. What is most important is how it is to be harnessed, exploited and carried into the future to the greater benefit of all.

The FIR has become the most transformative and disruptive change in history and it is occurring at a rapid pace. One particularly distinctive feature of the FIR will be the wider application of AI (Baweja et al., 2016), however experts the world over are discussing the transformative impact of not only AI but also technologies such as robotics, 3D printing and biotechnology, on almost every industry - from manufacturing and retail, to healthcare and entertainment (Acker, 2017). The FIR metaphor is most useful as a conceptual model to help government, society and business steer their way successfully across the most important shifts that will occur as these technologies become increasingly entrenched in our lives (Schwab, 2016a). These developments have massive repercussions for the global economy, as well as the relative competitiveness of developed and emerging nations and investors (Baweja et al., 2016). New business models, as well as ethical, social and safety issues, are being encountered as developing technologies come to life (Schwab, 2016a).

While the first three revolutionary movements were characterised mainly by advances in technology, the FIR is characterised by the application of technology and in a way that disrupts the existing industry (Cohen, 2017).Technological advances enable ever greater levels of automation and, along with the near universal ownership of smart devices in many parts of the world, are leading to a degree of interconnectedness that was hitherto unimaginable (Baweja et al., 2016). Research by the Institute for Spatial Economic Analysis (ISEA) found that job automation will affect certain metropolitan areas considerably harder than others, which implies that the impact of automation on jobs is likely to be more severe than previously predicted (Chen, 2017). A recent survey of Australian business leaders also found that Australian companies are amongst the least prepared of major economies for the arrival of AI technologies, despite spending the second-largest amount of money on automation (Opray, 2017). Moreover, based on the latest advances in mobile robotics and machine learning, even non-routine jobs, like healthcare diagnostics, truck driving or education, may be impacted (Chen, 2017).

In Cohen's (2017) opinion, the WEF loves these big, universal, complex issues that affect everyone, because they form a basis for interaction and a common agenda; in this case, the WEF have really hit the jackpot, because the idea of the FIR is all-inclusive, vital and ties into political trends, economic debates and even primitive

public fears that edge towards cultish Armageddon-type scenarios in which machines take over the world. The aforementioned ISEA report also stated that almost all large metropolitan areas in the US could lose more than 55% of their current jobs due to automation, with the exception of high-tech hubs such as Silicon Valley and Boston, which are considered least likely to be affected (Chen, 2017). With such wide-sweeping potential shifts, it is imperative that a cohesive society actively resolves some of the most candid questions on serious issues such as the ownership of personal data, security of social structures and systems, and the rights and responsibilities of the leaders of the new business landscape (Schwab, 2016a).

3.3 POSSIBLE GLOBAL CONSEQUENCES OF THE FIR

The replacement of jobs by machines has been a continuous trend since the IR, but it's anticipated to quicken meaningfully in the coming ten to twenty years (Chen, 2017). Certainly, automation can have positive effects, such as on ordinary systems of high volume processes, where skilled employees are still required to perform complex manual tasks and to manage and control these processes and machines. Consequently, a cumulative number of human machine interfaces will be established in future industrial manufacturing and production systems (Dombrowski & Wagner, 2014), which will lead to a dramatic evolution in the 'relationships' between man and machine (Leonhard, 2016).

3.3.1 A divided labour force

While technological revolutions frequently fuel fears of diminishing employment opportunities as "robots do all the work," the elements of the FIR, being extreme automation and extreme connectivity, may increase the productivity of existing jobs or generate demand for completely new jobs (Baweja et al., 2016). It is projected that between 35 and 50 percent of jobs existing today are at risk of being given up to automation (Marr, 2017). Low-skilled employment will, in all likelihood, continue to contract and there will be a growing assortment of middle-skilled jobs that will become susceptible as extreme automation is rolled out (Baweja et al., 2016). There is the risk that even professionals, including customer service representatives, diagnosticians and paralegals, will be susceptible to these changes (Marr, 2017). As data and talent rapidly become the highest-value inputs for businesses, cities globally can nurture

home-grown innovation ecosystems to quickly gain the benefit of the new efficiencies enabled by the FIR, and thus meet the requirements of their citizens while generating coveted services and products for global markets (Davis, 2015).

While total employment is not likely to fall in the long-run, there is the possibility of frictional unemployment and polarisation in the labour force, which will diminish once workers relocate, reskill or alternatively adapt to the situation at hand (Baweja et al., 2016). At the same time, it is difficult to think of an industry that will be unaffected as robots and AI become more widespread and affordable (Marr, 2017). Both the greater levels of inequality likely in the short-run, and a necessity for labour market flexibility to harness the FIR benefits in the long-run, would need to be considered in attempts to limit the impact of extreme automation (Baweja et al., 2016). Dombrowski and Wagner (2014) postulate probable impacts in which the future labourer will have to think less in detailed, individual processes and centrally organised scheduled tasks; instead, future tasks will progressively require an all-inclusive thinking process and self-organisation in the work situation.

3.3.2 Greater savings at the top

In the short-term, the impacts of divergence in the labour force and increased income inequality suggest that there will be larger gains for those at the top of the skills, income and wealth continuums (Baweja et al., 2016). These individuals are likely to be the best positioned, from a skills perspective, to take advantage of extreme automation and connectivity; already they usually have high savings rates and will benefit from holding more of those assets whose value will be enhanced by the FIR - this arrangement may not be limited to individuals but applicable to businesses as well (Baweja et al., 2016). While many companies have struggled to harness the power of these rapid advances in digitisation, and data and analytics technologies, companies that are fully leveraging these capabilities are already capturing a distinctive proportion of the benefits, transforming their businesses, outpacing, and occasionally disrupting, the rest of the market (Manyika, 2017).

According to Baweja et al. (2016), the FIR can be categorised by comparatively low capital intensity due to the means of distribution of extreme connectivity and automation, so the FIR prototype company may enjoy a minor human capital pool, but

still hold large economic value, both from a private or an equity market capitalisation perspective. Davis (2015) mentions that a hallmark of globalised, dematerialised markets is the trend to assign massive rewards to “stars”, that is, individuals, products or businesses who, either through fluke or distinctive talent, gain early and pervasive attention at the cost of those less fortunate or not quite as talented. At the same time, the very presence of global platforms to facilitate such dissemination, along with reduced transactional costs, also suggests substantial gains for those who own the platforms and connected infrastructure, and further generates new fears for aggravated inequality within countries (Davis, 2015). One such example is WhatsApp, which created extraordinary returns for a small group of creators and investors when Facebook agreed to pay USD 22 billion for the company, which then consisted of just 55 employees, in February 2014 (Baweja et al., 2016).

Today’s decision-makers are still too caught up in traditional, one dimensional, protectionist thinking, engrossed in short-term crises and profit maximisation, to deliberate strategically about the forces of change and to innovate and take advantage of new technology and the positive spin-off that can come from accepting these new movements (Pretorius, 2016). Still, early adopters may reap the financial benefits through lower borrowing costs in the short term, which could put downward pressure on interest rates in those parts of the economy in which the entity operates, possibly driving up the asset valuations of these firms and further widening inequality levels (Baweja et al., 2016).

3.3.3 The dollar dilemma

Baweja et al. (2016) are of the opinion that the United States (US) holds many of the key qualities needed for success in the FIR. Despite the fact that the US faces a variety of structural problems, including growing disparities in income and wealth, failing high school education rankings and a challenging healthcare system, it remains a popular choice for company formation, investment and corporate headquarters (Baweja et al., 2016). Of concern though are the inequalities evident in countries where public policies and their stage of economic development have a significant bearing on how their gains are realised (Davis, 2015). As US business and credit cycles are generally far more advanced than many other regions, the strengthening of the dollar adds to the difficulties of emerging market economies, even more so in those countries with the

additional competitive pressure of being dollar-pegged (Baweja et al., 2016). For these nations, the cost of debt servicing continues to rise, particularly for those companies that may have utilised the period of low US interest rates and extensive USD softness since the financial crisis to substantially increase their USD-denominated borrowing (Baweja et al., 2016).

3.3.4 Impact on governments - lack of effectiveness and adaptability

As the digital, physical and biological realms continue to converge, new platforms and technologies will progressively enable ordinary citizens to engage with governments, direct their efforts, voice their sentiments and even by-pass the control of public establishments; at the same time, these same authorities will acquire new technological powers to escalate their control over inhabitants with the help of ubiquitous surveillance structures and the capability to control digital infrastructure (Schwab, 2016c). Balkaran (2016) provides evidence that previous technological revolutions occurred as governments undertook bold missions, focusing not on minimising government failure but on maximising innovation. For the most part, however, authorities will gradually be pressurised into changing their existing methodologies for policymaking and civic engagement, as their fundamental roles diminish due to the new sources of competition and the reallocation and decentralisation of power brought about by new technologies (Schwab, 2016c). The introduction of new technology typically transforms work environments and alters circumstances to such an extent that existing regulations, practices and policies require either updating or possibly new creation, as they may no longer be valid or appropriate for the new environment (Balkaran, 2016)

The capacity of public systems and government authorities to change will govern their survival; in order to preserve their competitive edge, governments must prove proficient in embracing a realm of disruptive revolution, and either expose their structures to new levels of efficiency and transparency or face growing discontent (Schwab, 2016c). This reiterates Balkaran's assertion that "the public sector has little choice but to improve the way it operates" and to do so it must embrace digital transformation (Balkaran, 2016). Given the FIR's speed of change and far-reaching impacts, lawmakers and regulators are being challenged to an unparalleled point and are mostly unable to cope (Schwab, 2016c). Policymakers and the general public need

to prepare for impending new technology by establishing an understanding of how it may change society and the global economy over the coming years; they will furthermore need to decide how to invest in infrastructure and new forms of education, and figure out how disruptive economic change could affect comparative advantages (Manyika et al., 2013).

The FIR will also greatly influence domestic and international security, impacting both the nature and probability of conflict, as the history of international security and warfare is essentially connected to the technological revolution, and even more so in the present (Schwab, 2016c). The differences between violence and nonviolence, war and peace, and soldier and non-fighter are becoming dangerously blurred and as this process takes place and new technologies such as biological or autonomous weapons become easier to use, small groups and individuals will progressively join states in being capable of causing mass harm (Schwab, 2016c). National authorities will have to ensure an environment in which inhabitants can continue to prosper, even while emerging technologies disturb their lives; policymakers and officials will be confronted with issues like new biological abilities while continuing to safeguard the security, safety, privacy and civil rights of residents (Manyika et al., 2013).

3.3.5 The impact on people

The FIR will transform not only what people do but also the essence of who they are - their sense of privacy, consumption patterns, concepts of ownership, the time dedicated to work and to relaxation, and the ways in which they nurture their skills, advance their careers, meet people and foster relationships (Schwab, 2016c). Privacy concerns will be crucial, as biotech and AI revolutions will redefine what it means to be human by pushing back the existing thresholds of health, lifespan, reasoning and other capabilities, while forcing people to redefine their ethical and moral limitations (Wells, 2016). As individuals, humans instinctively cherish privacy, yet the tracking and sharing of people's data is a critical element in this new depth of connectivity; the discussions about important concerns, such as the effect on people's innermost lives and the loss of control over data, will only deepen in the years ahead (Schwab, 2016c).

3.4 DISRUPTIVE TECHNOLOGIES THAT SHAPE AND IMPACT BUSINESS AND ECONOMIES GLOBALLY

According to EY (2015a), FIR disruption is happening across all geographies and industries, with immense opportunities for enterprises to benefit from capturing enormous volumes of information from connected devices enabled by the IoT, move into new markets, introduce new business and delivery models, and transform existing products (EY, 2015). As some technologies are likely to upset the status quo, change the way people live and work, and alter value systems, business leaders cannot wait until evolving technologies are actually having these impacts to choose which advances are the 'truly big things' and which technologies to adopt (Manyika et al., 2013). At the same time, the advancement of the digital initiative also presents major challenges that must be addressed, such as shifting customer engagement and business models, fresh competition, unparalleled transparency, cybersecurity pressures and confidentiality fears (EY, 2015).

Manyika et al. (2013), in the report "**Disruptive technologies: Advances that will transform life, business and the global economy**", concentrate on those technologies with substantial potential to drive economic influence and disruption, and consider the following aspects in determining the characteristics of a disruptive technology:

- **The technology is rapidly evolving or undergoing breakthroughs**. Disruptive technologies usually exhibit a swift level of change in abilities in terms of performance or price in relation to replacements and alternative methodologies, or they undergo innovations that drive hastened rates of change.
- **The possible scope of influence is far-reaching**. In order to be economically disrupting, a technology needs to have a wide reach, touching not only businesses and industries, but also an extensive range of machines, services or products.
- **Substantial economic value may well be affected**. An economically disruptive technology should have the potential to create an immense economic effect, in which the prospective stake is significant in terms of earnings pools being disrupted, increments to GDP, and where capital investments could be rendered void.

- **Economic influence is possibly disruptive**. Technologies possessing the possibility to radically alter the status quo, thereby transforming how individuals live and work, generate innovative opportunities, move excesses for businesses and drive progress for nations (Manyika et al., 2013)

3.4.1 Mobile internet

Progressively fast internet connectivity and lower priced, increasingly capable mobile devices have meant that internet-enabled portable devices are no longer a luxury for a few, but have become entrenched in the lifestyle of billions of people who now own smartphones and tablets (Manyika et al., 2013). Together, users and the media are absorbed by IoT innovations already in the market (Patel, Shankuan & Thomas, 2017). The IoT can be described as "*the intelligent connectivity of smart devices by which objects can sense one another and communicate, thus changing how, where and by whom decisions about our physical world are made*" (Albert, 2015). These smart devices have sensors that communicate effortlessly over the internet with the cloud or other devices, producing data that makes the world more efficient, safer and better (Patel et al., 2017). Ubiquitous connectivity and propagation of apps are allowing users to go about their daily routines with new means of observing, understanding and even interacting with the physical world (Manyika et al., 2013), while at the same time, innovators enable increasingly sophisticated IoT technologies such as drone-delivery services, self-driving cars and other cutting-edge applications (Patel et al., 2017).

Similarly, mobile internet services offer uses across big business and the public sector, facilitating a more efficient provision of services and crafting opportunities through which to improve labour productivity (Manyika et al., 2013). Mobile devices have become the preferred tools for work and general communication, as more employees insist on being allowed to "bring your own device" to work - businesses therefore need to adapt to be able to support the newest mobile technologies (EY, 2015). Before 2010, less than 10% of the South African population had smartphones, with that figure rising to more than half the population in 2016 (Jacobs, 2016). A quarter of those users are limited in their optimal use of smart devices, however, due partly to the high cost of data (Jacobs, 2016), yet mobile is still catapulting over fixed broadband, not just in South Africa but in several countries, especially emerging markets, and webpage

views from mobile phones now outstrip those from personal computers in 48 countries (EY, 2015). South Africa is the leader in fixed-line broadband access in Africa. Although it lags behind developed countries, in comparison to African countries such as Nigeria (with mobile internet penetration of more than 25%) and Kenya (with mobile internet penetration of more than 30%), South Africa comes in at just over 36% penetration (Jacobs, 2016).

3.4.2 Artificial Intelligence (AI)

John McCarthy, an American cognitive scientist and computer scientist, first used the expression AI while a research fellow at the prestigious Massachusetts Institute of Technology (MIT) in the mid-1950s, describing it as "the science and engineering of making intelligent machines"; since then AI has developed into a multidisciplinary field that embraces not only computers and robotics but also computer science, neuroscience, linguistics, mathematics and psychology (Stuart, Currie, Goodman, Ives & Scott, 2015). Progressively, developments in AI, machine learning and ordinary user interfaces are enabling the automation of many knowledge workers' duties which have long been viewed as too difficult or impracticable for machines to perform (Manyika et al., 2013). Furthermore, as the capabilities of machines continue to improve, enabling them to identify faces, transform speech in real time, learn and process language, AI's capacity to mimic human actions and roles will expand (Stuart et al., 2015). Extreme automation via AI will progressively automate some of the abilities previously only possessed by humans (Baweja et al., 2016).

Improvements in data assimilation and collection, processing power and algorithms have enabled computer scientists to accomplish major advances in AI, moving the technologies beyond the lab and into many machine-learning systems already in commercial use in numerous applications (Barton, Woetzel, Seong & Tian, 2017). Three fundamental elements are enabling AI to flourish, namely:

- Dramatic increases in computing power, driven by growing use of cloud computing;
- Growth in big data (BD), with a compound annual growth rate (CAGR) of more than 50% since 2010, as more devices become connected; and
- Significant investments in the research and development (R&D) of basic AI technologies (Accenture, 2017a).

AI abilities are based on pure computer processing power, which explains how, with the marked decrease in the price of servers, cloud computing and other computer architecture, AI technology continues to gain momentum (Stuart et al., 2015). Progress in AI and machine learning are critical for the improvements in advanced robots, self-driving vehicles and the capabilities of knowledge work automation (Manyika et al., 2013). Where AI could be positioned to generate major advances is in big data processing, possibly encompassing the processing of languages and images which, until now, have been the capabilities of computers. Moreover, robots and AI could even begin to produce output, analyse results, make intricate decisions and adapt assumptions to environmental issues (Baweja et al., 2016).

The developments driven by the FIR in AI, are particularly gaining momentum in the domain of decision making (which is usually associated with management), as algorithms are developed to make progressively complex choices, thus putting modern-day management under further pressure to reflect the future scope of management practice (Oosthuizen, 2016). Policies of adoption and adaption are rising rapidly in sectors such as finance, healthcare and manufacturing (Barton, Woetzel, Seong & Tian, 2017), but irrespective of the particular industry or driver of change, the pace of transformation is generally unprecedented, with disruptive changes already reshaping business models and skill sets, and this rapid pace is expected to continue for the next five years (World Economic Forum, 2016).

Modern AI systems are now capable of dislodging humans in professional practices such as accounting, engineering and law, which traditionally relied on the intense, specific knowledge of experienced subject-matter experts (Stuart et al., 2015). Legal and financial services are starting to see the returns of knowledge worker automation. Law firms, for example, now use computers that examine thousands of legal documents to help in pre-trial research (work that previously would have taken hundreds or thousands of hours of paralegal labour) and AI has performed a role in financial transactions for some time, as AI algorithms are able to analyse numerous financial broadcasts, news stories and press releases, then make decisions concerning their trading significance, and act in milliseconds (faster and with greater data recall than any human trader) (Manyika et al., 2013). Banks also utilise machine learning to identify fraud, discover claims or charges outside an individual's normal

purchasing pattern, and even offer financial services like ‘Robo Advisor’ which uses AI to propose bespoke, inexpensive financial advice (Manyika et al., 2013).

Barton et al. (2017) note that China has developed into one of the prominent global centres for AI advancement, having recognised that the nation’s enormous populace and varied industry mix creates huge volumes of information and offers a colossal market. China’s largest tech companies invest substantially in the R&D of AI, having calculated that automation could add 0.8 to 1.4 percentage points to GDP growth per annum, depending on the speed of implementation (Barton et al., 2017).

The present anxious debate about the continuing impact of AI and robotics on today’s workforce requires talent strategies to assess the best way in which to deal with this transition successfully (World Economic Forum, 2016). “*The consequences of this unavoidable rise of smart machines, robots, AI and so-called cognitive computing are clear: our future does not lie in competing in jobs such as information storage, data processing and repetitive computational tasks (smart machines are certain to beat us, hands down) but, rather, our future lies in being more human and less like machines. In this future, making mistakes, failing, not complying and creatively destroying things are some of the key skills on which we will be able to beat machines for quite some time*” (Leonhard, 2014).

3.4.3 Cloud technology

Cloud technology enables the provision of a computer service or application via the internet or a network, with marginal or no local software or processing power needed; IT resources, whether for computation or storage, are therefore made available on an as-needed basis, while additional capacity can be effortlessly added, if required, without the need for capital investment in programming or new hardware (Manyika et al., 2013). Rapid developments in cloud computing technology, social media, linked devices, mobile and data analytics encourage enterprises to reconsider essential features of their business, including their services and product offering, how these are delivered and sustainable ways in which to optimise operations (EY, 2015). Cloud computing additionally facilitates the rapid advancement of internet-based services, from offline storage of private information (like music, books, photos), to search operations, media streaming, as well as the background processing abilities that

support mobile internet devices as they respond to, for example, verbal instructions or a request for directions (Manyika et al., 2013).

Cloud technology offers a mutual, safe and reliable environment, thus enabling the development of IT from a support function to a key member in business teams, as highly geared commercial process and application design tools, coupled with a wide range of cloud services, empower IT to rapidly produce solutions that provide a competitive business advantage (Hewlett-Packard, 2013), thereby enabling entirely new business and service models (Manyika et al., 2013). The latest computing devices range from the miniature, such as wearable devices and chips implanted under the skin, laptops, the computers inside mobile devices, desktops, TV sets, refrigerators and home servers, to the computing cloud reached by means of the internet, and all are connected via various communication and networking technologies (Alkhatib et al., 2014). Users increasingly demand the functionality of cloud, mobile and social technologies, which have become an indispensable part of their daily lives, and, importantly for the marketplace, are interacting with brands more than ever through the lightweight convenience of their mobile devices rather than via deskbound PCs (EY, 2015).

A study done by the International Data Corporation (IDC) indicated that cloud migration is in the strategic plans of most South African companies, who are either migrating now or will do in the very near future, although some businesses have been slow to adopt cloud technology due to either data protection concerns, a lack of local infrastructure or conservative investment strategies (Nebula, 2017). Abrahams and Schofield (2015) believe that governments have a key role to play in encouraging the use of cloud computing through, for example, the elimination of unnecessary legal and regulatory obstacles, being principal users themselves, nurturing cloud-technology skills and education, supporting related R&D ventures and the formation of public-private partnerships. Other major challenges facing the progress of cloud computing include the deficiency of suitable standards in some areas, the delay in a pervasive acceptance of current standards and the issues surrounding potential vendor lock-in and the inhibition of interoperability (Abrahams & Schofield, 2015).

3.4.4 3D Printing

To date, 3D printing has been employed predominantly by hobbyists, product designers and a few select industrial applications, but the performance of additive manufacturing equipment is quickly evolving, the choice of materials is increasing, and prices of both materials and printers are falling rapidly, all factors through which 3D printing is swiftly progressing to attain wider consumer acceptance and a greater number of manufacturing uses (Manyika et al., 2013). 3D printing enables the fabrication of items with particular properties constructed on a layer-by-layer basis and using different materials, including ceramics, plastics, gypsum or metals (Xiv, May & Pessl, 2016). Using 3D printing, an idea can be developed straight from a 3D design file to a completed part or manufactured article, potentially bypassing several traditional manufacturing steps; furthermore, it permits on-demand fabrication, which has interesting consequences for supply chains and the necessity of carrying spare parts (a significant expense for manufacturers) (Manyika et al., 2013).

Currently, 3D printing is applied mostly in the production of unique pieces or small runs, such as prototypes, spare parts or specialised items. The manufacturing process is considered to be environmentally friendly, since it requires fewer resources, waste is minimal and transport logistics can be mitigated (Xiv et al., 2016). Already, shoppers are able to design and order bespoke products online; it is likely that they will soon be able to merely press “print” instead of having to wait for a delivery (Montresor, 2016). Scientists have even bio-printed body parts through the use of an inkjet printing procedure, to layer human stem cells along with a supporting framework (Manyika et al., 2013). Moreover, it is foreseen that 3D printers will enable the self-production of many items, with only big items being manufactured in a few centralised factories, thereby muddling the future roles of consumers and producers (European Commission, 2016).

In South Africa, a significant outlay in 3D printing has been invested in the additive manufacturing of titanium parts, most significantly with the R40-million ‘Aeroswift’ project, a partnership between the local aeronautical manufacturer Aerosud and the National Laser Centre at the Council for Scientific and Industrial Research (CSIR), whose ambitions are to develop additive manufacturing methods and the world’s largest metal 3D printer (Wild, 2014). Furthermore, improved access to 3D printing

has enabled South African surgeons to ‘make’ a jaw implant when conventional opportunities proved too costly; this was only the second time that a 3D implant had been used in this manner (Coleman, 2016)**.**

3.4.5 Internet of things

The world’s digital systems keep on growing in magnitude and capability as the number of connected devices increases dramatically; with ever more servers, personal computers, mobile devices, actuators in machines and sensors of all varieties connecting to the internet (and to each other), the Internet of Things (IoT) has become a reality (Stuart et al., 2015). Including applications from monitoring the movement of products through a plant, to evaluating the dampness in a field of crops, or tracking the flow of water through utility pipelines, the IoT empowers private- and public-sector businesses to effectively manage resources, boost performance and generate new business models (Manyika et al., 2013). In more domestic functions, the IoT connects technologies in unanticipated and once-undreamed-of ways, such as being able to open the front door with a smartphone, controlling a robotic device from a distance with sensors attached to the users’ arm, and setting home appliances to select when they should operate (Stuart et al., 2015). Through remote monitoring, the IoT also has unlimited potential to improve the health of patients with chronic ailments and thereby mitigate a chief source of escalating health-care expenditures (Manyika et al., 2013). The power of an IoT network produces incredible prospects for big business globally, but also new types of challenges, in which those who remain unconnected will certainly fall behind (Stuart et al., 2015).

More than nine billion devices are connected through the internet and this number is projected to surge dramatically within the ensuing decade, increasing five-fold to fifty billion devices and, eventually, over one trillion (Manyika et al., 2013). One obvious way in which IoT technology is reshaping societies is through the deployment of smart, linked devices in towns and businesses worldwide, to collect data and amass insights which are then used to realise greater levels of efficiency, throughput and control over the consumption of scarce and natural resources (Sha, 2017). A specific illustration of resource controlling is in sustainable or smart cities where the benefits of IoT are seen to enable innovation at many levels; for example, innovative environmental methodologies for cooling with zero-energy datacentres combining solar energy with

careful datacentre management (Alkhatib et al., 2014). Closer to home, large metros in South Africa regularly face resource challenges in meeting residents' demand for electricity, and dealing with water scarcities and wastage. The challenges are only anticipated to grow in the years ahead because of increasing urbanisation, and this has become a major driver behind discussions concentrating on smart cities (Sha, 2017). The eight largest cities in South Africa are home to 37% of the population and generate 59% of the economic activity; the expectation is that by 2050, 80% of all South Africans will be living in these cities (Gedye, 2016).

The good news, however, is that significant headway is already being made in South Africa, as IoT projects are in progress and the development of smart cities is a priority (Sha, 2017). Cape Town and Johannesburg are considered the leaders in the race to become smart cities, although, all things considered, the two metros are only just getting 'out of the starting blocks' (Gedye, 2016). The IoT is critical to the realisation of a smart city, as it facilitates the traverse between the physical world and the digital one (Sha, 2017). South African cities need to have a long term plan to manage the following six key areas:

- gas and electricity;
- sanitation and waste;
- safety and security;
- water;
- transportation and traffic management; and
- connectivity (Gedye, 2016).

3.4.6 Energy storage

Energy storage (EnS) technology comprises batteries and other mechanisms that store energy for future use (Manyika et al., 2013). Customer EnS, new varieties of batteries (such as silicon anode and lithium-ion) and renewable energies (including improved biofuels and solar energy) can be considered disruptive technologies influencing several industries (Alkhatib et al., 2014). EnS is a restrictive element in many technologies, including mobile computing, consumer electronics, automobiles, distant automated systems and alternative energy creation (Lapthorne et al., 2013). Should new ways be found to hoard energy, at high density and through unique

innovations in battery technology, nanoscience and advanced materials, it would increase the possibilities for achieving new applications and manufactured products (Lapthorne et al., 2013). Lithium-ion (L-i) batteries and fuel cells are presently running electric and hybrid vehicles, together with billions of portable consumer electronic devices, and they have steadily increased in performance and declined in price, with cost per unit of storage capability falling radically over the last ten years (Manyika et al., 2013).

Progress in EnS technology has the capacity to make electric automobiles (plug-in hybrids, hybrids and all-electrics) more price competitive than vehicles built with internal-combustion engines (Manyika et al., 2013). Manyika et al. (2013) further highlight the symbiotic advances that exist between the development in EnS and renewable energy sources, with their ability to store electricity created by wind or solar thereby helping to incorporate renewables into the power grid. Enhanced control of household energy usage has also realised many savings possibilities. In future, built-in assessment tools in home appliances could, for example, determine when it is most viable that they be replaced, and these smart appliances could be designed to respond and self-regulate according to grid turbulences to optimise consumption and cost (Alkhatib et al., 2014). Furthermore, with respect to the power grid, innovative battery storage systems could aid and improve quality by monitoring frequency variations, handling peak loads, and reducing costs by enabling utilities to delay infrastructure expansion (Manyika et al., 2013).

In emerging economies, solar and battery systems present the possibility of delivering dependable power to previously unreached places (Manyika et al., 2013). The cost of EnS in battery packs is, for the most part an expensive aspect of solar, wind and mini-hydropower, but on the African continent, electronic devices are increasingly being powered by solar cells instead of expensive batteries (Grosskurth, 2010). Grosskurth (2010) reasons that even the poor will be able to afford solar driven chargers for their devices, including mobile devices, LED lamps, radios, and perhaps even sewing machines, a laptop computer or small electric tools. Such ubiquitous and dependable accessibility to light, communication and other low-power applications will meaningfully advance the opportunities of the continent’s rural inhabitants (Grosskurth, 2010).

In South Africa, solar, in particular, and, similarly, wind energy, do not generate power when it is most required, making these renewable energy sources more suitable to leverage in solving problems of peak demand, which can be done by incorporating EnS on a wider scale (Wilkinson, 2017). The purchase price of an L-i battery necessitates a long-term outlook vis-à-vis the return on investment, which calls for forward thinking and strategic resolve - qualities that need to be developed further in the African framework - with state and organised funding for EnS projects also needing enhancement (Wilkinson, 2017). Wilkinson (2017) is still buoyant that, in the long term, EnS will become ubiquitous in both small- and large-scale energy practices, motivated mostly by the economic paybacks it offers, even without state funding.

3.4.7 Advanced robotics

The word ‘robot’ has its roots in Czechoslovakia where it was first used in a science-fiction play in 1920, referring to human clones that were raised to work (Bloem, 2014). More than a half century ago robots began to alter the industrialised world and have since progressively changed how businesses produce goods, whether large or small, and substituted the need for human labour in a large range of applications, from satisfying warehouse orders to maintaining nuclear reactors (Stuart et al., 2015). Robots are capable of undertaking increasingly delicate and complex tasks, for instance picking and packing or handling small electronics parts, but are flexible and equally capable of working in frenzied conditions and functioning together with humans (Manyika et al., 2013). Robots are also becoming less expensive. They work untiringly and operate with unparalleled precision and, often, more power than humans, which is most important to the robustness and quality of products, from baby nutrition to vehicles (Bloem, 2014). The impact of industrial robots on industries is one side of the spectrum while, on the other side, personal and domestic robots are now changing human’s lives at home, where, for example, a robotic vacuum cleaner learn about its environment, cleans rooms and recharges itself without any human intervention, thereby automating a boring task that people previously did themselves (Stuart et al., 2015).

Modern manufacturing technologies, including robotics and automation, and practices such as ‘lean’, which focus on eliminating non-value-adding actions, are now being used all over the world as a result of progress in transport and communication

technologies, and the corresponding globalisation of supply chains (Lapthorne et al., 2013). The technology progression facilitates the decrease in industrial waste and redesigns consumption and production systems so as to be more effective in their use of resources, however, it also threatens jobs because of robotics and other innovations (Burda, 2015). Robots enable enterprises to lower labour overheads, realise improved productivity and provide reliable, superior quality, and, as robots advance from executors of monotonous tasks to flexible AI systems, they will take on many roles and responsibilities once thought to be beyond them (Stuart et al., 2015).

Recent advances in machine learning, robotics and AI are pushing the boundaries of a machine's capabilities in all aspects of economy and business (Manyika, 2017). The recurring theme is that robots need to adapt to humans, and not vice versa, in other words, this attitude must be applied to the extent that the fresh generation of smart industrial robots will learn from their human co-workers, who will merely show them the actions required (Bloem, 2014). Whereas automation has, for the most part, affected blue-collar jobs, and will in all likelihood continue to do so (EY, 2015), the greatest disruption may possibly be encountered by employees who have so far felt safe from robotic rivalry, namely those in middle-skilled professions, occupying the so-called white-collar jobs (Balkaran, 2016). The effect of new and innovative technologies will not be completely damaging to the job market, however, as it will create opportunities and needs to improve, service or operate subsequent generations of software and machines (EY, 2015).

By 2025, advanced machines may well be capable of consistently manufacturing higher quality goods by sensing and rectifying their own faults, and sensing and swiftly reacting to problems created by other robots or human co-workers, with this greater responsiveness enabling them to work safely alongside humans (Manyika et al., 2013). The dawn of 'cyber-physical entities' may permit robots and AI, by way of great automation and connectivity, to "cross the abyss" between the technosphere, the natural world and the human realm (Baweja et al., 2016). Innovative robotics promise a world with a reduced need for manual labour, one in which robotic workers and robotic human augmentation could lead to major improvements in productivity and may even prolong human lives (Manyika et al., 2013).

Robots allow us to exceed our conventional capabilities - private drones, for example, that cost just a few thousand rand now enable individuals to take photographs and shoot videos that previously necessitated the expense of hiring a crane, helicopter or plane, and the potential contributions of these robotic drones to areas like agriculture, energy and security are only now being fully understood (Stuart et al., 2015) . Stanford University computer scientists have developed an AI system through which robotic helicopters teach themselves to perform challenging stunts simply by watching other helicopters execute the equivalent manoeuvres (Talwar & Hancock, 2010). Improvements in interfaces, sensors and actuators, along with superior ergonomic and materials designs, are advancing robotic surgical procedures and dramatically improving the quality and effectiveness of human prosthetic devices. What's more, ultraprecise surgical robots are creating new methods of minimally invasive surgery that can mitigate postsurgical difficulties, facilitate speedy recovery and even reduce surgical death rates (Manyika et al., 2013). Furthermore, Manyika et al. (2013) conclude that numerous goods and services may become inexpensive and freely available due to these improvements and may even result in improved and less-restricted lives for the elderly and the physically handicapped, through the use of robotic prosthetics and 'exoskeletons' that fasten on like braces and assist in movement (Manyika et al., 2013).

Industries in emerging economies may be among the principal purchasers of robotics given the present rate of automation; yet, these economies could also be adversely affected by a corresponding falling demand for low-wage manual labour, upon which they rely for economic growth (Manyika et al., 2013). In South Africa, there are persistent observations that the introduction of advanced automation technologies in the manufacturing sector either restricts the creation of new jobs or actually leads to job losses (Williams, Cunningham & De Beer, 2014). Williams et al. (2014) further indicate that, in spite of advanced manufacturing being acknowledged globally as key to reversing deindustrialisation and to generating decent, well-paying jobs, the adverse correlation of progressive manufacturing and technological progress on employment has created opposition to the adoption of forward-thinking manufacturing practices by business. These opinions are, above all, evident in South Africa against the background of deteriorating employment opportunities and a decreasing manufacturing growth rate as a proportion of domestic growth, with antagonistic

management-worker labour relations frequently contributing to the debate surrounding current and anticipated job losses as a result of mechanisation (Williams et al., 2014). This situation may place substantial pressure upon governments and social systems, and will necessitate vigorous, flexible educational systems to improve and retool workers to be able to function in the new setting (EY, 2015).

A further noteworthy and common perception is that robotics and AI may drive the 'dehumanisation' of individuals' lives, affecting distinctive values such as compassion, sympathy, creativity and inspiration, and could possibly advance moral and ethical challenges (Burda, 2015). In his address at the World Economic Forum in Davos in 2016, the Prime Minister of Canada, Justin Trudeau, emphasised that "*it's not hard to see how the connections between computing, information, robotics and biotechnologies could deliver spectacular progress. It's also not hard to imagine how they could produce mass unemployment and greater inequality. Technology itself will not determine the future we get. Our choices will. Leadership will*" (Trudeau, 2016).

3.4.8 Autonomous and near-autonomous vehicles

An autonomous vehicle is one that can manoeuvre with reduced or no human intervention. Already, for many years, most commercial aircraft have been capable of functioning on autopilot, with on-board computers able to manage most facets of flying, including some aspects of landing and take-off (Manyika et al., 2013). According to Balkaran (2016), the potential to utilise self-driving or semi-autonomous machines is significant. From drone airplanes in a combat zone to Google's self-driving vehicle, the AI technologies of machine vision, sensors and actuators that are making these machines probable, are quickly improving (Manyika et al., 2013). Mining houses, too, have invested in autonomous equipment, including remote mining and driverless trucks which have cut expenses and improved productivity enormously (Du Plessis, 2016). Google's self-driving cars are already driving on freeways and urban streets (with a human co-pilot behind the steering wheel as backup in case of a malfunction in the system) in certain US states (Manyika et al., 2013).

Advancements in robotics are also likely to alter the way in which mass transportation is managed today to a more fully automated, autonomous system. The service of a driverless cab, just large enough to accommodate you and your baggage, sent off to

your hotel to take you to the airport, and automatically following the best route along the way is not far from becoming a reality (Alkhatib et al., 2014). South African-born Elon Musk's Tesla is providing Dubai with 200 Tesla vehicles as Dubai looks to become a front-runner amongst those countries incorporating self-driving cars; indeed, part of the Dubai Future Foundation's goal is to make 25% of all car trips autonomous by 2030 (Muioio, 2017). Some of the likely benefits of autonomous vehicles include increased safety and fewer deaths from vehicle crashes, reduced CO^2 emissions, more relaxation or work time for motorists (with hands-off driving) and improved productivity in the trucking industry (Manyika et al., 2013).

In the future, low-cost, commercially accessible submersibles and drones may well be used in a variety of applications (Manyika et al., 2013). Some applications of drones include:

- **Agriculture** – Drones can save farmers money through the early detection of dying plants, assisting with crops inventories, and by spraying pesticides, fertilizers or water on crops.
- **Delivery** - Drone-based delivery services undoubtedly constitute one of the most obvious applications; aside from the feasibility of Jeff Bezos' planned Amazon Prime Air, the ability to deliver goods directly to the customer's door by drone will certainly become real as the technology's capabilities advance and expand;
- **Engineering** - Engineering companies are also utilising drones in in-depth projects like transmission cables, maintenance assessments and oil pipelines.
- **Media** - Another use for drones is in media coverage where, previously, aerial footage was accessible only to large news corporations who could afford a helicopter; today, local reporters and smaller media channels can now easily capture aerial shots for news coverage.
- **Architecture and construction** - Architects can use images and shots of a property to construct 3D renderings of the buildings they aim to construct (Uzialko, 2017).

Developments in computer science, nanotechnology, image processing, materials science and several other fields have also led to amazing and innovative applications for robotics in medicine, which include such varied uses as autonomous transport or

supplies in hospitals, robotic surgery, telemedicine and rehabilitative support (Alkhatib et al., 2014). Hospital delivery robots are, in essence, autonomous vehicles that transport such critical items as provisions, instruments, specimens and waste, incorporating their capabilities in route planning for direction-finding, laser ranging for crash evasion and signalling, to open doors or use lifts (Alkhatib et al., 2014).

3.4.9 Next generation genomics

Next generation genomics, which is at the dawn of a new era of innovation, can be defined as "*the combination of next generation sequencing technologies, big data (BD) analytics and technologies with the ability to modify organisms, which include both recombinant techniques and DNA synthesis (i.e. synthetic biology)*" (Manyika et al., 2013). In the future, better understanding of genomics will permit pharmaceutical corporations to adapt drugs specially to the genetic profiles of individual patients and thereby significantly reduce unintentional side effects (Glenn, 2006). Furthermore, along with BD, rapid progress in genomics can also bring patients to a point where all major health choices are individually tailored (Alkhatib et al., 2014). The reduced cost of gene sequencing is already improving accessibility to large amounts of genetic information and the power of information technology is being used to hasten the analysis of data to determine how genes mutate and to control traits that cause disease (Manyika et al., 2013). The availability of such information enables scientists and technicians in corporations to creating new procedures to directly write DNA and introduce it into cells, subsequently constructing customised organisms and developing new drugs to treat cancer and other diseases (Manyika et al., 2013).

The accessibility of genetic and genomic information is facilitating far-reaching changes in the advancement of new therapies as gene expression profiling helps obtain unique insights into drug-disease relationships by showing how cells react to specific treatments (EY, 2015). Next generation genomics has the likelihood to alter the ways in which doctors identify and treat cancer and other diseases, thereby potentially prolonging lives by combining progress made in the science of sequencing and altering genetic material with the latest BD analytics capabilities (Manyika et al., 2013). The ubiquitous computing power now available is also helping to drive down the costs associated with genomic analysis and the sequence of proteins expressed by genes; this, in turn, could make it possible to tailor treatments that best suit each

individual, which could lessen waste and, in turn, improve medical outcomes and the viability of hospitals (Baweja et al., 2016). Improvements in the power and availability of genetic science could also have a significant impact on agriculture, as well as the production of high-value materials such as biofuels (Manyika et al., 2013). Farmers may be able to optimise soil types, crop rotations, watering programmes and other growing patterns based on a better understanding of crop genomes, and the possibility then arises of harvesting genetically modified crops that can propagate in places with poor soil conditions or limited access to water, or that can flourish in drier, colder climates or produce a greater portion of their mass as food (Manyika et al., 2013).

BD is finally evolving from the laboratories of computer science and machine learning to be incorporated in various practical, everyday scenarios in business, government, the military, science, politics, medicine, climatology and personal analytics. As a result, more data is being gathered on every aspect of operation, increasing productivity and consumer marketing, and turning to new markets (Alkhatib et al., 2014). The increasing significance of BD presents extra challenges for governments and companies, however, as attackers can abuse massive, distributed BD systems with inadequate security controls and can consequently gain access to incredible amounts of material at once (Hewlett-Packard, 2013). Governments have been in favour of the expansion of genomics (including BD), demonstrating support through investments in research, but they have not been as forward-looking when it comes to shaping policy. Here, administrations have to play a vital role in ensuring that next generation of genomics lives up to its potential to save lives, feed people and deliver fuels that will be less damaging to the environment (Manyika et al., 2013).

3.4.10 Advanced materials

Historically, breakthroughs in the superiority or competitive cost of basic resources have driven phases of disruptive progress; over the past few decades, with scientists having discovered methods to create materials with unbelievable characteristics (such as self-healing or self-cleaning smart materials, memory metals that can return to their original shapes, crystals that turn pressure into energy and nanomaterials), this tendency seems to be holding true (Manyika et al., 2013). In many instances, the breakthrough in new materials produces new production challenges, necessitating significant advances in manufacturing process technologies that can then be used for

other applications (Lapthorne et al., 2013). As innovative, advanced manufacturing technologies go mainstream, the influence will be felt all along supply chains and through many industries, changing years of outdated business practices (Stuart et al., 2015) The added value of materials increases as new materials - such as graphene (a nanomaterial with amazing properties including conductivity and strength on ultrathin sheets of graphite), diamond-like carbon, carbon nanotubes (tubular graphene), compounds (metallic, ceramic and organic) that have shape-memory and self-healing properties - are used increasingly in energy storage, computer and smart phone displays, improved chemicals and catalysts, consumer electronics, pharmaceuticals, aerospace and many other fields of manufacturing (Lapthorne et al., 2013). Imperceptible to the naked eye, nanomaterials have now found their way to improve products as varied and ordinary as pharmaceuticals, bacteria-killing socks, sunscreens and composite bicycle frames (Manyika et al., 2013).

A key driver emerging as change sweeps around the world is that of digital transformation, which has the latency to meaningfully improve consumer lives and craft extensive societal good, while simultaneously providing industries with new opportunities for value creation and capture (Accenture, 2017b). Closely linked to this is the influence of nanotechnology and nanoscience. Nanomaterials are made possible by controlling substances at a nanoscale (which is less than 100 nanometres or molecular scale), thereby enabling the manipulation of ordinary materials to assume new properties (whether greater reactivity, rare electrical properties, or massive strength per unit of weight). This process makes possible new varieties of medicines, super-slick coatings, robust composites and other improvements, such as the research currently underway in pharmaceutical businesses using nanoparticles for directed drug treatments of illnesses such as cancer (Manyika et al., 2013). What is certain is that digitalisation will be a foundation for transformational change, but, again, these transformations are not without challenges as, in many instances, the gains from digitisation have been unequal, with the benefits not reaching those who need them most (Accenture, 2017b). Businesses across various sectors are further struggling with challenges linked to shifting customer expectations, cultural transformation, dated regulation and skill deficiencies, among others (Accenture, 2017b).

3.5 BLOCKCHAIN

The digital revolution is crafting fundamentally new methodologies that transform the way in which organisations and individuals engage and collaborate. Over the last decade, an alternate digital paradigm has been slowly taking shape at the periphery of the internet (Institute for the future, 2017). This radical methodology, called blockchain, is an example of a "distributive ledger" (Bloem et al., 2014), meaning that it is a distributed or shared electronic ledger that utilises software algorithms to record and approve trades and transactions reliably and anonymously. The recording of the transactions is shared amongst numerous parties and once the data is entered it cannot be changed, as the downstream chain underpins upstream trades (Curran, Eckert & Bhardwaj, 2016). Fundamentally, blockchain is a network of computers that each have to approve an operation before it can be confirmed and documented (Montresor, 2016). Stakeholders are starting to comprehend the latent disruptive nature of blockchain technology and are beginning to experiment with its most promising applications; the fundamental question being asked is: *What would a world driven by blockchain technology look like a decade from now?* (Institute for the future, 2017).

Indeed, the blockchain is fast becoming a symbol of the FIR (Kemp, 2016) and is understood not just as a set of financial tools or currency but as a technology that will alter the way mankind looks at the world. This technology supports Bitcoin, the cryptocurrency that gave birth to blockchain, and is the ultimate product of extreme connectivity since it relies for its existence on the interconnection of a large number of computers (Baweja et al., 2016). The technology is shaking the foundations of how value (whether in the form of money, information or resources) is managed and tracked, and, in so doing, is creating opportunities for new flows of value – value that is relative to the users of blockchain technology. Further into the future, the texture of daily life for individuals at work and play will have been changed by blockchain, including the way in which people think about societies and economies (Institute for the future, 2017).

Expectations include that blockchain will be used as a platform to collect taxes; that it will make it possible for immigrants (or transient labour) to send money back home

(via cryptocurrency) in places where access to financial institutions is inadequate; and that it will significantly reduce financial fraud as each transaction will be documented and disseminated on a public ledger, accessible to anyone with access to an internet connection (Montresor, 2016). The insurance industry could similarly be transformed as it is conceivable that insurance claims be processed by means of automation, with blockchain policies that immediately pay claims constructed on pre-set data from a trusted third party, thus further improving access to information and mitigating administrative overheads (Baweja et al., 2016).

Although the billions of smart devices linked to the IoT could potentially transform cities, homes and lives, these devices do, at the same time, create serious potential security threats. Any integrated security model in use today will struggle to scale up to meet the demands of IoT, especially as the devices are usually designed to be tiny and inconspicuous, meaning that to extract them from circulation could be challenging, especially if they are captured in a botnet or 'go rogue' (Compton, 2017). Blockchain can assist in alleviating these security concerns, can further facilitate third party verification and, finally, can also assist in avoiding several inputs of the same data across IoT devices (Eastwood, 2017). The technology provides reassurances that the information is authentic and that the system introducing it is well-defined. With the power of cryptographic processes as its basis, blockchain offers a fascinating alternative and, as it is designed for distributed control, and added benefit of building a security system on blockchain is that it should be more scalable than a traditionally constructed system (Compton, 2017). Compton (2017) further indicates that blockchain's robust safeguards against data tampering would help to avoid the potential of disruption from misleading data transmitted by a rogue device in a factory, home or transportation system.

Blockchain is, however, in its infancy and major obstacles to commercial implementation still remain. Firstly, blockchain is fragmented; secondly, it still requires substantial input from regulators; and the third hurdle is that of scalability. The blockchain is, by design, massively power 'hungry', so more effective utilisation of power will be key to the development of larger blockchains (Kemp, 2016). Despite these obstacles, the potential uses and ubiquity of the system are enormous.

3.6 SHORT TERM FUTURE TRENDS

The IoT is revolutionising the world, with a recent McKinsey report foreseeing that almost 50 billion objects worldwide will be connected by 2020 (Williams, 2017). Williams (2017) examines some of the significant IoT trends linking the physical and digital worlds, and the potential for these to open new and thrilling prospects in industries such as healthcare, retail, farming and entertainment. What these trends also indicate is the exponentiality of the FIR, how rapidly new trends are introduced and how equally quickly these also become 'old'. Some of the most noteworthy trends include the following:

Voice controlled devices

These wireless devices are capable of a myriad of voice-interaction options, including the capability to play back music, create to-do lists, set alarms, stream podcasts, play audiobooks and provide concurrent useful information like weather, traffic and news (Williams, 2017).

Invisible retail world

The online retail sphere provides an example of how IoT can turn a consumer's ordinary routine into an invisible retail world, as the system functions as a one-click ordering system for everyday products such as pet food, domestic supplies, beauty supplies and baby products (Williams, 2017).

Fitbits, smartwatches and health devices

A study released by Parks Associates revealed that demand for wearables and smart watches is growing as healthcare tools are increasingly integrated with other IoT applications, thus providing significant growth opportunity for both manufacturers and app developers (Williams, 2017).

Social virtual reality (VR) experiences

Socially-enabled VR experiences are engaging with audiences in new and exciting ways (Williams, 2017).

Connected cars

Consumers are growing to expect more connectivity in their cars, but pricing, safety, and data privacy concerns inhibit market growth (Williams, 2017).

Smartphone cash

With billions of smartphones being sold globally, smartphone users are using cashless payments more frequently, and more and more retailers and businesses are supporting smartphone-enabled payment methods (Williams, 2017).

Connected clothes

Smart clothes are set to be the next biggest disruptive force of IoT as some 10 billion products, with distinctive digital characteristics and data profiles, will be hosted in the cloud by manufacturers. Levi's has combined with Google to release a smart-connected denim jacket for cyclists, permitting them to regulate their apps to help with navigation or to play music. Other manufacturers offer a line of smart shirts, along with a 'smart bra' that has implanted biosensors to record heart rate and breathing (Williams, 2017).

Smart toys

Companies have released wirelessly-connected toys that allow parents to stay connected with their children by sending voice messages over Wi-Fi via phone. These toys further assist parents to digitally establish a trusted circle of friends, so that youngsters can connect with their parents, grandparents or other family members who want to keep in touch (Williams, 2017).

Connected cows

A cow-monitoring system developed by an Israeli tech firm provides farmers with the ability to increase milk production and streamline the calving process to ensure that farmers maintain an edge over the competition (Williams, 2017).

Solar roadways

This is a modular system of individually engineered solar panels that can substitute roadways of every kind, from paving to asphalt. The surfaces even contain LED lights to generate lines and signage without the need for paint (Williams, 2017).

3.7 CONCLUSION

This chapter reviewed the trends that are most prevalent in the market as well as those disruptive technologies that that are turning industries ‘on their head’, so to speak. Consequences of the FIR for these affect industries, both locally and globally, were also considered. The next chapter will provide a review and in-depth discussion of scenario-based planning, scenarios, CLA as a methodology, and other concepts of interest for the FIR in South Africa.

CHAPTER 4
THE SIX PILLARS OF FUTURES STUDIES
"THE PLOT"

4.1 INTRODUCTION

Futures studies have been judged as deficient in a conceptual outline or a foresight methodology, but recent frameworks have been developed with a dynamic theory and practice at their foundation, including Voros' common foresight method framework and the six pillars approach, an offshoot of Dator's Manoa Research Centre for Futures Studies (Inayatullah, 2010a). Foresight can be seen as the essential element of success, since without it humans are unable to prepare and plan for the future. However, despite its critical importance having been proven time and time again, foresight is now much harder to achieve as everything in the world is changing and advancing at a more rapid pace than ever before (World Future Society, 2004).

Gaining an understanding of the uncertainty intrinsic in the external and future environments, and testing the strength of any strategic plan against a set of possible futures, are critical components of long-term and strategic planning. Any level of uncertainty must be evaluated carefully before any organisational, whether private or public sector, decisions can be made (Du Plessis, 2016). The future is unspoilt, promising and rich in potential, while at the same time uncertain and multi-layered. True to its nature, no specifics or evidence of the future exist – although some immediate futures seem probable, others, even if possible, may never materialise – and yet the future matters and not all futures are favoured (European Commission, 2014).

Futures questions are summarised as a response to fear, will, hidden assumptions, preferred futures, alternative futures and next steps (Inayatullah, 2008). These six pillars of futures studies are identified as: mapping, anticipation, timing, deepening, creating alternatives and transforming. They provide a theory of futures thinking that is linked to methods and tools, and refined through practice; they may be utilised as theory or used in a futures workshop environment (Inayatullah, 2008).

4.2 FUTURE MAPPED

Pillar one in futures studies is used to map the past, present and future, as it is through mapping time that it becomes clearer where humanity has come from and where mankind is going (Inayatullah, 2008). The first undertaking in this paper will be to consider and discuss, from a global perspective, the key trends typifying the FIR today and, without endeavouring to predict the future, contemplate the where, the who, the what and the how of the FIR, today and as it progresses into the future. Thereafter, a detailed environmental scan (ES) of the FIR from a South African viewpoint will be performed to identify the forces of the present, and to reveal the quantitative drivers and developments that exist and will have an effect on the future of the FIR. Environmental scanning is defined by Choo (2005) as "*the acquisition and use of information about events, trends and relationships in an organisation's external environment, the knowledge of which would assist with planning the organisation's future course of action*". According to Du Plessis (2016), when "*selecting our future, it is essential to have a handle on the possibilities of the future*".

Alsan and Atilla Oner (2003) point out that in this phase the collation and condensing of data results in strategic knowledge and, additionally, that creativity aids in transforming that knowledge into understanding. Knowledge may be separated into two parts: knowledge looking at the past is 'analysis', while knowledge referring to the future is 'foresight' (Oner & Oner, 2003). The term 'tracking' in this phase was used by Lindgren and Bandhold (2003) as it entails tracing changes in the environment that could possibly impact the fundamental question, and discovering trends, drivers and unknowns that need to be considered since they could have an influence on the central question. A distinct importance of trends is that they offer a link between past and future, permitting the conversion of information about what has happened in the past into knowledge about what might happen in the future (Du Plessis, 2016). This research will attempt to recognise the key trends and happenings leading up to the present and build a historical timeline to the present to ascertain the connections and discontinuations in the history of the IRs.

4.2.1 The evolution from the First to the Fourth IR

Futurists identify that the future world is inextricably linked with the present-day world and believe that one can learn abundantly about what may occur in the future by observing methodically that which is happening now. Significantly, the most important observations should not be of sudden or one-off events, but rather an examination of trends, the continuing shifts in factors such as population, technology, land usage and governmental activities (World Future Society, 2004). For mapping purposes, Inayatullah's (2008) departure point is to consider the ‘‘shared history’’, which is a reflection of the key trends and happenings that have led up to the present and includes the creation of a historical timeline. Questions raised in this process include: What are the continuities in history? What is discontinuous? Has change been stable or have there been jumps in time? Once this framework is complete, it can be used to consider the state of the future.

The first Industrial Revolution mechanised production using water and steam power to create mechanical production facilities, the second used electric power for mass production, and the third used information technology to automate production. The fourth revolution will, it seems, blur the lines between the physical, the digital and biological realms (Falcioni, 2016). While the earlier IRs were driven by rapid developments in automation and connectivity, starting with the technologies that launched the first Industrial Revolution in eighteenth century England through to the exponential increases in computing power today, the FIR is similarly based on the same two forces of automation and connectivity (Baweja et al., 2016). Figure 4.1, below, indicates the timeline from the first IR to the FIR. It is clear that each revolution has progressively shortened in life cycle and the FIR’s cycle is expected to be exponentially shorter than the first three.

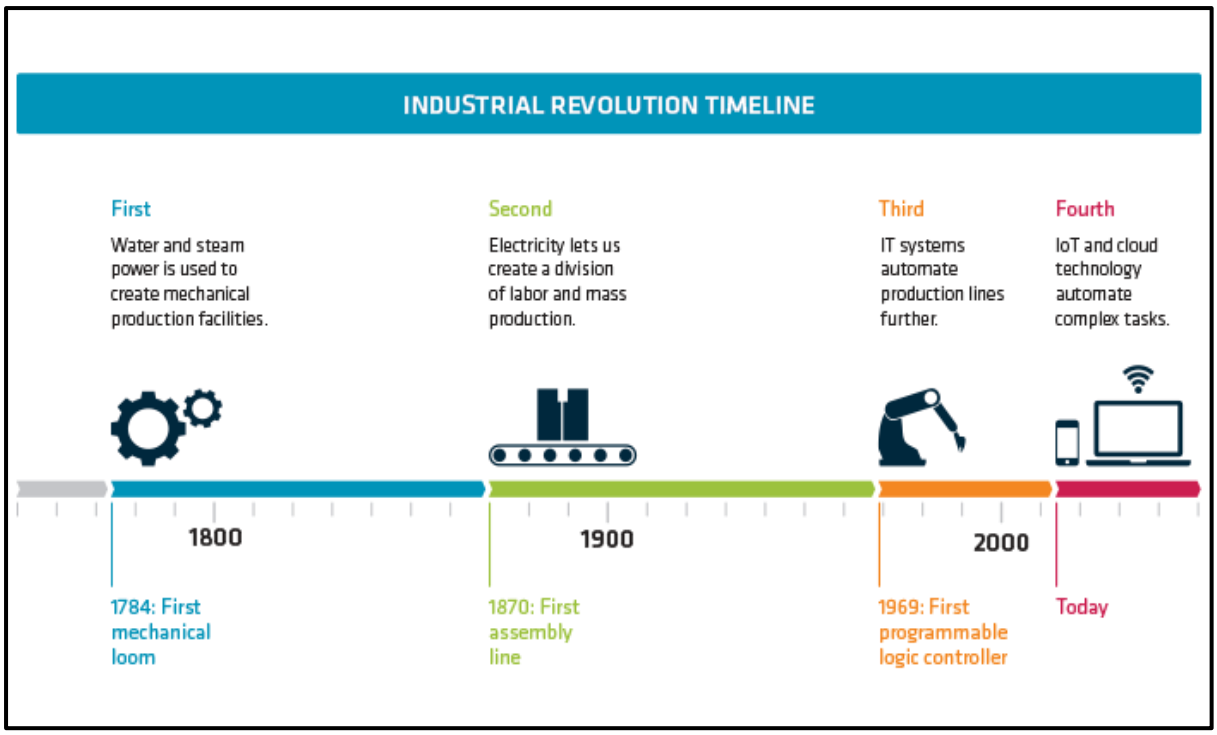


Figure 4.1: Industrial revolution timeline (Source: Mjølner Informatics A/S)

Considering Inayatullah's (2008) conundrum of continuous versus discontinuous histories, it is firstly suggested that connections do exist from one revolution to the next, in that advances in technology have historically resulted in industries moving from being labour intensive to machine reliant. Humans have always been at risk of losing their livelihood, as machines and technologies have made certain tasks redundant with each iteration of IR. From a discontinuous or irregular historical perspective, there has been a defined 'jump' in the duration of each revolution. The timeframes have become progressively shorter as technologies have exerted a greater impact each time - even more pronounced in the FIR.

4.2.2 Global trends shaping the FIR

Cornish (2004) suggests that the extraordinary changes taking place in human life and the swiftness of these changes indicate that something amazing is happening in the world, dubbing this spectacle the "Great Transformation" (Cornish, 2004). According to Du Plessis (2016), the global environment is going through massive changes when it comes to technology, the economy and social institutions. It is easy to envisage the intertwining and connectedness of all these changes and, as a result, to appreciate that the environment is having to deal with an all-encompassing transformation.

Schwab (2016) foresees that the fundamental and all-inclusive nature of the FIR means it will affect and be impacted by all countries, markets, segments and people, while Du Plessis (2016) further espouses that the extensive effects of these interrelated global trends and the impacts among them will reformat and disrupt the economic and commercial landscape, as has been observed in the past. Du Plessis (2016) cites Larsen (2006) in saying that "*global trends are the great forces in societal development that will very likely influence the future in all areas for many years to come*" and, furthermore, that these trends embody knowledge about the probable future. Table 4.1, below, summarises some of the recent major global trends that have been identified by leading publications and organisations.

Table 4.1: Summary of global megatrends

Source	Global megatrend
McKinsey & Company	Mobile internet Automation of knowledge work The Internet of Things Cloud technology Advanced robotics Autonomous and near-autonomous vehicles Next-generation genomics Energy storage 3D printing Advanced materials Advanced oil and gas exploration and recovery Renewable energy
EY	Digital future Entrepreneurship rising Global marketplace Urban world Resourceful planet Health reimagined
PwC	Artificial intelligence Augmented reality Blockchain Drones Internet of Things Robots Virtual reality 3D printing

Organisation for Economic Co-operation and Development (OECD) (Megatrends affecting science, technology and innovation)	Demography Natural resources and energy Climate change and environment Globalisation Role of governments Economy, jobs and productivity Society Health, inequality and well-being

Source: McKinsey & Company, 2013; EY, 2015; PwC, 2016; OECD, 2016

It is important, then, to consider and expound on a selection of these global trends that will aid in revealing the drivers, uncertainties and possible issues uniquely influencing the FIR landscape of the future.

4.2.2.1 Digital future

A recent report by EY (2015a) identified six megatrends considered to possess the capacity, both now and in the future, to disrupt and rearrange the world in astonishing and unexpected ways. Disruption is occurring across all areas of business and geographies, empowered by the merger of mobile, social, big data, cloud and a rising demand for ubiquitous access to data (EY, 2015). These developments have massive repercussions for investors, the global economy and the relative competitiveness of developed and emerging nations (Baweja et al., 2016).

4.2.2.1.1 Impact of the digital revolution on business and revenue models

According to EY (2015), disruption is happening across all industries and in all geographies, providing opportunities for enterprises to benefit from the enormous volumes of information from the devices connected by the IoT, to move in new markets, to transform existing products and to introduce new business and delivery models (EY, 2015). New business models are indeed being encountered as emerging technologies come to life, along with ethical, safety and social issues (Schwab, 2016a). As evidence of the continual shift and adaption of business models, a survey in 2015 by the Economist Intelligence Unit (EIU) revealed that up to 80% of companies are experiencing or observing changes in the manner in which customers access services and goods, and in excess of 51% are, as a consequence, altering the way in which goods and services are priced and delivered (EY, 2015). This shift is therefore forcing businesses to adapt and adjust to remain relevant and is, at the same time,

resulting in new business models, new companies, new products, new actions, and new means of surviving in the world today (Morgan, 2014).

4.2.2.1.2 Diminishing PC usage and growing mobile device acceptance

The use of mobile technology is catapulting over that of fixed broadband in several countries, especially in emerging markets. Webpage views from mobile phones now outstrip those from PCs in 48 countries and Ericsson estimated in 2015 that the then-two-billion mobile broadband connections would swell to nearly eight billion by 2019 (EY, 2015). Some companies have started to test the next generation of broadband networks in anticipation of this need, for example, Google Fibre in Kansas City, which is virtually a hundred times faster than currently available commercial high-speed broadband (Manyika et al., 2013).

4.2.2.1.3 Digital revolution and an explosion of data are altering businesses and customer relationships

Exceptional opportunities are available today to help companies recognise consumer requirements, preferences and actions, as the volume and forms of customer data from sources like social media, online spending trends and geo-location information are growing exponentially (Manyika et al., 2013). Persistent monitoring and BD produces vast quantities of fresh information to assist with new research methodologies and customer behaviour science, and thus support a business's sustainable growth plans (OECD, 2016). Businesses that can extract significance from this data using data mining and data analytics will benefit most, deriving subsequent competitive advantage by understanding customers, and subsequently ensuring the tailoring of services and products to each individual (EY, 2015). Manyika (2017) states that a number of businesses struggle to change from legacy data systems to a flexible and agile architecture that can extract the maximum out of BD and analytics, and suggests that businesses may be required to digitise processes more fully so as to capture essential information from customer contacts, equipment, supply chains and internal practices. Along with the gathering and analysis of BD comes the responsibility of maintaining the confidentiality and integrity of this data, as the increasing significance of BD presents specific challenges for governments and companies in the potential abuse of massive, distributed BD systems (Hewlett-Packard, 2013).

4.2.2.1.4 Digital disruption is altering the market environment and competitive context of most industries

Technology can no longer be seen as a stand-alone industry as it continually and dramatically reshapes almost every industry, with the ubiquity and influence of fresh technologies distorting sector frontiers as companies develop their own digital solutions and strategies (EY, 2015). Established corporations are continuously exposed to additional pressure from emergent disruptors and pacesetters from other countries and industries, and, consequently, new technological upheavals stimulate further disturbance (Bloem et al., 2014). In order to remain competitive, businesses must adapt their services to capitalise on mobile networks, which often necessitates substantial investment, although the reduced barriers to entry in launching a mobile-based online business make it easier for disruptors to challenge traditional online companies (Manyika et al., 2013).

Companies, not ordinarily considered to be technology players, are now establishing their own digital platforms in the marketplace, offering novel solutions to meet the distinctive requirements of partners and customers (EY, 2015). In several sectors, corporate competitors will follow different methodologies and will not divulge details around their strategies or progress for fear of losing a competitive advantage (International Energy Agency, 2014). However, as this technology ecosystem explodes, industry participants will start to purchase and implement digital technologies from competitors, while at the same time competing with current technology business partners offering comparably vertical solutions (EY, 2015).

4.2.2.1.5 Cyber threats are making it tougher to protect information, intellectual property and personal data

Data breaches are increasing in both size and regularity, with five of the ten major instances occurring in 2013 and 2014, with the theft of information and other practices of cybercrime, taking a substantial economic toll on industries and countries alike (EY, 2015). As individuals, humans instinctively recognise the importance of privacy, yet the tracking and sharing of data about individuals is a critical part of this new connectivity, and so the discussions and important concerns such as the effect on people's innermost lives and the loss of control over data, will only deepen (Schwab, 2016c). According to EY (2015), the Centre for Strategic and International Studies

estimates digital criminality and intellectual property theft at between $375 billion and $575 billion per annum – an amount greater than the annual GDP of many nations (EY, 2015).

The transformation to a more globally connected world leads to increased security fears and could perhaps trigger new international arms races, likely to impact government expenditure on science, technology and innovation, however governments will continue to collect and gradually make available the vast amounts of data that are so valuable for innovation and research (OECD, 2016). As has been suggested in the previous chapter, while governments have demonstrated support through investments in research, they still need to address the policies and concerns surrounding the protection of data (Manyika et al., 2013). Privacy concerns will continue to be crucial, as biotech and AI revolutions will require the redefinition of what it means to be human by pushing back the existing thresholds of life span, health, reasoning and capabilities, forcing people to reassess their moral and ethical limitations (Wells, 2016).

4.2.2.1.6 Nimbler workstyles and the means to employ talent in the digital realm

Certain industries, like mining and manufacturing, still necessitate workforces that are time- and site-bound, however it is becoming increasingly commonplace for workers to be virtual, connecting flexibly to the office anytime, from anyplace and on any device (EY, 2015), although the effect on work-life balance of this arrangement is still uncertain (OECD, 2016). These changes will generate new challenges as leaders now need to keep workforces that are spread over vast geographies engaged, productive and content, which will require different management and organisational skills sets and possibly make organisational cultures difficult to uphold (EY, 2015). Companies will gradually connect and team up remotely with freelancers and independent workers via digital talent platforms (World Economic Forum, 2016). Advances in technology are making it easier for businesses to access networks of anonymous workers by means of virtual crowdsourcing and freelance platforms. In using these models, companies are principally becoming ‘network orchestrators’, linking skills and resources as required rather than having to possess and maintain them (EY, 2015).

4.2.2.1.7 Digital and robotic technologies will progressively supplement or replace workers

While the replacement of jobs by machines has been a trend since the first IR, it is anticipated to quicken substantially in the coming ten to twenty years (Chen, 2017). Historically the focus of automation has been on tasks that are routine and repetitive, however progress in technology is seeing the mechanisation of other classes of jobs, together with some that were previously considered safe from replacement (EY, 2015). Baweja et al. (2016), too, concur that low-skilled employment will, in all likelihood, continue to contract and there will be a growing assortment of middle-skilled jobs that will become susceptible as automation is rolled out, which, as Marr (2017) suggests, may further include the roles of professionals, such as paralegals, diagnosticians and customer service representatives. Whereas individuals at the upper end of the skills continuum may profit significantly, a greater number of people will be consigned either to lower-skilled jobs that cannot easily be automated, or simply to the unemployment line, which will place a substantial burden upon governments and social structures. Healthy, responsive educational systems are therefore required to develop and re-skill labourers to function in the new surroundings (EY, 2015). What should also be noted, as Dmitriev et al. (2016) point out, is that the FIR will create fewer new jobs in new sectors than the previous three IRs (Dmitriev et al., 2016).

4.2.2.2 Role of government

Governments continue to play a vital role in ensuring scientific self-sufficiency and in supporting essential science (OECD, 2016) to maximise innovation. For the most part, however, as their fundamental role of conducting policy diminishes due to new sources of competition and the reallocation and decentralisation of power brought about by technologies, governments face pressure to change their existing methodology to civic engagement and policymaking (Schwab, 2016c). Governments are therefore attempting to innovate, initiate experiments and rely more and more on digital technologies for policy design, delivery and assessment (OECD, 2016).

The biggest gains from the FIR are expected to be seized by those countries with adaptable economies, which further incentivises governments to cut red tape and barriers to trade (Baweja et al., 2016). Policymakers need to make use of mobile internet access so as to improve services, increase efficiency and drive economic

expansion (Manyika et al., 2013). The internet is a potent tool with which to increase transparency, automate income collection, streamline service supply, and deliver efficiency improvements (Giyose, 2014). Governments also play a central role in fast-tracking the implementation of mobile internet access by backing basic research and assisting in breaking down major barriers, such as scarce bandwidth (Manyika et al., 2013).

4.2.2.3 Blockchain and cryptocurrencies

Digital technologies will continue to disrupt many sectors, including financial services, lending platforms, online payment mechanisms, equity crowdfunding, cryptocurrencies and blockchain (OECD, 2016). As described earlier in this paper, blockchain is a distributed or shared electronic ledger that utilises software algorithms to record and approve trades or transactions reliably and anonymously (Curran et al., 2016). Blockchain is an example of extreme connectivity, relying for its very existence on the interconnections between a great number of computers (Baweja et al., 2016). Prior to blockchain, people depended on 'reliable' institutions such banks to act as intermediaries in their transactions, but now blockchain can act as that trusted expert on all types of operations (Montresor, 2016). As the system that underpins the cryptocurrency Bitcoin, blockchain further has the potential to improve transparency and confidence, while at the same time reducing transaction charges (Baweja et al., 2016). According to Isa (2017), cryptocurrencies are essentially digital assets that use decentralised technologies that enable users to anonymously effect secure payments of any value, anywhere in the world with minimal fees and without the involvement of banks or any central authority (Isa, 2017). The uses for this type of technology are limitless.

The disadvantage to these positive aspects and opportunities, however, is the so-called 'dark web'. In this domain, cryptocurrencies have become the payment of choice for illegal and criminal activities, such as drug dealing, tax evasion and money laundering, and policymakers are in a predicament about how to control and regulate the industry (Isa, 2017).

4.2.3 Emerging drivers shaping the FIR in South Africa

South African companies are hindered by legacy systems and technologies, corporate structures, business models, as well as investments in archaic infrastructure – and all this with a workforce that might not be equipped for the FIR that is already happening across the globe (Accenture, 2017a). From a South African perspective, the FIR brings its own challenges and influences that need to be identified and managed. These include (i) processing power and big data, (ii) the changing nature of work as it becomes more flexible, (iii) the middle class in emerging markets, (iv) mobile internet and cloud technology, (v) geopolitical volatility, (vi) climate change and natural resources, (vii) sharing economy and crowdsourcing, and (viii) new energy supplies and technologies (World Economic Forum, 2016). Some of these factors will be discussed and elaborated upon below.

4.2.3.1 Processing power and big data

Big data (BD) is one of the main challenges faced by present-day science and business. As the equipment and performances progress, more and more data is created, with the result that businesses are struggling to keep up with the speed of technological progress and the overabundance of this data (Mail and Guardian, 2016). Evolving from the computer science and machine learning laboratories into various practical everyday scenarios, BD is gathering momentum in every aspect of operation, increasing productivity, consumer marketing and venturing into new markets (Alkhatib et al., 2014). The South African government recognises the importance of managing and embracing the concept of BD. At the unveiling of the Inter-University Institute for Data Intensive Astronomy (IDIA) - a partnership between the University of Cape Town, North-West University, the University of Pretoria and the University of the Western Cape - the Minister of Science and Technology Naledi Pandor said that South Africa's venture in and focus on BD data was "*not only due, but crucial if South Africa is to play a significant role in the world economy in the coming decades*" (Mail and Guardian, 2016).

The Mail and Guardian (2016) further elaborates that IDIA is leading the African Research Cloud (ARC) (which is principally set up as a platform for data-intensive research), with the aim of creating a continent-wide platform, and is about demystifying BD, permitting individuals, particularly learners and researchers, to interact with the

data. One of the big beneficiaries of ARC will be the Square Kilometre Array (SKA) project, which, upon completion, will be the biggest radio telescope in the world, spanning thousands of dishes and antennas, and producing more data in one day than is presently on the whole of the internet, (Mail and Guardian, 2016). SKA is as much a supercomputing system as it is a telescope and will necessitate the development of supercomputers faster than any currently in existence (Adam, 2016).

4.2.3.2 Changing nature of work, flexible work

It is estimated that between 35 and 50 percent of jobs that exist today are at risk of being lost to automation (Marr, 2017). Low-skilled employment will, in all likelihood, continue to contract and there will be a growing assortment of middle-skilled jobs that will become susceptible as extreme automation is rolled out (Baweja et al., 2016). Modern AI systems are now capable of dislodging humans in professional practices such as accounting, engineering and law, which have traditionally relied on the intense, narrow knowledge of experienced subject-matter experts (Stuart et al., 2015). In South Africa there are similarly persistent observations that the introduction of advanced technologies and automation in the manufacturing sector either does not create new jobs or actually leads to job losses (Williams et al., 2014). There is anxiety about the necessity to 'protect' low-skill workers, which should not be unexpected in a labour market where high levels of unemployment are driven by an absence of education and skills (Adão, 2016). Williams et al. (2014) further assert that in spite of advanced manufacturing being acknowledged globally as key to reversing deindustrialisation and generating decent, well-paying jobs, there are persistent objections regarding the adverse correlation between technological progress and employment, which has created opposition to the adoption of forward-thinking manufacturing practices. These opinions are clearly evident in South Africa against the background of deteriorating employment and a decreasing manufacturing growth rate as a proportion of domestic growth, where antagonistic management-worker labour relations are contributing to current and anticipated job losses as a result of mechanisation (Williams et al., 2014).

This may place substantial pressure upon government and social systems, and will necessitate vigorous, flexible educational systems to improve and retool workers to function effectively in the new setting (EY, 2015). The capacity to adjust and change

swiftly in reaction to advanced technologies necessitates a high degree of organisational agility but, at the same time, South Africa is experiencing a myriad of structural and cultural obstacles as well as social problems, which may impede or interrupt businesses and government from completely integrating technologies into the economy, so that they may eventually derive the possible benefits of development and competitiveness that these technologies offer (Accenture, 2017a).

4.2.3.3 Mobile internet and cloud technology

Progressively competitively priced and capable mobile devices and internet connectivity have meant that internet-enabled portable devices are no longer a luxury for a few, but have become a way of life for billions of people who now own smartphones and tablets (Manyika et al., 2013). Cloud computing is a means of allowing ubiquitous, expedient, on-demand network access to a pool of configurable computing resources (such as networks, storage, servers, applications and other services) that can be speedily provisioned and freed with only negligible management effort or service provider interface (Abrahams & Schofield, 2015). Rapid developments in cloud computing, linked devices, mobile, social media and data analytics are encouraging many enterprises to reconsider fundamental features of their business, including their product and service offering, delivery methods, and operational sustainability (EY, 2015).

A study done by the International Data Corporation (IDC) indicated that cloud migration is in the strategic plans of the majority of South African companies who are either migrating now, or plan to do so in the very near future, but some businesses have been slow to adopt cloud technology due to a lack of local infrastructure, data protection concerns and conservative investment strategies (Nebula, 2017). Abrahams and Schofield (2015) believe that governments have a key role to play in encouraging the use of cloud computing, but other major challenges facing the progress of cloud computing include a lack of universally accepted standards and issues surrounding interoperability (Abrahams & Schofield, 2015).

4.2.3.4 New energy supplies and technologies

Energy storage (EnS) technology, described earlier as comprising batteries and other systems that store energy for future use (Manyika et al., 2013) can be disruptive in

both industries and communities, with the potential to deliver power, and hence opportunities, as never before. The South African government has acknowledged that independent power producers should be permitted to enter the market to increase the country's power generating capability (Barton, 2015), and Wilkinson (2017) is still buoyant that, in the long term, EnS will become ubiquitous in both small- and large-scale energy practices, motivated mostly by the economic paybacks it offers, and even without state funding.

4.3 ANTICIPATION

When anticipating the future, data gleaned during the mapping stage is interpreted through the analysis of emerging issues to detect areas in which new social innovation arises (Inayatullah, 2008). Anticipation of the future is grounded on identified assumptions and therefore does not challenge its validity (Gould, 2008). Inayatullah (2008) stresses that the process looks to identify issues before they become unmanageable and costly, and, at the same time, seeks new opportunities and possibilities, while also considering emerging issues that could also include disrupters. According to Gould (2008), in this process the objective is also to imagine the likely path of current difficulties or issues and what possible futures these issues could create. This will lead to the discovery of responses to fundamental questions that are crucial to the creation of foresight (Du Plessis, 2016). In this study, such questions include:

- What does the FIR really mean for South Africa's technology industry?
- What are the possible issues that could challenge the realisation of the future of South Africa's technology industry?
- What can be done about these issues today?

4.4 TIMING THE FUTURE

The third pillar of Inayatullah's six pillars of futures studies is that of timing the future, which refers to the pursuit of the grand patterns of history and the identification of the models of change (Inayatullah, 2008). Macrohistorians and grand thinkers have

wrestled with these questions for thousands of years, with these foundational ideas and differing opinions resulting from their thinking:

- The future is linear, stage like, with progress ahead; through hard work people will realise a good future (Inayatullah, 2008);
- The future is cyclical, and those 'at the top' will one day find themselves 'at the bottom'. Those on top are unable to adapt and adjust as the world changes, as their success was based on a mastery of yesterday's conditions and few are able to reinvent the necessary basic values (Inayatullah, 2008);
- The future is spiral, with parts that are linear and progress based, and parts that are cyclical. Leadership that is courageous and has foresight can create a positive spiral. The beliefs of the past are challenged but the past is not rejected; rather it is incorporated in a march toward a better future (Inayatullah, 2008);
- New futures are regularly driven by a creative minority challenging the idea of a used future, and who, instead of imitating everyone else, would rather innovate – whether that be social, political, cultural, spiritual or technological innovation. These change agents imagine a different future and they inspire others to work toward it (Inayatullah, 2008).

There are critical periods in human history when the action of a few can have a dramatic impact, and it is in these periods that old ways of behavior are no longer helpful – something that performed well before no longer works in the altered reality (Inayatullah, 2008). Timing the future therefore concentrates on the judicious use of macro- and micropatterns of modification to better impact social truth (Inayatullah, 2010a).

The FIR in the South African context is confronted by a number of complex challenges and problems, including infrastructure constraints, the impact on labour, a lack of skills, regulatory uncertainty, the impact on the fiscus and inequality**.** While the FIR is decidedly relevant, it does not deal with the unrelenting realities of increasing inequality and growing unemployment in many developing markets, including South Africa (City Press, 2016). The concept of a used future must be challenged through social, environmental and technological innovation in imagining a transformed future and consequently inspiring the various technology industries to work towards this desired future (Du Plessis, 2016). According to the report by the National Planning

Commission (2011), the evolution to new energy technologies, advances such as the convergence of nanotechnology, information technology, biotechnology and cognitive science in new forms will undoubtedly reshape societies, economies and the way of life. It is similarly critical that a collective undertaking and push for transformation is supported by formal change, and a transparent policy and regulatory environment (Du Plessis, 2016). Moreover, many of South Africa's challenges, such as managing water and ecosystems, reducing the effects of climate change and developing infrastructure (road, rail, water, energy, technology and broadband) require both a regional perspective and regional initiatives (National Planning Commission, 2011).

Government and industries will need to be courageous and accept that the FIR is a reality and late starters will be at a complete disadvantage to the rest of the world. As part of the solution to become and remain competitive, management will need to be innovative, exhibit entrepreneurial boldness and implement economic incentives to drive change (Balkaran, 2016). To remain viable into the future, industries must reinvent themselves and transform if need be, adapting to changing market conditions with new innovative strategies in a world where rapid change, uncertainty and complexity are the new standards (Du Plessis, 2016).

4.5 DEEPENING THE FUTURE

Futures studies are uniquely positioned to address the use of techniques like causal layered analysis (CLA), which allows for the systematic and in-depth exploration of problems (Kotze, 2010). Derived from theories of poststructuralist discussion, and developed by Inayatullah (1998), CLA provides a basis for evaluating the social hypothesis of the 'real' and proposes a layered approach with which to analyse the results of the key focus areas of research (Inayatullah, 1998). Puglisi (2001) explains that the CLA method assumes four levels of analysis:

- The **litany** is a study of future trends and issues, mainly in terms of features that are frequently disconnected; here assumptions are rarely questioned.
- The **systemic view** looking at social causes and analysis that gives understanding to qualitative data, including social, cultural, economic or political factors.

- The **discourse or worldview** is a deeper level of analysis and is linked with discourses and debates surrounding, for example, globalisation procedures, population and consumption discussions.
- The **myth or metaphor** refers to the deep ‘stories’, the unconscious dimensions of a problem or dilemma (Puglisi, 2001).

These four levels are used by futurists to find the full array of stories, the conscious, unconscious and emotive view of the issues. CLA’s ability to create new ways of knowing by interpreting and reinterpreting issues and their solutions provides a rich method for the analysis of scenarios and case studies (Gould, 2008).

According to (Puglisi, 2001), CLA uses various forms of knowledge, incorporating the analysis of non-textual and poetic or artistic expression with sets of knowledge from other civilisations in the futures processes, on the assumption that it is not only the visions of the future that shape our actions but also the ways in which those visions are shaped and the ways in which problems are framed. CLA opens up space for the delivery of constitutive discussions, which can then be shaped as scenarios. CLA can categorise the many different perceptions of realities while remaining sensitive to horizontal and vertical spaces (Puglisi, 2001). In other words, CLA is a search for integration in methodology, seeking to combine different research traditions (Inayatullah, 2005). What is evident, according to Inayatullah (2004), is that CLA enables and encourages the advent of authentic alternate scenarios and preferred futures (Du Plessis, 2016). Consequently, it is crucial to deepen the exploration into the future of the FIR in the South African environment by probing the underlying stories, assumptions, social causes, metaphors and worldviews about the South African technology across various industry and sectors.

4.6 APPLICATION OF CAUSAL LAYERED ANALYSIS

Causal layered analysis (CLA) comprises four layers, with each step change probing deeper than the previous (Kotze, 2010). The ability of causal layered analysis to transcend language and cultural barriers, and bring people from different backgrounds together, positions it well to overcome not only the challenges around open mindedness but also the challenges stemming from information ‘stickiness’, thus

providing a platform for eliciting and capturing the wealth of tacit knowledge held by participants (Kotze, 2010). This method has been developed in order to explore the world of the alternative futures, investigating both the present and the past with a multidimensional approach (Puglisi, 2001).

According to Inayatullah (2005), CLA is best applied prior to the development of scenarios or strategies, because it 'opens up' a vertical space for scenarios of differing categories. Some benefits of this methodology are:

- It encompasses and enriches the scenarios to be used in the selection;
- The 'deepening' of the future, when used in a workshop setting, leads to different dimensions of knowledge among the participants involved;
- It appeals to a broader range of people as the use thereof incorporates a non-textual and almost artistic expression in the futures process;
- It layers participants' opinions and positions, both conflicting and harmonious ones;
- It moves away from debate and back-and-forth discussion, beyond the shallow and obvious to the marginal and deeper;
- It caters for a range of transformative activities;
- It leads to policy activities that can be derived from alternative layers of analysis; and
- CLA re-establishes a vertical form of social analysis, which is derived from postmodern relativism to global ethics (Inayatullah, 2005).

In this study, the application of CLA is based on the reviewed literature on the FIR and the determination of possible futures. The CLA completed under three headings, described in tables 4.2, 4.3 and 4.4, below, as follows:

- Table 4.2: CLA – Understanding the readiness of private and public sector for the FIR – **'Infrastructure uncertainty';**
- Table 4.3: CLA – Understanding the readiness of private and public sector for the FIR – **'Labour and the economy';** and
- Table 4.4: CLA – Understanding the readiness of private and public sector for the FIR – **'A sustainable society'**.

Table 4.2: CLA – Understanding the readiness of private and public sector for the FIR – **'Infrastructure uncertainty'**

CLA Level	Societal Approach
Litany	Uncertainty about progress being made in South Africa to embrace the FIR, with the prospect that the country is lagging behind the rest of the world with respect to FIR technology infrastructure and implementation.
Social Causes	Adequacy of the South African technological infrastructure to support the FIR and the subsequent demand as business opportunities emerge, creating the likelihood of an uncertain or unsupportive regulatory environment that could be harmful to the effective growth of the FIR components.
World View	From the South African stakeholder view, the private sector (representing government) and the private sector (being business and individuals) need to collaborate to provide the necessary investment funding to ensure that technological infrastructure is built and in place to support the ideological view that economism is achieved.
Myth and Metaphor	Technological singularity – "singularity is near"; in the South African context, is technology the solution to most of the world's problems?

(Source: Author's own construction)

Table 4.3: CLA – Understanding the readiness of private and public sector for the FIR – **'Labour and the economy'**

CLA Level	Societal Approach
Litany	Assessing the current impact (or lack thereof) of the FIR on the South African labour and technological environment and further determining South Africa's dependency on the technological sector to drive economic development.
Social Causes	Considerable loss of employment and income due to the introduction of FIR disruptive technology, especially around AI and automation,

	further creating problems with the ease of doing business in South Africa as a result of the FIR.
World View	From the South African stakeholder view, the private sector (representing government, trade unions and educational institutions) and the private sector (being business and individuals) need to collaborate to increase employment and job security, while at the same time growing the economy, thereby supporting the ideological view that economism is achieved. All participants need to further consider the additional ideological view of the plurality of blockchain as the vehicle to bring AI and IoT to South Africa.
Myth and Metaphor	Technological singularity – "singularity is near"; will the consequence of AI and automation lead to total job losses and replace the need for human interaction and intervention?

(Source: Author's own construction)

Table 4.4: CLA – Understanding the readiness of private and public sector for the FIR – **'A sustainable society'**

CLA Level	**Societal Approach**
Litany	Sustainability of the FIR and possible contribution to societal and communal development
Social Causes	The societal appetite for the FIR and related technology by the private and public sector
World View	From the South African stakeholder view, the private sector (representing government and educational institutions), the private sector (being business and individuals) and religious institutions need to collaborate to minimise the impact of the FIR on the 'humanism' of individuals and further need to contribute to the development of communities, thereby supporting the ideological view that sustainability is achieved.
Myth and Metaphor	Technological singularity – "singularity is near"; will robots take over the world? "the Vernor Vinge effect" (researcher's own term)

(Source: Author's own construction)

4.6.1 Litany

The '**litany**' level of analysis is the sanctioned public narrative of the issues (Inayatullah, 1998) or the day-to-day future, the frequently established headlines of how things either are or ought to be (Inayatullah, 2008) and in which issues, events and trends are not connected but appear discontinuous (Inayatullah, 1998). Nevertheless, this research has recognised that the progress made in technologies in the FIR has strongly highlighted the realities that are evident in the litany layer. Slaughter (2002) corroborates this by indicating that technology is one of the key trends in the litany layer. This layer is known for quantitative developments and difficulties, which are misused by the media and politicians thereby resulting in high public visibility (Kotze, 2010). Owing to their political nature, these developments or problems are inclined to just as rapidly fall out of vogue, to be replaced by some other new trend. Little to no analysis is completed at this level, as data and trends tend to be considered as fact (Kotze, 2010).

Technology is the central component in the FIR and this phenomenon is considered disruptive, not only to individuals but also to business (Ofir, 2016). Technology may thus be viewed in terms of both its potential economic impact and its capacity to disrupt; these effects go hand-in-hand and both are of critical importance to leaders (Manyika et al., 2013). The FIR is a global trend that will result in new ways of creating value, novel business models, and increased networking and collaboration between several partners in international networks of value creation (Sendler, 2013). There is uncertainty as to just how the FIR will unfold, however one thing is clear: the critical response must be integrated and comprehensive, involving all stakeholders of the global society, from public and private sectors to academia and civil society (Schwab, 2016c). The repercussions for nations and businesses that do not embrace and adapt to the occurrence are gloomy (Pretorius, 2016), however, thus far, only a few global investors and leaders have noticed and reacted to the revolution. Already, they have reaped the benefits, so, in order not to be left behind, South African business leaders, economists, educators and investors too, must reassess and adjust to this phenomenon (Beck & Schwab, 2016).

This research has highlighted the first issue on hand - **uncertainty about the progress being made in South Africa to embrace the FIR** - revealing that, despite the apparent slow progress in the acceptance and embrace of the FIR, certain pockets or departments in the South African government have acknowledged the importance and potential impact of the FIR on the country. Minister of Trade and Industry, Dr Rob Davies, speaking during the 'Investment Dialogue' session of the 2017 'Investing in African Mining' Indaba programme in Cape Town, acknowledged that the FIR will offer new opportunities to achieve inclusive and sustainable growth by fast-tracking market integration in Africa through industrial corridors and regional integration. Davies further added that the effects of the FIR will not be limited to the manufacturing arena, but should similarly extend to service sectors, including e-commerce and the legal and accounting professions (Medupe, 2017).

From a business perspective, companies understand both the magnitude of embracing the FIR, as well as the catastrophic impact of ignoring it. What is important to consider, especially for South Africa, is the concept of a digital nation; the country should take note of Kenya's investment into its own 'Silicon Savannah' which is taking that country into the most exciting technology advancement on the African continent (Jacobs, 2016). There is good news in that significant headway is already being made in South Africa, as IoT projects are in progress, including the development of smart cities (specifically Cape Town and Johannesburg), which utilise a number of the disruptive components and technologies of the FIR (Sha, 2017). However, the effective 'smart city rollout' is restricted as there has been no coordinating body or even a set of coordinating regulations to facilitate or assist with the rollout. A further stumbling block for co-ordinated urban planning is the country's volatile politics and ever-changing leadership dynamic (Hubbard, 2017).

Further research was conducted here to consider and evaluate the **prospect that South Africa is 'behind the curve' in comparison to the rest of the world with respect to FIR technology infrastructure and implementation**. In order to complete this evaluation, it is important to understand what infrastructure and plans of action need to be in place for the country and its inhabitants to take maximum advantage of the potential benefits of the FIR. In the view of Schiessl (2016), a large portion of technology and intellectual property (IP) may have originated in developed economies,

but it is perhaps in emerging economies where the changes will be most extreme (Schiessl, 2016). According to the World Bank (2011), broadband internet penetration on the African continent grew from zero at the start of 2000 to almost 19 million in 2010 (which is only about 2% of the population of the continent), with the growth averaging 200% per year between 2005 and 2009, and where South Africa and Nigeria accounted for 80% of the broadband internet subscribers in sub-Saharan Africa (Bankole et al., 2014). A poor technology infrastructure, confusion over exactly how people share data and access information, poor education and an overall deficiency of maths and science skills are still some reasons, however, being cited for Africa's inability to participate in the FIR movement (City Press, 2016).

According to Dobek Pater, managing director of Africa Analysis, some of the challenges that South Africa faces with respect to technology advancement into 2035 include:

- The perceived sluggish headway being encountered in creating an enabling environment for rapid technology advancement, which is considered to be primarily government's domain of responsibility;
- An extreme shortage of the skills necessary to drive innovation, maintenance and the deployment of technologies;
- The deplorable state of the South African economy, which results in reduced levels of disposable income, translates into sluggish adoption and usage rates, and further reduces the acceptance of new technologies by businesses;
- The poor situation of public education, translating into reduced technology literacy rates among the populace;
- Rand weakness versus major global currencies, making the acquisition of technology that much more expensive, which further limits deployment and acceptance rates (Jacobs, 2016).

Unfortunately, South Africa's technology readiness had slipped in the Global Competitiveness Index (GCI) report for 2016/2017, issued by the World Economic Forum (WEF, 2016a). The country scored poorly on the availability of latest technologies (WEF, 2016a), which may indicate that it is lagging behind the rest of the world in its preparations to embrace the FIR. On the positive side, the report reflected

an increase in the number of internet users and fixed broad band internet subscriptions, which is the backbone of the IoT, linking the multitude of smart devices in use.

An assessment of the current impact of the FIR on the South African labour and technological environment (or lack thereof) was the third issue considered by the researcher. The technological changes in all of the digital domains, connectivity, robotics and big data will have a far-reaching impact on the labour market into 2035. A major concern from a South African standpoint is the lack of skills needed to take advantage of the FIR. As highlighted earlier, the poor state of the country's education system perpetuates and exacerbates this skills shortage. A key strategic drive identified by Pretorius (2016) is that organisations across all industries need to invest in the reskilling of current employees as part of their transformation and future workforce planning efforts. Companies are great 'universities' for educating the workforce of the future; investing in the training of employees, interns and apprentices, to drive growth and innovation, usually amounts to specialised instruction and hands-on experience that cannot be obtained at even the most prestigious universities (Benioff, 2017).

With the prodigious growth in AI capabilities, many professions previously considered immune to replacement are now at risk. Modern AI systems are now capable of dislodging humans in professional practices such as accounting, engineering and law, which have traditionally relied on the intense, narrow knowledge of experienced subject-matter experts (Stuart et al., 2015). Banks also utilise machine learning to identify fraud, discover charges or claims outside of a customer's normal buying pattern, and even offer to financial services, such as 'Robo Advisor' which uses AI to propose inexpensive but bespoke financial advice (Manyika et al., 2013). South African examples of these are SmartRand, Bizank and Sygnia RoboAdvisor (Tarrant, 2016).

Despite global acknowledgement that advanced manufacturing may, in fact, be key to reversing deindustrialisation and generating well-paying jobs, there remain persistent observations, noted earlier, about diminishing job opportunities in the manufacturing

sector exacerbated by the introduction of advanced technologies and automation (Williams et al., 2014). Against South Africa's background of deteriorating employment and decreasing manufacturing growth rate, where antagonistic management-worker labour relations further contribute to current and anticipated job losses, in the researcher's opinion, it appears that the FIR may have continued and sustained resistance from the country's unions.

The next issue to be tackled by the research at the litany level is the **sustainability of the FIR and possible contribution to societal and communal development**. Sustainability, along with challenges such as climate change, call for society to become more futures-oriented (McGrail, 2011). The longer term outlook is essential in guaranteeing that a concern for inter- and intra-generation equity is built into planning methodologies (Puglisi, 2001). A sustainable society would demonstrate foresight, have a futures-responsive culture and would be determined and prudent in its futures creation (McGrail, 2011). While society cannot completely control the future, it can influence the course of history by making a worthwhile effort to consider the balance between what is desired and what is possible (Glenn, 2004). In order to be sustainable, the FIR would need continuous and collective support from government, business and society, and would needs to be woven into the daily fabric of routine for all inhabitants into 2035.

Disruptive technologies have the potential to help solve the real problems of poverty and inequality found in growing African cities and fundamentally driving structural transformation (Mtongana, 2016). While the FIR is decidedly relevant, it does not deal with the unrelenting realities of increasing inequality and growing unemployment in many developing markets, including that of South Africa (City Press, 2016). The potentially higher levels of inequality in the short-run and a need for labour market flexibility to harness the FIR benefits in the long-run, would both need to be taken into account to limit the impact of extreme automation (Baweja et al., 2016). Pretorius (2016) mentions that organisations can no longer be reactive in their upskilling of the nation's labour force and, as such, a change in mind-set is needed when upskilling talent, which should simultaneously address societal needs (Pretorius, 2016).

From a community perspective, the concept of smart cities is gaining traction in South Africa as a means to encourage environmental sustainability, and to enhance municipal service delivery and efficiency, as urban developers utilise the IoT to better coordinate and manage a city's or community's assets (Hubbard, 2017).

The last issue researched in the litany layer is **South Africa's dependency on the technological sector to drive economic development**. It may appear challenging for the African continent to be part of the new economic revolution, yet, at the same time, also full of promise since, after years of overreliance on unpredictable commodities cycles, exceptional struggles of structural change are currently being executed across several African economies (Ondimba, 2016). For South Africa, the elements of energy transitions (which includes rising energy prices and a desire for energy security), food security (such as the rising demand for food and consequently higher food prices globally), climate change and new technologies will continue to drive changes in the way societies work (National Planning Commission, 2011). If computers and machines replace jobs, then the capacity to tax labour income will be reduced in the long run, which is likely to mean that the corresponding social costs of taxes, relative to lost employment and lower GDP, will increase (Borg, 2016). This is further confirmed by Burda (2015), who suggests that the long term sustainability of fiscal policy would be undermined by an erosion of taxes and the need for increased expenditures, necessitating a significant cut in the spend on social security, a quick solution for employment of young people, and problems in the social framing of the large number of refugees and migrants (Burda, 2015).

There is the realisation by government of the importance of moving to digital platforms and the need for all sectors of society, government and business to be included in the digital future, but unfortunately the South African government's approach to the acceptance of the digital future has resulted in unnecessary and ultimately counterproductive delays (Jacobs, 2016). There are some who are of the opinion that the mentality for digital advancement is almost non-existent in South Africa, especially as evidenced by the troubled telecommunications sector, which would play an integral role in advancing the South African agenda to further the FIR in the country. A robust telecommunications infrastructure is vital to enhance efficiency, effectiveness and

transparency in institutional and trade activities which would further result in improvements in trade efficiency (Bankole et al., 2014).

4.6.2 Systemic causes

According to Inayatullah (1998), this layer of analysis deals with the systemic causes of the interrelated social, cultural, economic, political, technological, environmental and historical factors of an issue and the causal data. Unlike the litany level, the second level explores the trends and data in an attempt to gain an insight through analysis rather than blind acceptance, and is categorised by the use of technical methods and models constructed on a robust academic foundation (Kotze, 2010). In line with this research, the study at the systemic layer will try to identify drivers and trends that cause the issues accentuated by the litany analysis as they appear to the world and especially to South Africa.

The issues highlighted in Table 4.2, above, will in all likelihood transcend and merge between the social, cultural, economic, political, technological, environmental and historical factors that characterise this layer. The first issue, surrounding the **considerable loss of employment and income due to the introduction of FIR disruptive technology, especially due to AI and automation,** will impact the social, economic, technological and historic elements. Borg (2016) cites estimates from Frey and Osborne, that 40% to 50% of all jobs that presently exist will either be changed or cease to be and further asserts that since the global financial crisis of 2008, the number of new jobs have not been traditional, full-time jobs with full social benefits, but instead have arisen from self-employment, seasonal work, short-term contracts and part-time employment, demonstrating that, ultimately, job security was being weakened (Borg, 2016).

In the WEF 2017 report, ‘The Future of Jobs’, it is suggested that the FIR will cause approximately 7.1 million jobs to disappear over the period from 2015 to 2020 (WEF, 2016). What should also be noted, as Dmitriev et al. (2016) point out, is that the FIR will create fewer new jobs in new sectors than the previous three IRs. From an African outlook, Samans and Zahidi (2017), from the WEF, predict that 41% of all work activities in South Africa are vulnerable to automation, 44% in Ethiopia, 52% in Kenya

and 46% in Nigeria; and employers are already identifying an inadequately skilled labour force as a key limitation to businesses - in South Africa alone, 39% of core skills considered essential across a number of professions are predicted to be completely different by 2020.

Much of the present skills instability is a result of the number of jobs that are becoming more extreme in their use of digital technologies. According to Samans and Zahidi (2017), some of the professions presently trending on the African mainland include the creative industries, 3D designers, food technologists, data center workers and education, care and health workers. The question of competitive advantage springs to mind at this point in the research, where the quality and skills of the workforce will be a critical feature in capturing this advantage (Lapthorne et al., 2013). In order to build a pipeline of future talents, South Africa's educators need to design future-ready curricula that encourage creativity, critical thinking and emotional intelligence and, at the same time, fast-track the acquisition of digital, as well as science, technology, engineering and mathematics (STEM) skills to embrace the way individuals will work and cooperate in the FIR (Samans & Zahidi, 2017). According to the GCI, South Africa ranks 123 out of 138 when it comes to health and primary education, and 77 out 138 for higher education and training (WEF, 2016a), implying that there is an uphill battle ahead for the country's education structure if the FIR is to be effectively exploited into 2035.

One impact of AI, according to Barton et al. (2017), is that China has developed into one of the prominent global centres for AI development, with the nation's enormous population and varied industry mix creating huge volumes of data and offering a colossal market. China's largest tech companies have made substantial R&D investments in AI, having calculated that, by automating places of work with AI, 0.8 to 1.4 percentage points could be added to GDP growth per annum, dependent on the speed of implementation (Barton et al., 2017). Of concern for Samans and Zahidi (2017) is the fact that a much smaller group of African professionals have studied software and hardware software engineering, and even fewer have focused on AI, which does not bode well for South Africa's competitiveness or even just staying abreast with global counterparts. Again South Africa's education system needs to be redesigned to encourage learners to study these specialist career paths.

When the issue of the **ease of doing business as a result of the FIR** is viewed critically, the following factors of economic and political are considered to be relevant and applicable. Ease of business in a country relates to how easy or difficult it is for a local businessperson or foreign business to open and run a business while conforming to applicable regulations (World Bank, 2017). With the onset of globalisation, and with so many countries vying for the same piece of investment pie, the need to stay relevant and investment-attractive is of utmost importance to most countries. Some of the ways in which a country can influence or attract the investment dollar (or euro, pound and, recently, the yuan) is by having a stable political environment, a skilled workforce, proper infrastructure and, finally, the ease with which a corporate can do business in that country. In the GCI of 2016/2017, South Africa ranked 64 out of 138 for infrastructure, 97 out of 138 for labour market efficiency and 28 out of 138 for goods market efficiency (WEF, 2016a). Some of the sub-components' statistics do not make for good reading, if South Africa wants to be a preferred destination for foreign direct investment (FDI): The number of days to start a business in South Africa runs at 125 days (Nigeria 119 days, Republic of Korea 15 days); the number of procedures to start a business is 54 (Nigeria 107, Republic of Korea 11); and the burden of customs procedures 65 (Nigeria 132, Republic of Korea 49) (WEF, 2016a).

While South Africa may be ahead of other African countries, it lags behind some of the major competitors in the global village. In the longer term, it is likely that a significant shift in global economic power will continue with rapid growth in Brazil, Russia, India, China and other middle-income countries where these changes will likely have a significant direct implication for South Africa's economy as well as for the wider African region (National Planning Commission, 2011). The South African government did not score well in the 'instutions' category of the GCI either, with the following positions achieved (out of 138): public trust in politicians, 109; favouritism in decisions of government officials, 115; wastefulness of government spending, 88; burden of government regulation, 106; business costs of crime and violence, 133; reliability of police services, 115 (WEF, 2016a).

According to the World Bank (2017), governments wanting to improve a country's economy and its regulatory environment for various industries need to ascertain how they equate to the regulatory environments of other economies. Some of the challenges faced in doing business in South Africa include dealing with construction permits, getting electricity, registering property, securing credit and protecting investors, paying taxes, trading across borders, enforcing contracts and, finally, dealing with the diverse cultures in the country (World Bank, 2017). A stable political environment is one of the key factors for attracting foreign direct investment (FDI), yet, in the view of the researcher, not enough is being done to rectify the fundamental shortcomings of the political malaise that may indeed deter the FDI so necessary to South Africa's progress.

The world is evolving at an ever-increasing pace, driven by continuing progress in digital technologies and other fundamental enabling technologies and sciences (European Commission, 2016). While the National Development Plan (NDP) is considered the blueprint for initiating and dealing with economic development, the significant influence and swiftness of these disruptive technologies necessitates a reexamination of the implementation of the NDP. Government is less equipped to reap the benefits of the FIR than business, which uses technology to lower costs, please customers and raise profits. The reasons for this include:

- absence of competitive pressure;
- a propensity to reinvent the wheel; and
- an emphasis on technology rather than on society (Balkaran, 2016).

The WEF's 2016 GCI report provides insight into the **adequacy of the technological infrastructure to support the FIR and the subsequent demand as business opportunities emerge**. As far as mobile-cellular telephone subscriptions are concerned, South Africa ranks a respectable 15 out of 138 (WEF, 2016a). However, the country's internet access in schools ranks a poor 111 out of 138, which could prove to be a stumbling block in the eventual drive to improve the education system and take advantage of the FIR via STEM opportunities. When it comes to technological readiness, South Africa ranks an almost respectable 49 out of 138 (WEF, 2016a). When considering these results, it is vital that government examines the shortcomings

in depth, in order to ascertain the processes and changes required to absorb and utilise the FIR into the South African environment.

Business alone cannot determine and manage the effect of the FIR in South Africa; its success or failure will be determined first and foremost by political action, which makes it imperative for leadership to invest in an interconnected, functional infrastructure (Ichikowitz, 2016). Currently, some reasons being cited for Africa's inability to fully participate in the movement include a poor technology infrastructure, the ways in which data is shared and information accessed, insufficient education and an overall deficiency of maths and science skills (City Press, 2016). A robust telecommunications infrastructure is also important to enhance efficiency, effectiveness and transparency in institutional and trade activities, and would further result in improvements in trade efficiency (Bankole et al., 2014). Without adequate investment in skills and physical infrastructure, there is the danger that advanced robotics may disadvantage many and be of advantage to just a few (Ichikowitz, 2016). Accenture (2017a) reports that structural inadequacies hamper the capacity of South Africa's citizens to completely integrate fresh technologies into the economy. Some of these weaknesses include ineffectual innovation systems at a national level, the poor quality of education systems (from primary to university levels), inadequate scientific research bodies, a poor growth-enabling infrastructure, low levels of trust and a deficiency of collaborative approaches, all of which hinder the establishment of an integrated environment (Accenture, 2017a).

The next issue to be considered in this layer is the **uncertain or unsupportive regulatory environment that could be harmful to the effective growth of the FIR components.** If the government does not grasp the importance of the FIR, South Africa is in danger of being left 'out in the cold' while other countries, including those from the African continent, embrace the new phenomenon. The capacity of governmental systems and public authorities to change will determine the country's economic survival; if the government proves capable of embracing a world of disruptive revolution, exposing its structures to the levels of transparency and efficiency that will enable it to maintain a competitive edge, South Africa will endure – if not, it will face growing discontent (Schwab, 2016c). Policymakers must respond to the evolving landscape by assuming roles of leadership and ensuring that education

is prioritized as a matter of national importance (especially in preparedness for STEM opportunities). Alternatively, they run the risk of compromising a country's ability to prepare its people for a healthy and sustainable future (Davies, Fidler & Gorbis, 2011).

Grosskurth (2010) cites discussions held with citizens of African countries like Kenya, Rwanda, Uganda, South Africa, Nigeria and Ghana, in which people repeatedly emphasised how much their lives, their cities and their countries had changed recently. Many expressed delight that friends and family living distances away could now be reached with just a phone call or a 'mouse click'. Along with these observations is the belief that extraordinary educational and business opportunities are developing. According to Burda (2015), the five crucial issues influencing the future of labour markets and work circumstances are technology, demographics, economics, sociological developments and **government policies**. Du Plessis (2014a) stresses that strategies to alleviate the macro-economic and social challenges of information communication technology (ICT) management, as well as its acceptance and proper integration into the FIR, should concentrate on:

- the formation of a predictable and stable regulatory framework;
- improved government structures and organisational capability;
- the establishment of partnerships and formation of agreements between government, local stakeholders and private stakeholders to boost socio-economic and development outcomes; and
- the advancement of local procurement and value added services in the ICT environment.

Balkaran (2017) states that South Africa's post-apartheid government's efforts to redress historical economic inequalities with a series of laws and policies have, in the years following their implementation, proved largely trite or sterile. The apparent lack of effectiveness by government to implement regulatory policies and agendas that would fully exploit the benefits of the FIR needs to be fully understood. In many respects, South Africans are worse off today than they were 20 years ago, and the majority are yet to see a tangible positive change in their economic circumstances. Indeed, many see the lack of advancement in their economic livelihoods to be as a direct result of the non-implementation of economic policies and general poor

performance of the government of today (Balkaran, 2017). The employment of strategic transformation and implementation of regulatory imperatives by government requires a combination of empowered people with innovative technology and re-engineered business practices, which can best be achieved through effective transformational leadership. This latter is bound to be of great value in the effective change management process that will be required once these policies are designed, approved and implemented (Van Niekerk, 2005).

The last issue to be considered in this section is that of **the societal appetite for the FIR and related technology by the private and public sector**. The European Commission (2016) suggests that advancements in ICT will drive key social transformations and that the complexity and diversity of societies will make these changes the most challenging to anticipate. This research has highlighted the conundrum facing society – whether individual or collective, public or private – regarding the extent to which it should embrace the technology that comes with the FIR: Embrace technology too fully and the possibility exists that it could take over people's lives, jobs or humanity; ignore technology and society will lag behind the progress made by the rest of the world, effectively remaining 'in the dark-ages'. The positive expectation is that, in a future further past the digital age, a new type of 'humanism' could arise, in which new technologies profoundly advance the human form, reduce ageing and boost human physical, intellectual and cognitive capabilities; an expectation which, at the same time, creates unique ethical concerns that further necessitate an assessment of mankind's essential values and principles (European Commission, 2016).

Public and private institutions are under pressure to react promptly to serious issues such as globalisation, new communication and information technology, and the intensifying economic role of knowledge (Van Niekerk, 2005). As a societal driver, ICT advances will continually be propelled and encouraged by social challenges. As additional and more ambitious policy objectives are set - those for example, relating to the quality of life or new sustainability challenges - new ICT competences will be required to offer effective responses further up the technology supply chain (European Commission, 2016), thus further generating new technological and societal advances. It is concerning that progress in South Africa's ICT sector has not been complemented

by an awareness of the principal policy objectives of reasonable access for all, and by the complete range of communications services that typify modern economies (National Planning Commission, 2011).

It is important to consider the investment being made in the infrastructure of a country. Prosperous countries generally invest extensively and are constantly modernising public infrastructure to suit their settlement, economic and trade patterns; however, in South Africa, a generation of infrastructure upgrading has effectively been squandered as government's investment in new and existing infrastructure falls far short of the capacity necessary to meet the country's economic and social requirements (National Planning Commission, 2011). The FIR brings additional challenges as society moves toward an era of greater responsibility and accountability. Higher levels of trust are being placed in science and scientists, with growing expectations of science and technology to deliver answers to ongoing societal concerns such as education, hunger and the environment (Talwar & Hancock, 2010). To ensure an effective societal impact, the following issues will need to be addressed:

- Trust should be established and preserved between all social participants;
- A communal analysis of the issue should be crafted, along with a shared appreciation that all stakeholders must commit to finding resolutions;
- A clear vision should be outlined of what participants are looking for, with manageable objectives; and
- Leaders should be motivated to assume responsibility for the associated possible risks (National Planning Commission, 2011).

4.6.3 Worldview

The third layer of futures studies analysis drills even deeper and endeavours to discover the worldviews fundamental to the trends and problems defined in the previous layer. This presents an opportunity to outline the problem in the 'litany' layer, by not only considering how the various discourses cause and withstand the trends, but also by legitimising and strengthening them (Kotze, 2010). This level is less about the technical inquiry but more about how factors like political views, culture and religion impact people's views about the world (Inayatullah, 2005). Whereas the second layer

has a strong technical grounding, this layer uses language to reveal the meanings and diverse ways of knowing (Kotze, 2010). From a foundation of diverse worldviews, discrete alternate scenarios can be derived by adding a horizontal dimension to the layered analysis (Inayatullah, 2008). Two distinct layers of discourse are recognised at this layer, namely the stakeholder layer and the ideological layer

4.6.3.1 Stakeholder view

Mankind has learnt significantly from its journey towards globalisation and this knowledge can now be used advantageously, providing it is technology and not political interference that enables this progression. The modern model of international trade demonstrates beyond any doubt that those economies that are open to foreign economic trade, the transfer of technology, capital movements and financial transfers stand a greater chance of ensuring superior and long-term development prospects (Kolodko, 2003). It is therefore a primary obligation of any government to ensure the creation of an investor-friendly environment – an obligation which should be extended to include the adoption and embrace of the technologies within the FIR.

Varying views and interests are held by the many stakeholders included in both the private and public arenas connected with technology and ICT industries. The first stakeholders to be considered in this level of analysis are those within the **public** domain, which includes government, educational systems and trade unions. Jeff Radebe (South African Minister in the Presidency for Planning, Monitoring and Evaluation) indicated at the National Development Plan (NDP) Youth Ambassador Masterclass, held in Johannesburg in July 2017 that "*the FIR will transform societies and empower individuals, companies and governments in ways that were previously unthinkable. As government, we are well aware that we cannot thrive administratively without incorporating technological innovations. We are constantly on the lookout for new inventions in order to enhance the effectiveness of our operations to improve the lives of the people of South Africa*" (Arcangeli, 2017). Mawashe (2017) suggests that technology provides a "transformative power" that can propel South Africa forward if it receives investment from government and business.

There are major benefits to being a first mover in technology and the South African government should be forging clear strategies that involve all the benefits of the FIR

(Harvey, 2017). Public-private collaborations are powerful levers for progress, therefore, in order for South African innovators to leverage and improve capabilities, policy-makers need to offer a favourable intellectual property regime which makes it easier to do business in the country and a competitive backdrop (Mawashe, 2017). Radebe emphasises the South African government's regard for ICT as the industry strategic to the country's future growth, with the potential to transform the lives of millions of young people while continuing to create jobs not even considered possible a few years ago – it will be up to local innovators and entrepreneurs, however, to eventually create those millions of jobs required in order to have an all-encompassing economy (Arcangeli, 2017).

Radebe further stresses that the dream of realising a brighter future for South Africa requires training in ICT and business development as crucial elements in the education system (Arcangeli, 2017). As highlighted above, the GCI most recently ranked South Africa's health and primary education system at 123 out of a global 138, and at 77 out 138 for higher education and training (WEF, 2016a). These educational institutions need to play an integral role in achieving this dream and must take their lead from the government's action plan. They will have to align the curricula to take into account those jobs or professions that will only arise or be created as a result of the FIR, and also adjust the curricula for jobs likely to be replaced by AI, robots and similarly advanced technologies. A major concern, from a South African standpoint, is the lack of skills needed to take advantage of the FIR as, while the replacement of humans by machines has been a continuous trend since the first IR, it is anticipated to meaningfully quicken in the coming ten to twenty years (Chen, 2017) because of the substantial advantages of utilising such technology. AI, for instance, can extract a medical finding from an x-ray quicker than a radiologist and with unerring accuracy, while robots can assemble cars faster and more precisely than assembly line operators (Harvey, 2017). Advancements have reached the point where highly skilled jobs are as susceptible to replacement by automation as those which do not require much education or training (Balkaran, 2016).

Harvey (2017) states that any revolution comes with corresponding risks and, in this instance, it is that of increasing joblessness. Worries of extensive technological job losses are nothing new, yet past experience has shown such fears to be unfounded

because, instead, technological breakthroughs actually create more jobs than are replaced (Page, 2017). One of the major problems confronting South Africa is that too many people (especially the leaders) are caught up in a protectionist mode (Venter, 2017). The future South African workforce will need to align and upgrade its skillset to match the new requirements if it is to keep abreast with all the fresh advances and changes of the FIR. Regrettably, when dialogues about change begin, trade union leaders and other stakeholders tend to move directly into a protectionist mode, expressing opposition to change and disseminating warnings that the FIR is going to "kill jobs" (Venter, 2017). Unions are likely to endeavour to protect and maintain their membership base – the loss of job equals loss of members equals loss of revenue. So how, then, are the unions to assist in embracing the FIR? Firstly, the unions need to recognise and accept that change is inevitable. Secondly, they must plan for this future, preferably with a mission in mind, such as to be a top ten digital economy by 2035. Thirdly, that mission needs to be developed in collaboration with workers, employers and other concerned parties, and, fourthly, unions need to be permitted a fundamental role in the development of skills policies. Lastly, unions need to share in the rewards or spoils of improved productivity within the workforce.

The second group of stakeholders are considered here under the **private** realm and include businesses and individuals. The impact of globalisation on businesses has been extensive, enabling companies to step into the international arena as technology has 'made the world a smaller place'. That said, while global opportunities have increased for businesses, so too has competition. Businesses rely increasingly on networks and partnerships, and many have had to adopt disruptive business models in order to stay ahead of competitors. The FIR is helping to bring these disruptive business models and technologies to the global market – how they are exploited remains the decision of business leaders.

Business South Africa is looking to leverage the wealth of possibilities embedded in FIR – from mobile internet, to AI, IoT and 3D printing, to name a few. Aside from the prospects these technologies present, the FIR also offers opportunities for savings in labour costs, improvements in the quality and consistency of products, and efficiencies in productivity. The mobile internet has a myriad uses across big business and the public sector, enabling a more efficient provision of services and crafting opportunities

to improve labour force productivity (Manyika et al., 2013). The world's digital systems keep growing in magnitude and capability as the number of connected devices increases dramatically; with ever more servers, personal computers, mobile devices, actuators in machines and sensors of all varieties connecting to the internet (and to each other), the Internet of Things (IoT) has become a reality (Stuart et al., 2015). Of course, machines are still learning, but with human assistance it is anticipated that machines will soon be more intelligent than humans (Harvey, 2017). Progress in AI, machine learning and ordinary user interfaces are enabling the automation of many knowledge worker duties that have long been viewed as too difficult or impracticable for machines to perform (Manyika et al., 2013), however, as the capabilities of machines to identify faces, to transform speech in real time and to process language continue to improve, so, too, will AI's capacity to mimic human actions and roles continue to advance (Stuart et al., 2015).

As mentioned by Harvey (2017), 3D printing will revolutionise manufacturing business models in incredible ways. While 3D printing technology facilitates the fabrication of items with particular properties constructed on a layer-by-layer basis and with different ingredients (Xiv et al., 2016), the ability of the 3D printing process to take an idea straight from a 3D design file to a complete article, has the potential to bypass several traditional manufacturing steps, and can permit on-demand fabrication, which has interesting consequences for supply chains (Manyika et al., 2013).

From an individualistic locus, the FIR presents other challenges to be considered and overcome. Table 4.5, below, highlights those opportunities and challenges that are most relevant for both business and a workforce individual.

Table 4.5 FIR opportunities and challenges

FOURTH INDUSTRIAL REVOLUTION	
OPPORTUNITIES	**CHALLENGES**
Raise salaries and improve quality of life for people everywhere.	**Greater global inequality due to the disruption of the job market.**
New products and services that increase efficiency and personal well-being.	**Rise of social tensions due to job market segregation between qualified and unqualified individuals.**
Lowered costs for transport, business and communications.	**Greater difference between returns from investment and those from employment.**
Greater efficiency for supply chains.	**Decreasing size of the middle class.**
New markets and economic growth.	

(Source: Signaturit, 2016)

The FIR will transform not only what people do but also who they are, including intangible effects on their identity and the associated problems connected with such existential impacts: their sense of privacy, concepts of ownership, consumption patterns, the time dedicated to work and relaxation, and the ways in which they advance their careers, nurture their skills, meet people and foster relationships are all likely to be altered (Schwab, 2016c). Harvey (2017) further highlights that new technologies threaten to worsen existing inequalities (from within and between countries) and that this intensifying inequality and accompanying income torpor will become socially problematic. Numerous analyses of the problems of inequality in economic, gender-related, racial and other aspects (Dmitriev et al., 2016) have further highlighted that unequal societies are inclined to be more violent, have greater imprisonment rates and inferior levels of life expectancy than their comparative counterparts (Harvey, 2017).

Shortcomings in talent, training and education need to be rethought, with a view to bridging the growing gap, thus ensuring technology can become integral to lower and middle class lifestyles especially and increasing public awareness of the societal expectations of science and technology at all levels of education. Harvey (2017) further warns that the value and benefits of new technologies may become

concentrated in the hands of the currently wealthy, and that those who did not profit from previous levels of industrialisation run the risk of being further left behind. Lapthorne et al. (2013), in their report **'The Future of Manufacturing: a new era of opportunity and challenge for the UK'**, similarly identified that it is crucial that policy makers focus on the supply of skilled workers, apprenticeship schemes, support for researchers and the supply of skilled managers, and that furthermore, firms will need to pay additional attention to building multidisciplinary teams to develop increasingly complex products and possibly innovative business models (Lapthorne et al., 2013). Therefore, in order for businesses to remain competitive and relevant, it will be critically important that the present workforce is re-skilled to absorb the impact of the FIR.

The final stakeholders reflected upon in this section are the **religious** communities embedded in the fabric of society. As the world appears increasingly divided, religious literacy is essential to understand and managing the FIR impact on the essence of humanity. Schwab (2016d) makes reference to the Pew Research Centre's data confirming that the world is becoming more religious as it becomes further interconnected. The WEF (2016b) indicates that the organisation's strategy incorporates values that reflect the general consensus across religions, cultures and philosophies, thus linking three common human objectives:

- the equity and dignity of humans (no matter their gender, race, cultural background or beliefs);
- the significance of recognising a common good that surpasses individual interests; and
- the necessity for stewardship (driven mainly by a sense of concern for the welfare of future generations) (WEF, 2016b).

Debates and deliberations flourish around philosophical questions such as: whether AI and robotics contradict God's creation or are a threat to humans; and whether advances in biotechnology like cloning, genetic modification or in vitro fertilization are ethical. For decades, AI has advanced rapidly to the current point where computers can interpret X-rays, fly planes and scrutinise forensic evidence, while algorithms can paint a work of art and compose a piece of music in the style of Bach. This eruption of AI (frequently stated as 'the singularity') is one of several futures that technologists

have anticipated for robots, but the prospect of their risk to humans, no matter how small, is tangible enough to advocate precautionary measures and more than 8 000 people, including Stephen Hawking and Elon Musk, have signed an open letter cautioning against the possible 'pitfalls' of AI advancement (Merritt, 2017). Amongst the questions debated, for instance, is: Can AI have a soul? Although this may seem ridiculous to some, it bears considering in relations to technologies such as genetic cloning and in vitro fertilisation. In such cases, it may be argued that intelligent life is being created by humans, but doubtless countless religious believers would agree that those beings have a soul. The question that arises, then, that if a person has a soul and then creates a physical copy of themselves, is the assumption that the physical copy will then also have a soul? However, if a human brain were to be digitally encoded, then AI would be the digital version of that human; correspondingly, if a digital copy is created, does that digital copy also have a soul? And, if AI machines do indeed have souls, are those machines able to form a relationship with God? Merritt (2017) suggests that there are no easy responses for Christians prepared to entertain these questions – and even argues that there is certainly a case to be made that Christians should not trouble themselves in the first place. There is no message in the Christian Bible of the anticipation of non-human intelligence, as the Bible teaches that God establishes a unique relationship with humans and the book of Genesis further states that God "created human beings in God's own image". Therefore, in the researcher's opinion, there is no contradiction with religious belief.

When Charles Darwin promoted the notion of natural selection in the 1800s, it defied traditional Christian dogmas about the origins of life and this controversy has continued with biotechnology and modern genetics (Merritt, 2017). Biotechnology touches upon the innermost dimensions of human life, blurring the lines between human and non-human, life and non-life, and confronting the ethical and political self-understandings that underpin democratic foundations (Hurlbut, 2015). In most cases the religious discussion is still undecided when it comes to issues such as cloning or stem cell research, with many religious intellectuals still openly debating the pros and cons of influential new sciences that could deliver, at the same time, potential for hope and potential for horror (Sullivan, 2013). It is, therefore, critical that faith and religion leaders engage in outlining the moral charter of the FIR (Schwab, 2016d). Hurlbut (2015) espouses that new biotechnologies have upset fundamental but delicate

foundations in the backdrop of collective life, conveying the urgent question as to the criteria needed to define inclusion in the moral civic society. Sullivan (2013) discusses three crucial questions:

- Would cloning in some way debase traditional family lineage and relationships?
- Is the termination of a fertilized embryo in the course of research deemed to be murder?
- Does cloning interfere with God's universe in ways that man should not?

The 'moral status' of the human embryo is of particularly earnest debate, especially as the in vitro human embryo can be visualised, debated and administered as an autonomous entity (Hurlbut, 2015). The question being asked is: "*Is man 'playing God' and entering that realm where the relationship of Creator versus created could confuse and disrupt the basic tenets of faith of the religious populous?*" Faith is the greatest controlling force directing economic and societal exchanges, and is the foundation of ethical and moral guidance for many communities and individuals. Schwab (2016d) advocates that spiritual beliefs, religion and faith are capable of discovering new forms of innovativeness, while remaining linked to the nourishing characteristics of man's traditional value structures and, at the same time, taking every opportunity to utilise the power of faith to revitalise new social resurgence that will enable man to be part of something larger - a universal, connected civilisation.

4.6.3.2 Ideological view

Inayatullah (2004) defines the ideological view as "*deeply held positions on how the world is and should be*". More broadly speaking, it is a set of conscious or unconscious notions which create goals, expectations and actions or a set of concepts suggested by the main class of a society to all participants of this society (Marope, 2014). Three layers have been identified in this research as comprising the ideological view, namely Economism, Sustainability and Plurality of Blockchain.

4.6.3.2.1 Economism

Haubrich and Wolff (2006) refer to economism as the assertion that theorists and decision makers have miscalculated the potential impact of the economic realm on policy making. This layer rests on the global financial system, which, in turn, rests on

the worldview of free enterprise, which, itself, finally rests on the myth of greed, the 'invisible hand', and self-centredness (Inayatullah, 2004). Haubrich and Wolff (2006) claim that economism comes in two disguises. The first is a psychological interpretation about the motivation that drives human action, which is assumed to be largely encouraged by economic motives to improve one's own material welfare. In this research, a closer assessment of the FIR (globally and in South Africa) recognised there to be similar elements existing to those stated by the worldviews of the FIR and of the broader ICT industry, as discussed previously under the view of the stakeholder. All these factors indicate the need of both the public and private sector to find business solutions to the challenges faced in the acceptance and embrace of the FIR. Nevertheless, this research reasons that these solutions or proposals are grounded on aspects synonymous with those offered by previously cited authors, namely that human action is indeed motivationally driven, and in this case it is assumed to be primarily encouraged by the economic motivations of improving one's own material well-being. Furthermore, the ubiquitous nature and global acceptance of the FIR, as far as economism is concerned, can be directly connected to individuals' desires to improve their own material well-being. This economic motivator is evidenced in some of the aspects of FIR described earlier in this paper, including:

- early adopters of the FIR reaping the financial benefit as others 'play catch-up';
- the reduced cost of gene sequencing which enables the availability of vast amounts of genetic data, rapidly analysed by the powerful IT – which is profitable for businesses;
- L-i batteries, specifically, have seen steady increases in performance and declines in price;
- robots enable enterprises to lower labour overheads, realise improved productivity and provide reliable, superior quality; and
- while the FIR is making lives simpler and easier, it is, at the same time, generating superior profits for businesses.

The second interpretation refers to the theoretical fundamentals on which public policy is and ought to be built. Economism, in this political model, puts the blame on public policy for establishing economic effectiveness as the primary policy objective, for the application of extravagant economic tools to detect the policy most appropriate to attaining that goal, and for dependency on the market, even possibly as the

establishment best equipped to determine the necessary framework. Therefore, the policy adoptions made as a result exceed, or at least reduce, the other vital values that direct human activities and that the social order might, as a consequence, uphold, such as equality, community, solidarity or friendship (Haubrich & Wolff, 2006).

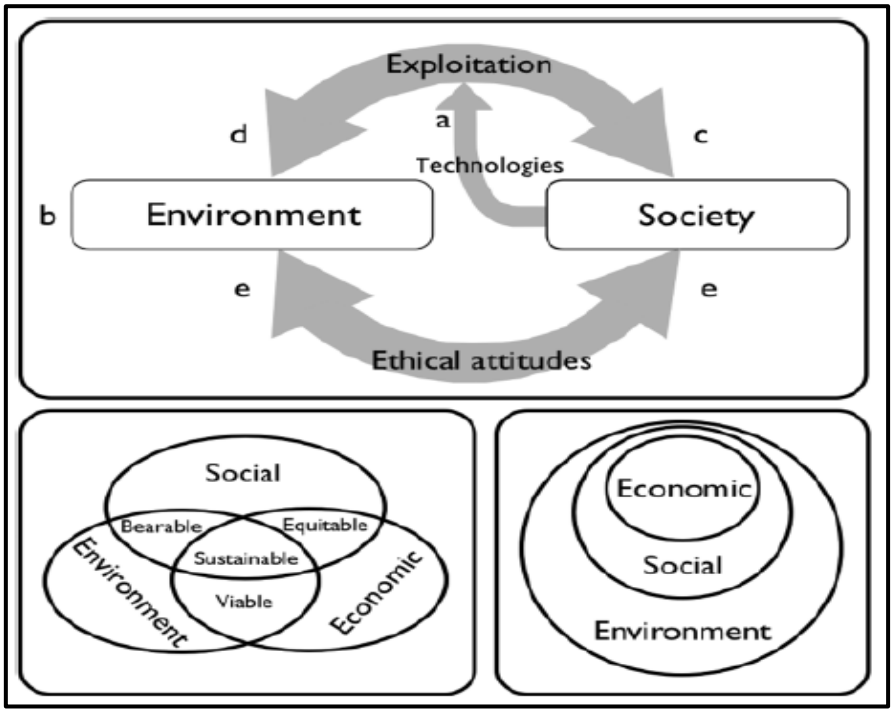
The emphasis on economic efficiency is an imperative for the South African government who should subject public expenditures to much more stringent economic scrutiny. Since 1994, the expansion of the welfare state has had an adverse effect on economic efficiency and international competitiveness, and has thus become a source of major economic problems, including declining productivity, growth and high levels of unemployment. The government therefore need to resolve to reduce public spending and taxes, and to reassign responsibility for individual well-being from the state to the individual. Investments into public services, such as health, transport and education, may need to be reduced and rather applied in those sectors that will drive economic growth, create jobs and improve competitiveness. This means investing in FIR-related technology industries and professions that can contribute to moving the country out of technological obscurity and into the limelight of global technology.

As indicated in this research, the FIR is recognised by policymakers as a game changer and needs to be embraced, however there appears to be no urgency in the adoption of FIR – in fact, adoption rates are extremely poor from the public sector. The apparent abundance of technological improvements being witnessed and coming forward are not necessarily being taken advantage of, due to the lack of regulatory support from various role players in the public sector. The FIR has the potential to address a number of basic needs in the populace, such as health, education, energy, housing, water, sanitation and transport if properly employed. The crucial imperative is that the policies adopted and implemented need to be of an all-inclusive nature, one that assists in eradicating the scourge of inequality and improving the lives of all the country's inhabitants. Progressing into 2035, the aim and objective for the country is to be rewarded for the adoption of these economic policies by considerable increases in the output of services and products, improved living circumstances, as well as better international competitiveness.

4.6.3.2.2 Sustainability

Vucetich and Nelson (2010) view sustainability as the relationship between society and the environment, involving both a physical element (exploitation) and an ethical outlook (as illustrated in Figure 4.2 below). The relationship is impacted by (a) our technologies, (b) our understanding of the environment, (c) our understanding of how exploitation affects society, (d) our understanding of how exploitation affects the environment, and (e) how we understand our ethical attitudes about ourselves and nature. History offers abundant proof that dimensions (a) to (d) are inadequate for accomplishing sustainability. Instead, ethical approaches (e) are a critical feature of any relationship involving humans, yet are the neglected element of sustainability. This model of sustainability highlights that technology is conceptually less important to exploitation, defining only our efficiency and capability of exploitation. Ethics governs how mankind use technologies. Vucetich and Nelson (2010) further challenge previous conceptual models of sustainability, depicted on the lower panels of Figure 4.2, and are of the opinion that these models are silent about the role of technology, which has become a central focus, and ethics, which ought to become the central focus.

Figure 4.2: Critical dimensions model of sustainability



(Source: Vucetich & Nelson, 2010)

This research ascribes to the five critical dimensions model of sustainability described by Vucetich and Nelson (2010), as it suggests a more holistic methodology to sustainability. Burda (2015) reports that, in 2015, all UN-affiliated countries adopted a set of 17 sustainable development goals, or global goals, with a view to ending poverty, protecting the planet and ensuring prosperity for all. The specific targets of these goals address poverty, health, energy, education, hunger and food security, water and sanitation, all of which may be assisted by the contributions of technological developments (Burda, 2015). Although the FIR is about technology, Coleman (2016) proposes that these technologies can similarly accelerate access to water, food, energy, healthcare and education (Coleman, 2016). There is a global necessity, for example, to decrease fossil fuel reliance but still guarantee energy supplies, and Africa has the potential to become a source of renewable energy through the harvesting of solar, wind, water and biomass sources, which are substantial enough for local supply and the export of significant volumes of stored energy. One of the real benefits of the FIR is the strides made in the development of clean, efficient and sustainable energy technologies, which are of particular significance from a South African standpoint because of the increase of fuel prices, together with the increased political and environmental worries, and the current economic slump.

Progress in ES technology could make electric automobiles (hybrids, plug-in hybrids, and all-electrics) more competitively priced than even vehicles built with internal-combustion engines (Manyika et al., 2013). Electric vehicles (EVs) accounted for 0.06% of the global total vehicle fleet in 2016 and there were over 720 000 highway-capable EVs on the road around the world, with the Nissan Leaf and the Tesla S leading the way (Monk, 2016). Some of the challenges facing the EV industry include that of vehicle pricing versus internal-combustion vehicles, the lack of commercial vehicles, the size of available vehicles, and the absence of ways in which to tax people who use EVs. Some tactics adopted by governments and private entities to increase sales have included subsidies, free parking, the use of the bus lane, free charging, free road tolls, no taxes (such as GST or VAT) on purchases, and low licencing fees. L-i battery technology is the main form of battery power for EVs, with battery prices and power density improving as research promotes better battery technology. According to Monk (2016), some of the power-charging challenges for EV include the location and number of the charge points, as fast charging can only occur at places

with a substation. By installing charge points in carparks, businesses could attract environmentally sophisticated clients.

There are currently approximately 300 EVs whizzing along South Africa's roads (with only 40 charging points) and by 2050, there should be three million; however, what is standing in the way of this progress are the convoluted pieces of legislation that is applicable to any machine that moves but that does not burn diesel or petrol (Kings, 2017). The government is aware of this problem and the Department of Trade and Industry has drawn up the **'Strategy for Policy Direction Promoting Green Transport Technologies in South Africa'** (also known as the 'green transport strategy') to address the target of three million EVs. Cars are also the source of 10% of the country's carbon emissions and, with the bulk of toxic pollutants released in densely packed cities, these gases contribute to the 20 000 deaths related to air pollution each year (Kings, 2017). As more and more EVs are developed in humanity's drive to reduce the impact on the planet, the platinum industry is being challenged by, among others, South African-born Elon Musk's Tesla Corporation, who are using L-i to power their vehicles (Mtongana, 2017). Mtongana (2017) further elaborates that the world will need to use more hydrogen fuel cells in order to save the platinum industry – South Africa produces 80% of the world's supply of this precious metal. The prospect of losing jobs in the platinum mining industry is real and something business and government need to take cognisance of in the long-term. Of more urgent concern, though, is that there is no coherent plan by government for the EV sector and that, instead, eight departments and utilities are each following their own path, resulting in misalignment and policy fragmentation – government has an uphill battle to put this strategy on the correct 'highway'.

In the 'five critical dimensions' model of sustainability, the ethical dimension is considered to be the most important, after technologies. Essentially, Vucetich and Nelson (2010) contend that it is extremely foolhardy to try to achieve sustainability with science and technology alone. Consequently, in light of the energy challenges described in this analysis, and from the viewpoint of sustainability, all participants of the FIR (public, private and individuals) need, firstly, to recognise that sustainability cannot be attained through a fragmented methodology. Businesses or industries should scrutinise all opportunities in an effort to drive sustainability, which includes

sourcing, product development, packaging, manufacturing, distribution, transportation and services. As environmental impact is a strategic undertaking, it needs to be considered as part of overall business strategy.

The second aspect to be considered here is that all FIR participants need to address the ethical element as emphasised in the aforementioned model. One aspect of ethical behaviour is, in broad terms, conducted according to the law. Many ethical transgressions result when leaders or managers place personal interests over the welfare of an industry or organisation, employees or the public (Marope, 2014). Leaders should look further than self-interest so as to build greater good. Shared leadership can provide a strong system of checks and balances, thereby decreasing the likelihood of unethical and criminal behaviour. The FIR brings its own dilemmas, as new business models are encountered, as well as ethical, safety and social issues, as emerging technologies come to life (Schwab, 2016a). Privacy concerns are crucial, as biotech and AI revolutions will redefine what it means to be human by pushing at the existing thresholds of life span, health, reasoning and capabilities, forcing people to redefine their moral and ethical limitations (Wells, 2016). The increasing significance of BD presents extra challenges for governments and companies, as attackers can abuse massive, distributed BD systems, which in many instances have inadequate security controls and can consequently gain access to incredible amounts of material at once and could be used for unethical purposes (Hewlett-Packard, 2013).

4.6.3.2.3 Plurality of blockchain

Blockchain is rapidly becoming a symbol of the FIR. In reiteration of earlier definitions in this work, blockchain is a distributed or shared electronic ledger that utilises software algorithms to record and approve trades or transactions reliably and anonymously, with the recording of those transactions being shared amongst numerous parties. Once the data is entered, it cannot be changed, as the downstream chain underpins upstream trades (Curran et al., 2016). Blockchain works through cryptography, validating parties' identities and generating immutable hashes (digests) of every ledger record, page of records (block) and the binding that connects (chains) each block to the previous ones (Kemp, 2016). The process offers assurances that data is authentic, and that new data is well-defined (Compton, 2017). Blockchain can alleviate security fears, facilitate third party authentication and reduce multiple inputs of identical data

across IoT devices (Eastwood, 2017). With blockchain's robust securities against information tampering, the system can assist in the prevention of disruption from a rogue device attempting to transmit misleading information (Compton, 2017). Furthermore, as it is a shared, unalterable ledger of transactions, it offers a sense of accountability and engenders trust across business processes as there is no single entity that has dominion over the records (Eastwood, 2017).

Blockchain is also the system that underpins the cryptocurrency Bitcoin (Baweja et al., 2016). By shifting the foundations of how money, information and resources are exchanged and tracked, blockchain technology will undoubtedly create enormous opportunities for new flows of value and value-types (Institute for the future, 2017). Given the nature and assumed integrity of blockchain, questions arise as to whether blockchain could become the backbone of the FIR. Blockchain is seen to be the ultimate creation of extreme connectivity, relying for its existence on the interconnection with a great number of computers (Baweja et al., 2016). Together with the billions of smart devices linked on the IoT, it has the potential to transform homes, cities, businesses and lives (Compton, 2017) and can, furthermore, act as that trusted expert on all types of operations (Montresor, 2016).

4.6.4 Myth or metaphor

The fourth layer of analysis in futures studies explores what is labelled the myth or metaphor layer. This concerns the discovery of the unarticulated, deeply rooted, highly emotional and unconscious 'stories behind the story' (Inayatullah, 2005). It endeavours to deconstruct the worldview into images which can go beyond other structures of interpretation; images are of chief importance to this layer, due to the limitations of language (Kotze, 2010). DuBrin (2011) maintains that a carefully selected metaphor or analogy appeals to the imagination, to the intellect and to values. According to this research, the dominant worldview is that technological singularity is an inevitable outcome of the FIR. The first metaphor chosen for this layer is that the 'technological singularity is near', adapted from the title of the book 'The Singularity is Near', by one of the prominent prophets of the singularity, Google's director of engineering, Ray Kurzweil (Galeon & Reedy, 2017). The singularity, a phrase initially derived from mathematics, expresses the point at which we are incapable of deciphering its precise properties (Tzezana, 2017). In relation to technology,

singularity is that point at which all the progresses in technology, particularly in AI, will result in machines that are smarter than human beings (Galeon & Reedy, 2017). The concept of singularity has escalated to prominence in the last two decades largely because of two thinkers, namely Kurzweil and the scientist and science fiction writer Vernor Vinge who, in 1993, wrote that *"within thirty years, we will have the technological means to create superhuman intelligence. Shortly after, the human era will be ended"* (Galeon & Reedy, 2017). In reflecting back on this research, the timeframe that Vinge envisioned does not seem unrealistic, considering the exponential growth and the speed at which the FIR has totally outstripped its predecessors. From this perspective, the end may be nearer than has been foreseen.

The possible net result of technological singularity may be that AI and automation will lead to total job losses and replace the need for human interaction and intervention. As Leonhard (2014) suggests, our future may instead lie in "being more human and less like machines". At a recent discussion on AI in South Africa, hosted by Accenture and GIBS Business School, it was suggested that, instead of replacing humans, AI ought to make people more productive and that businesses executing AI solutions should accept the burden of reskilling their workforce; in other words, inclusive economic progress has to be a driver (Accenture, 2017a). Talent strategies must take this transition into account (World Economic Forum, 2016). It is clear that FIR and, in particular, AI offer immense potential globally, including in South Africa, but they will not materialise overnight. The first step is for government, business and labour to comprehend their potential and to work together to make the changes that matter (Mzimba, 2017). As the research has highlighted, South Africa's embrace of the FIR has not been as complete and rapid as that of some of its global counterparts, so the inevitability of the 'technological singularity is near' metaphor may be delayed. The country is facing a myriad cultural, social and structural obstacles, which hamper government and businesses from fully incorporating AI technologies into the economy, ultimately affecting the potential for growth and competitiveness that AI presents.

The alternate scenario is that the singularity is an opportunity for humankind to advance. Kurzweil foresees that the same technology that makes AIs more intelligent will empower humans as well, as these machines will 'power' all humans. Galeon and Reedy (2017) further cite Kurzweil as suggesting that the machines are, in fact, making

humans smarter and that, while they may not yet be inside people's bodies, by the 2030s they are envisaged to have the capacity to connect to an individual's neocortex (the part of the brain where humans do their thinking), which will then connect to the cloud. What this means is that AI will affect everything, thereby meeting the physical needs of all humans and even further expanding people's minds.

The second metaphor chosen in this study is that robots will 'take over' the world; the researcher has called this the 'Vernor Vinge effect', after the scientist and science fiction writer of the same name. This metaphor represents a sinister and darker potential influence of AI. Some of the most popular science fiction movies – including 2001: A Space Odyssey, The Terminator, The Matrix, Transcendence and Ex Machina - have inspired the belief that AI will advance to a point at which humankind will not be able to control their creations, resulting in the demise of the human civilisation. This fear of the swift progress of technology, and mankind's growing dependence on its capabilities, is undoubtedly warranted, given the abilities of modern machines designed, for example, for military purposes (Sainato, 2015). Science fiction, which creates convincing and complex scenarios about the future, offers one possibility in understanding the interactive quality of future evolution (Lombardo, 2008); in many of these scenarios, the technology, like AI and robots, has a nefarious role to play in the scenario outcome. According to Sainato (2015), technology has had a major impact on warfare since the Iraq war commenced in 2001, in particular, with unmanned drones providing continued surveillance and swift assaults on targets, and small robots used to disarm explosive devices. Currently, the military is funding research to create increasingly self-aware and autonomous robots to reduce the need for the endangerment of human soldiers. Boston Dynamics released a video showing a frightening, six-foot-tall, 320-pound humanoid robot named Atlas, running freely in the woods. The company has since received funding from the US Department of Defence to develop an even more agile version (Sainato, 2015). Figure 4.3, below, shows the 2017 version of Atlas, along with some other robots from the Boston Dynamics stable.

Figure 4.3: Atlas robot (2017) next to BigDog, WildCat, and AlphaDog

(Source: Boston Dynamics, 2017)

Sainato (2015) also maintains that the interaction between the rapidly evolving fields of information technology, nanotechnology, biotechnology and networked communications make such a dream/nightmare scenario quite conceivable within the next couple of generations.

4.7 CREATING ALTERNATIVES

Conforming to the structural guidelines of Inayatullah (2008), this section will now create alternatives, attained through the construction of scenarios, to expand upon the future of the FIR in South Africa. Slaughter (2002) regards this is the “tool par excellence” of futures studies, while, for Inayatullah (2008), scenario planning is a valuable technique to reveal the present, creating a level of uncertainty and offering alternatives.

In the phase of creating alternatives, the critical objective is to apply the scenario methodology by studying the likely scenarios and confronting the challenges faced by the South African public and private sectors in embracing the FIR into 2035. Kreibich et al. (2012) discuss the fact that many scenario analysts emphasise that scenarios are hypothetical ideas, thus failing to assert that the scenarios created actually

represent reality. Scenarios are inclined to be constructed from technological, social, environmental, economic and political interpretations about what the future is expected to contain (Gould, 2008) and as, by nature, the future is intrinsically unknown, none of the scenarios developed will necessarily unfold as imagined (Puglisi, 2001).

Scenario planning is based on the following principles: multiple scenarios must reflect uncertainty but be limited to four plausible futures; they must be internally reliable, with related events, and relevant to the issues of concern, producing challenging ideas against which future strategies and planning can be considered (Du Plessis, 2016). Adendorff explains that a good set of scenarios needs to leave the reader questioning whether that option which is highly likely or probable to occur, thereby encouraging the reader to ruminate even further on the subject (Adendorff, 2015). The extensive scenario building model designed by Peter Schwartz, which focusses on the organisational and offers specified guidelines with which to plot and develop scenarios, has been adopted for the purpose of this research. The scenario structure is composed of the following four variables, which have been dubbed with sci-fi movie titles to accentuate the intrinsic 'stories' of the scenario analysis:

- Best case (what the organisation aspires to) – **"The Fifth Element"**;
- Worst case (where everything goes bad) – **"Terminator"**;
- Outlier (a surprise future based on a disruptive emerging issue) – **"The Matrix"**; and
- Business as usual (no change) (Inayatullah, 2010a) – **"The Day the Earth Stood Still"**.

4.7.1 "The Fifth Element" – the best case scenario

The movie from which this scenario's title was taken centres around what are deemed to be man's best qualities. The four elements of the title - earth, water, wind and fire - are supplemented by a fifth, representing life, a 'supreme being' who embodies that which is perfect in human form and further represents hope for mankind.

Under this scenario, by the year 2035 the embrace of the FIR is complete and successful. Government and the private sector have combined forces to extract the maximum benefit the FIR has to offer, for the greater good of the country's inhabitants.

AI has not taken over mankind, as the ‘singularity’ foretold, but has been incorporated into society and is seen to support and aid people. The feared job losses have not materialised but, on the contrary, numerous previously non-existent jobs have been created, requiring new skillsets. This has necessitated investment in the education system to improve the level of teaching and required a better quality of curricula to fill the STEM positions being created by the FIR. The number of tertiary facilities have grown, not in a ‘brick and mortar’ sense but rather through the use of technology, and e-learning facilities have become the norm as learners are using smart and other technological devices to access lectures and learning material.

The new jobs that have been created offer more opportunities for the youth and have drastically reduced the unemployment rate. Crime has reduced as the country’s employable workforce is suitably employed and the temptation to turn to crime has been diminished. The police force is using the latest technologies to ensure that law and order is maintained, from drones to robotic police and autonomous police vehicles. Government and private business have invested heavily in the infrastructure needed to support the FIR. In ‘smart cities’, autonomous transport and EVs are the norm, internet is freely available and is considered a basic right, and BD has been effectively mined, resulting critical and informative insights to improve the management of financial, medical and environmental resources. In 2035, drone technology has advanced to a point where the technology is used for deliveries, conveying people in ‘drone taxis’, and thus reducing the congestion on the roads, resulting in less air pollution, lower carbon emissions, fewer vehicle accidents and deaths, as well as the redundancy of that scourge of the road – taxi drivers.

Advances in medical and nanotechnology have meant that cures have been found for cancer, diabetes, malaria and HIV/AIDS. Mind-controlled prosthetics have advanced to such a point that they have become cheap and affordable, assisting amputees medically and psychologically, to fit easily into society again. Medical advances have meant that life expectancy of South Africans has improved and that the average ages of its inhabitants are increasing.

4.7.2 "Terminator" – worst case scenario

This movie chosen to best reflect this scenario epitomises the potential 'technological singularity' of which mankind is so afraid. 'Skynet', the AI to control and rule over all AI, is the eventual culmination and convergence of AI into one 'supreme super system' that forces mankind underground and into a fight for survival to preserve the human race.

It is the year 2035; the 1993 prediction of Vernor Vinge has come to pass and AI rules the world. The warnings of Stephen Hawking, Elon Musk and Bill Gates that AI will rule mankind have been ignored (Sainato, 2015). Humans have been replaced in all jobs by AI and robots, and people are now fighting for survival as there is no work for them to earn any money to buy food. The value of currencies has collapsed as AI does not recognise or see the need for money. Humans have been forced out of the cities and now stay on the outskirts in squatter camps, with many moving further into rural areas. There is no differentiation between classes anymore, as every individual is equalized by the AI view of the human race. Numerous individuals have resorted to mankind's earlier past and have become subsistence farmers, living off the land and bartering with other farmers to obtain much needed supplies and services.

The government infrastructure fails as AI now controls all aspects of the economy, with no need for human interaction or input. Raw materials and other resources are mined by AI to build and maintain the AI and robotic workforce. There is no need for fossil fuels for power stations and cars, as alternative energy sources, like solar, wind power and batteries (with improved storage capacities) are used by the new owners of the Earth. Carbon emissions are reduced, resulting in the slow and eventual reversal of global warming. Medical advances and infrastructure deteriorate as AI do not get sick, possibly only redundant, so existing hospital eventually start to fall apart and there is nowhere else for sick humans to go. Suddenly natural resources like clean, running water are scarce; sanitation becomes a problem, the lack of waste disposal and sewage treatment facilities leads to increased health problems and disease. Abruptly, life expectancy of humans is reduced; there is an increase in neo-natal and child deaths, and the population is no longer increasing, but rather getting smaller.

Education is no longer important; there are no more educational facilities as the AI has closed them down in the quest to ‘dumb down’ the human populace. As a result of the collapse of government, crime and lawlessness in the squatter camps escalates to unmanageable levels and criminals turn to stealing from the new AI masters. This results in continued retaliation and raids by the AI ‘robocops’ in the squatter camps, with loss of human life, both innocent and guilty.

4.7.3 “The Matrix” – the outlier scenario

This movie portrays a dystopian future in which ‘reality’, as observed by most humans, is in fact a simulated realism called ‘the Matrix’, created by intelligent machines to pacify the human populace, while in actual fact their bodies' electrical activity and heat are being used as a source of energy by these sentient machines. This concept forms the basis for the researcher’s ‘outlier’ scenario, which has been adapted from the European Commission's (2016) Digital Futures report, in which the lines between humans and AI becomes a blurred feint.

The singularity is the new norm in 2035. Mankind’s physical and intellectual abilities have been improved with bio-technological augmentation and implants such as memory and energy storage. This leads to the emergence of a new human - a ‘trans-person’ or cyborg - as technology and bio-medicine have significantly improved the human condition, fundamentally enhancing our physical, cognitive and psychological capabilities. Cyborgs complete complex tasks in a similar way to humans, taking over mundane jobs from construction to agriculture, from office to manufacturing automation. Trans-persons enjoy healthier and longer lives. Technology has advanced to a point where organs are regenerated in-vitro and implanted, with a 100% success rate, or are grown by means of limitless stem cells. Bio-computers and ‘nano-bots’ are the common means of for diagnosis and treatment, thereby prolonging both ongoing vitality and lifespan.

In 2035, the matrix is a reality. The internet has continued to expand as the global connector. Advances in core technologies and the requirement to support increasingly sophisticated application scenarios instantly bridge the gap between virtual and physical worlds, exchanging trillions of bytes of data monthly. This enables predictions and decisions, based purely on scientific data and people’s desires, to be executed

more easily and quicker than ever, as agreement can be reached about, for example, where to build a school or even to place a traffic light (if these still exist in 2035), based on the results of virtual tests and simulations. The employment landscape will not escape unscathed. Technology will continue to transform the nature of work, the dynamics of businesses and the labour marketplace. The FIR has brought about countless new occupations, with novel and innovative professions replacing many of the earlier unskilled jobs. The new 'trans-person' has no further need to attend educational facilities as any knowledge required is simply uploaded via the internet or through the bio-technological augmentation or electronic implants. People are able to change occupations according to individual requirements and aspirations all through their life. The concept of stable, permanent employment will become a remnant of the twentieth century as inhabitants instead follow the occupations that interest them, regardless of age.

4.7.4 "The Day the Earth Stood Still" – it is 'business as usual'

The researcher has selected this movie because of the title, and not necessarily the storyline, for this scenario. In it, the notion explored is that of the inability of the role players in society to grasp the FIR and make it work for the greater good of all - no meaningful effort is made to move the country forward and so it remains stagnant, in an eternal loop of non-development and non-progress.

It is the year 2035, and the public and private sector continue to trundle along with no clear plan of action or direction concerning how the FIR will be absorbed into the economy and ordinary people's daily lives. The government continues to acknowledge the possible benefit of the FIR and sets up workshops and task forces to discuss the phenomenon, but never arrives at an effective action plan. Meanwhile, elsewhere on the African continent, countries have been adopting the FIR vigorously and, as a result, have leapfrogged South Africa to become more advanced and economic powerhouses. Businesses recognise that accepting the FIR is critical to the survival and success of the organisation; however, due to the pressures from government and unions to preserve jobs, the push to merge AI into industries is not as robust as they would like. This inability to use AI effectively has resulted in companies employing unskilled, inefficient labour at unsustainably high wages, resulting in the country having priced itself out of the global market, with lower demand for its products. This

mean lower foreign earnings as well as lower FDI as the local market is not investor friendly – its labour laws are draconian and the ease of doing business is inefficient. Moreover, the sluggish adoption of FIR has meant that the necessary upskilling of the workforce has also been slow, even, in some cases, non-existent. The curricula that was identified to bring the STEM skills through the educational ranks has not been implemented, resulting in the country being 'behind the curve' in comparison to its African and global counterparts. Furthermore, this apparent lack of AI skills necessitates the importing of skilled labour to implement AI in those businesses that are using the technology, a practice which, in turn, adds to tensions between business, unions and the local workforce.

On the plus side, advances in medical technology have benefited some of the country's inhabitants. The technology is still expensive due to the retarded uptake by industries of technologies like nano- and bio-technology, and is therefore only available to the select few. Even medical aids are stretched to be able to fund these revolutionary and, in some instances, life-changing technologies. The gap between the haves and have-nots is still widening. South Africa is still heavily reliant on fossil-fuel driven technology and the envisaged three million EVs on the road have not materialised (Kings, 2017). The infrastructure necessary for the EV technology is still in the planning phase and has been for many years. The introduction and uptake of autonomous car technology has also been delayed, primarily due to the poor transport infrastructure. Because the country has not moved away from being a social welfare state, most of the taxes collected go towards bloated public sector salaries and social grants - leaving very little money to repair the deteriorating rail and road infrastructure, including the proliferation of potholes, which have become a symbol of the ineffective government of the time.

4.8 CONCLUSION

Any of the above four diverse scenarios could potentially come to fruition over the next two decades in the run up to 2035. These four stories are representative of the possible courses that the FIR could take from a South African perspective. The reality is that it is virtually impossible to predict which of the scenarios will emerge to form the future of the industry in South Africa. However, what is of utmost importance is that

the public and private sector of South Africa embrace the FIR but, at the same, prepare for the eventuality of any of these scenarios and ponder on even the most unlikely events that may occur to shape the future.

What the private and public sector needs to do is refrain from selecting one of the scenarios above any of the others, in the vain belief that a particular scenario will indeed become the realised future. The ‘golden thread’ through all these scenarios is the importance of the influence of the FIR on the labour force and the jobs of the future, which could potential result not only in job losses but in the reality of singularity replacing ALL jobs. This will have to form a significant consideration in the formulation of the **“Future Vision of the FIR in South Africa towards 2035”**. The next chapter will seek to present an idyllic, realisable future for the FIR in South Africa through a vision and set of contextually-aligned, useful recommendations.

CHAPTER 5
TRANSFORMING THE FUTURE
"EPILOGUE"

5.1 INTRODUCTION

The future of the FIR in the South African context was expanded upon in the preceding chapter, creating alternative futures through the developing of scenarios. In order to oppose the possible and probable challenges that the public and private sectors face in the embrace of the FIR in South Africa into 2035, plausible scenarios were offered. Furthermore, possible solutions to address the postulated research questions highlighted in this study were also presented, with the ultimate aim of addressing the research objective as envisaged at the start. This chapter will strive to provide recommendations and conclusions to the questions raised by this research.

This chapter will begin by focusing on the sixth and final pillar of Inayatullah's method-linked theory of futures thinking: the pillar of transforming the present and creating the future (Inayatullah, 2008). In this phase of transformation, the future is narrowed down to the favoured version, revealing 'win-win' solutions devoid of compromise. The issues that need reflection include the formulation of the preferred future for all stakeholders of South Africa impacted by the FIR as the country moves to the ideal, sustainable future for its inhabitants up to 2035 and beyond. This research adopts the attitude that a positive, hopeful future can be fashioned and formed by the present day actions of all South African stakeholders who have embraced the FIR. This is in reference to the fifth basic concept of futures philosophy as defined by Inayatullah, that of the model of social change (Inayatullah, 2008). The aim is to focus on the revelation and to chart a variety of alternatives to improve uncertainty planning as South Africans implement the FIR in the country's progress to 2035.

The South African public and private sectors need to determine the acceptable scope of adjustment and to establish the consequences of available choices in influencing the ideal world in which they wish to prosper. The primary objective is to raise the confidence of the various participants to help with the creation of a preferred future, taking into consideration the FIR through the formation of additional effective

strategies and innovative thinking, and crafting capabilities that will guarantee long-term progress of businesses and the reduction of perceived job losses.

5.2 USING THE FUTURE

The sixth basic concept of futures thinking is the use of the future (Inayatullah, 2008). Whereas futures thinking can be purely about foresight learning and helping businesses with fresh competencies, at a deeper level it can assist with the establishment of effective strategies (Du Plessis, 2016), thereby creating capacity. Discovering the correct strategy is important, but even more important is to use the correct tools and to encourage self-confidence to create the preferred future. The ensuing deeper level is emergence. The manner in which the future is approached touches all facets of the human mind, meaning that theories of the future ought to be evaluated by encompassing their overall effect on humans and human psychology (Lombardo, 2008). Futures thinking assists to create the settings for a paradigm shift. The establishment or industry envisages a new future, empowers stakeholders, creates a new strategy, uses tools and then a new future emerges (Inayatullah, 2008).

5.3 FUTURE CREATION

In order to transform the present and craft the future that embraces the influence and impact of the FIR in South Africa, it is vital to gauge the fundamental issue and associated choices that must be made in creating a preferred future for the stakeholders of the industry, comprising government, business, labour, society, local communities and other interested groups. The objective is to discover the correct tools and to aid in establishing the confidence necessary to create the preferred future of the FIR in the South African context: a **“Future Vision of the FIR in South Africa towards 2035”**. Lindgren and Bandhold (2003) describe a vision as a positively laden idea of a desired future. The vision should provide all stakeholders with a sense of what is possible, and inspire them to pull in the same direction and align individual goals and ambitions with that of the collective or institutional.

To aid the creation of the South African FIR future, strategies are reviewed and proposed that provide a foundation for the development of the **“Future Vision of the**

FIR in South Africa towards 2035", which will assist the relevant stakeholders to use the tools with confidence in the creation of a desired future (Inayatullah, 2008). Some questions that need to be asked about the decisions that will realise the desired future include:

- What choices need to be taken today to guarantee an enduring and positive impact of the FIR on the fortunes of South Africans?
- What decisions need to be made to ensure the protection and growth of jobs in South Africa, as impacted by the FIR?
- What infrastructural changes need to be made to ensure that the FIR is accepted and benefits all of South Africa's inhabitants?

The recommended **"Future Vision of the FIR in South Africa towards 2035"** embodies an attainable, realistic and desirable future that could become the basis for the development and advancement of the FIR in the South African context – this is essential for the vision, so as to transform the ICT and relevant industries towards the realisation of a preferred future. The previous chapter highlighted the possibilities for the future in four scenarios, the most positive of which, the "Fifth Element" scenario, offers a future in which all stakeholders approve of and embrace the FIR in South Africa, and the benefits are maximised for all involved. In addition, the scenario provides some ideas on the essential steps needed for the innovation and transformation of the industries impacted by the FIR as it exponentially grows.

5.4 ENVISIONING THE PREFERRED FUTURE

The desired future of the FIR in South Africa is as a result of industry transformation and acceptance of the phenomenon; the embracing of an all-encompassing, extensive and innovative approach to reduce the costs of technology, create new jobs and increase levels of employment, with greater productivity in the public and private sector and advanced, sustainable and national development. Under this scenario, the embrace of the FIR is complete and successful by the year 2035. Government and the private sector have combined forces to extract the maximum benefit the FIR has to offer and, through innovation, South Africa is a transformed, innovative, global leader in most of the FIR elements. The FIR is a powerful, sustainable and major contributor to the progress and prosperity of the South African economy, able to contribute to the

greater good of the country's inhabitants. The foretold 'singularity' has not come to pass; instead, AI has been integrated into society and is seen as a support and aid to people – humans remain the masters of AI and not the other way around. As a result of vigorous technological innovation, South Africa is acknowledged as the chief technological 'disruptor' and renowned for its excellence in a number of the elements of the FIR, including AI, EV, BD and alternative and sustainable energy generation, resulting in significantly enhanced productivity and reduced production costs, which have made the country globally competitive. The feared job losses have not materialised and instead the FIR has created numerous previously non-existent jobs that require new skillsets. There has been major investment by the public and private sectors in the education system to improve the level of teaching and the correct implementation of the curricula required to fill the STEM positions being created by the FIR. There has been a considerable increase in the number of quality tertiary facilities, and a transition from traditional 'brick and mortar' to low-cost e-learning facilities. These allow learners to use the smart and other technological devices brought about by the FIR, to access lectures and learning material. In 2035, the quality of teaching is of such a standard that learners are able to attend either private or public facilities without being compromised or penalised from a teaching perspective. In order to assist those unskilled workers that have been impacted by mechanisation and automation, a skills training programme has been established to counteract this effect. This transferrable skills training programme has been introduced throughout all industries as a measure to equip workers with skills applicable to other industries in case of job losses.

Communities were included in all facets of the employment of the FIR and through mutually favourable, development-focussed co-operation with these communities, government and the private sector have been able to meet and exceed the expectations set by the communities in sharing the FIR-related benefits. As is expected with an all-inclusive approach to the FIR of the future, there is a partnership with society and local communities as strategic stakeholders in the development and utilisation of FIR throughout the country. Sustainability in the development and growth of the FIR industry was accomplished through the combined efforts of all the stakeholders through co-operation, motivation, innovation and education. Through the collective purpose and vision of these community partnerships, the FIR was

transformed from being a wealth creation opportunity for the select few or minority, to being a cooperative investment for all participants. As a result of the success of these partnerships, communities are socially and economically revived, further resulting in the near elimination of informal settlements.

The biggest impact of the FIR has been on the job market. Borg (2016) cites Frey and Osborne's estimates that between 40% to 50% of all jobs would either be changed or cease to exist in forward-looking economies. In this vision of 2035, however, this is not the reality. Instead, new jobs have been created that compensate for the loss of unskilled jobs in the workforce. These new jobs present more opportunities for the youth, resulting in a drastic fall in the unemployment rate. The skilled workforce is able to demand a higher wage, thereby improve their quality of life and living conditions. These higher wages are offset against the improvement in productivity and quality of products produced, through which the country is still able to be competitive and a leader in most fields. Crime levels have reduced as the country's workforce is suitably employed and the temptation to turn to crime is diminished. A comprehensive and transparent governance process in the public and private sectors assists in the FIR's support of the sustainable progress and socio-economic development goals of South Africa. This greatly enhanced governance setting stimulates continuous investment in human and physical capital, further stimulating sound economic growth and diversification. The improved governance is grounded on a vibrant legal framework, responsible policymaking, encouragement of FIR acceptance, pursuance of prospects for locals, and the reinvestment of profits to realise equitable consequences for present and future generations. The ICT and industries benefiting from the FIR are being run by a transformed, inclusive and representative group of industry leaders. Attuned to social values, these leaders are dedicated to the shared vision and purpose, improving environmental and social performance, and including all stakeholders in decision-making. They recognise the necessity for best practices, broad stakeholder engagement, and the significance of embracing practical, sustainable development principles.

Government and the private sector have invested heavily in the infrastructure needed to support the FIR. The significantly improved attractiveness of the country has caught the attention of the global community and given rise to an increased cut of FDI, which

has further helped to fund the infrastructure investment. There has been a marked increase in the number of ‘smart cities’ in the country, resulting in autonomous transport and EVs being the norm; the internet is freely available and is seen as a basic right. BD has been effectively mined and has resulted in critical and informative insights being discovered, thereby improving the management of financial, medical and environmental resources. The success of the SKA project and the resultant BD gathering has put the country on the map and enhanced its reputation in managing major projects. Drone technology has advanced to a point where drones are used to assist the police force to maintain law and order, for deliveries, and for conveying people in ‘drone-taxis’, thereby reducing congestion on the roads, resulting in less air pollution, and the reduction of carbon emissions and vehicle accidents. Advances in medical and nanotechnology in South Africa in 2035 have led to cures for cancer, diabetes, malaria and HIV/AIDS and the introduction of affordable mind-controlled prosthetics that radically improve the lives of amputees. Medical advances have further improved life expectancy.

5.5 THE FUTURE VISION OF THE FIR IN SOUTH AFRICA

The desired future of the FIR in South African is set against a backdrop of public and private sector collaboration and transformation, as the main objective is to develop the country into a global leader on the technology front and for FIR to be a critical provider to South Africa’s progress and economic prosperity. This would be achieved through innovation, along with robust education infrastructure to deliver the skilled labour force, and co-operation with all stakeholders. The question that needs to be asked is: how does the FIR in South Africa contribute and what needs to be done to transform the industry into an advanced, integrated and sustainable development partner which encapsulates an all-inclusive sustainable growth and socio-economic development environment? As indicated in Chapter 4, the ‘golden thread’ noted in the research is the impact that the FIR will have on employment and jobs. Consequently, the vision must cater for and come up with radical plans to minimise job losses, and even, potentially, create more than are lost. Steered by the principles and strategic fundamentals identified and discussed earlier, the **“Future Vision of the FIR in South Africa towards 2035”** can be formulated and presented.

5.5.1 A shared vision

From the onset, all public and private sector stakeholders have to agree on the importance of a shared vision that benefits the whole South African populace. The exponential growth and ubiquitous nature of the FIR means that there can be no delay in arriving at and agreeing on the vision – the longer the delay, the further the country will fall behind its global counterparts. The **"Future Vision of the FIR in South Africa towards 2035"** supports the creation of a practical and lasting South African FIR strategy, collaborated and sanctioned by all stakeholders, and delivering clear guidance for the sustainable development of the FIR industry. Thus collaborated and sanctioned by all stakeholders, the strategy has to facilitate as a standard for future technological development, accepting society's perception on the realisation of lasting, sustainable benefits from the country's technological innovators.

The domestic FIR strategy will consist of programmes that undertake to deliver on the following:

- radically improve teamwork, collaboration and communication among all participants;
- clearly recognise industry problems and the related answers;
- determine the skills shortage and put action plans in place;
- increase the awareness and understanding of South Africa's technology sector and capability;
- boost investment in the vital infrastructure required to accommodate the many elements of the FIR;
- encourage a culture of research and development in the industry;
- fast-track the development of innovative technologies to improve the FIR's social, economic and environmental performance; and
- recommend partnership between the industry and research organisations.

The principal aims of the vision are to deliver an impartial, trusted platform upon which to bring together people with diverse points of view and perspectives. The vision strives for dialogue about what best aids society's interest. This is achieved through the employment of a representative sharing process with the ultimate goal of moving towards an improved understanding of the system's interdependence and a superior sense of a shared purpose.

5.5.2 Global competitiveness

The vision strives to encourage all participating stakeholders, from government to business, local communities, labour and society, to work in partnership and develop a competitive industry, thereby contributing to lasting prosperity for all, while, at the same time, assisting with national growth and progress. All stakeholders need to adopt a long-term mind-set to support the development of value creation and a value-adding framework.

The vision aims to increase efficiencies, improve productivity and, at the same time, reduce input costs. Through technological innovation, South Africa's technological industry can become renowned as a global leader in disruptive technologies like AI, robotics, EnS, BD and renewable energy generation, to name a few. The vision strives to build an industry future that is founded on the pillars of financial and operational transparency, regulatory observance, governance, social development and environmental accountability.

5.5.3 Driving education, a skilled workforce and job creation

At inception, all stakeholders must realise that in order to achieve this vision, essential and crucial changes need to be made to the education system. The importance of the STEM related subjects and curricula imply that the partnership between public and private sectors is paramount to ensure that the vision becomes a reality. The main goal of these partnerships is to grow the skilled workforce required to fill the new types of occupations created by the FIR. Programmes are executed that aggressively promote a competitive, knowledge-driven industry in which committed skills- and research-enhancement programmes are followed in partnership with education and research bodies. Transferrable skills training programmes are implemented nationwide at various centres to counteract the negative effect of AI proliferation, automation and mechanisation on employment in the various industries. These programmes are intended to equip workers with the necessary new skills that can be transferred to other industries. Various strategies are implemented to develop alternate ways to stimulate employment; including capitalising on the country's newfound importance and stature in the global technological arena.

5.5.4 Innovation

In the **"Future Vision of the FIR in South Africa towards 2035"**, the FIR industry assists the country in becoming globally bold and results in forceful and consultative social, environmental, technological and commercial innovation. Furthermore, it facilitates the implementation of a nationwide strategy that embraces commercial improvement programmes, to elevate operating and management practices to best practice and to support with the speedy identification of technologies with the potential to alter numerous industries. The vision inspires businesses to apply innovation to the total operating environment and to speed up the process by entering into agreements with technology providers as entities which already harness organisational intelligence.

The vision further aims to inspire companies to implement innovative practices to meet community expectations, with the creation of communally advantageous, development-centred collaborations with government, local companies, local communities and other associated industries. Consistent with an all-encompassing methodology to the **"Future Vision of the FIR in South Africa towards 2035"**, the relationship with society means that local communities are incorporated as strategic stakeholders in embracing and accepting the FIR elements across the country. Partnerships, especially those emphasising joint ownership, risk management and mutual benefits, form critical components of the **"Future Vision of the FIR in South Africa towards 2035"**.

5.5.5 Environment and society

The vision seeks the formation of an influential technology industry grounded on a robust society and healthy environment. The vision further identifies the need for best operating practices, all-encompassing stakeholder engagement, and the significance of embracing and accepting the FIR to deliver sustainable development philosophies in practical ways. The technological industry assigns significance to the matching of economic benefits with social and environmental concerns, without compromising the capability to meet the needs of future generations. In the vision, a business's social environment develops radically through trust built across the stakeholder spectrum,

between government, business, local communities, labour and society. A stable and robust labour environment is created through the implementation of ground-breaking social and workforce programmes, in association with relevant stakeholder training and human resource development strategies. An economically and socially engaged labour force is created through dynamic learner ship programmes and employee ownership structures for those unskilled workers impacted by the explosive effect of automation and AI. In the vision, an empowered and robust workforce environment has the assurance of unions to advance economic and social empowerment. The significant improvement in the investment attractiveness of South Africa will capture global attention, leading to substantial inflows of FDI. In the vision, South Africa meaningfully develops its ability to adapt to transformation, solving many of the legacies of mistrust from the past and forming new, transparent ways of communicating and interacting with all investors and stakeholders.

Having reviewed the preferred scenario and completing the last of the six pillars to formulate the **"Future Vision of the FIR in South Africa towards 2035"**, the rest of this chapter will be dedicated to an examination of whether the research questions and research objectives have been answered and achieved, a review of the problem statement, as well as the contribution of the research and conclusions, recommendations for the future of the FIR in South Africa, and some practical guidelines to address the strategic issues of the FIR of the future vision.

5.6 SETTING UP FOR THE FINAL SCENE

Lombardo (2008) recognises that a good science fiction novel discusses belief systems, social institutions, the environment and transformed cultures, along with progress in technology and science, and should further consider how all these variables intermingle and intermesh to produce a future reality. Is it possible that the creation of scenarios and preferred futures can be likened to the work of a sci-fi novelist? The preceding section of this work focused on the sixth pillar of transforming the present and creating the future. The preferred future was narrowed down and focused on exposing win-win solutions for the FIR in the South African context without compromise. This chapter's purpose is to provide an overview of the research

conducted and will end with a recommendation of strategies in support of a **"Future Vision of the FIR in South Africa towards 2035"**.

5.7 LOOKING BACK

The global and exponential growth in technology as a result of the FIR has meant that countries and organisations not embracing the FIR are at risk of stagnating. The increasing intensity of the growth of these disruptive technologies has meant that the South African environment, which is already under siege by a host of forces, is confronted by an unclear future. Difficulties, such as an unreliable regulatory background, poor ICT infrastructure, rising costs, stressed commodity prices, plunging productivity, high unemployment, corruption and mounting social burdens, are hindering the FIR's implementation, resulting in poor profitability and the inability to remain competitive on the global stage. Flowing from these challenges, it can be seen that it is becoming progressively challenging to anticipate the future and external conditions with any certainty as prevailing business models and traditional practices become obsolete in this ever-changing environment.

The outcomes of the examination of futures study's methodology and theory has reinforced the argument, offered at the commencement of this research paper, that a requirement exists to essentially modify the methods of planning for the future when considering the FIR in South African towards 2035. This study has recognised that growth, as a result of the adoption of the FIR in South Africa, needs to be driven and guided by selected leaders, both in the public and private sectors, and must be measured in terms of job security and growth, as well as the social gains and benefits for the country's people. Decisions made today are frequently with a view to an uncertain future. According to Blyth (2005), the future is a mystery and yet man chooses to dedicate numerous resources and energy to the discussion and study of available possibilities before making a decision about new directions or new investments. By exploring and accepting uncertainty around the influence of the FIR, industries and participants are permitted to identify points of awareness when moving toward the future. Central to this process is the practice of advancing new insights through the use of futures studies, which enables an organisation and, in this case, the South African private and public sectors, to participate in the creation of wisdom.

Nowadays, choices, combined judgements and policies are increasingly informed by or founded on and reinforced by futures studies. The study of the future and scenario design has made significant advancement recently, with scholars creating intellectual traditions and a rock-solid base of understanding. Scenarios can be considered learning tools, assisting societies in learning from the future and thereby altering the ways in which they reflect and act based on their acceptance of new insights and understanding (Blyth, 2005).

5.8 CONSIDERING THE PROBLEM STATEMENT, RESEARCH QUESTIONS AND RESEARCH OBJECTIVES

The **problem statement**, formulated in 1.2 above, considered that, as a result of the growing importance and possible major impact of the FIR on the global economies, South Africa is at risk of not being adequately prepared to participate and benefit from this event, which will have a consequent negative impact on the economy and socio-economic system in the country. This research intended to create new insight and understanding concerning the future of the FIR in South Africa in the years leading up to 2035, through the design and formulation of scenarios. The **primary research objective**, as stated in 1.3.1 above, was to investigate the readiness of private and public sector South Africa for the FIR by developing alternative scenarios, including the identification of the desired future for the South African private and public sector in the period up to 2035. The primary objective was achieved through the establishment of innovative strategies in which both the public and private sector can, together as co-stakeholders, embrace and accept the FIR. One of the aims of this research was to provide the public and private sectors with practical yet progressive ideas on how to tackle some of the issues faced by this country as a consequence of the potentially ‘game-changing’ status of the FIR.

The research method was planned around the six pillars of futures studies of Inayatullah, in which emphasis was placed on scenario planning and the creation of alternative scenarios for the FIR in South Africa towards 2035. CLA was applied as a technique to deepen the future and facilitate the observation of issues from various viewpoints in crafting transformative spaces.

The **secondary research objectives**, outlined in Table 5.1 below, related to certain factors that were considered in determining whether South Africa is indeed ready for the FIR.

Table 5.1: Secondary research objectives	
RO_1	To conduct an in-depth analysis of FIR in South Africa and establish if the private and public sectors are taking note of the phenomenon.
RO_2	To consider emerging threats and opportunities that will influence the future of FIR in South Africa by plotting various alternative futures in accordance with specific drivers identified.
RO_3	To inspire dialogue throughout all industries, at all levels of stake holding, to develop an inclusive, consistent strategic plan to embrace the FIR.
RO_4	To gain a better understanding of the best possible future for South Africa, the nature of development and failure in the African context will also be explored.
RO_5	To analyse South Africa's progress and failure in terms of the FIR.
RO_6	To develop a simple yet practical set of recommendations to address the main factors that inhibit the possible implementation of the FIR, with the aim of improving the level of technology management in South Africa.

From the objectives discussed previously, the study outlined questions formulated to support the objectives of the research. The research endeavoured to create strategies illustrating how South Africa can adapt to the challenges it faces by embracing the FIR as indicated. The **research questions** for this study were articulated, incorporated and addressed in order to underpin the research, thereby ensuring the attainment of the research objectives.

Table 5.2: Secondary research questions	
RQ_1	What are the factors to be considered to determine the readiness of South African business for the FIR?
RQ_2	What are the potential implications and impact on the South African labour market as a result of the FIR movement?
RQ_3	Which industry sectors will be most impacted by the FIR?

RQ_4	What are the consequences to the South African economy of not embracing the FIR?
RQ_5	Who are the role-players to be involved in the determination of skills shortages and does South Africa have the capacity to overcome these shortages?
RQ_6	What are the potential implications and impact on the South African socio-economic system as a result of the FIR movement?

Through the application of scenario design and development as tools, a comprehensive view was formed of the FIR in South Africa's extremely uncertain world, looking additionally at stories about the future, supporting the various stakeholders in identifying and adjusting to the dynamically shifting environment. Blyth (2005) suggests that scenario planning gradually releases humans from conditioned worldviews and traditions, and exposes them to fresh perspectives and behaviours, which, in so doing, enriches decisions made about the future and guides strategic choices for future triumph. In this study, scenarios were further utilised to articulate alternate, potential paths into the future, embracing present selections and actions with insight on how they could possibly shape the future. Scenario planning, a rounded, inclusive methodology, was used to enhance understanding and cultivate insight into the extensive implications of the issues and driving forces influencing the FIR. This method permits the various stakeholders to see the future in several plausible ways. These fashioned scenarios formed the groundwork of a **"Future Vision of the FIR in South Africa towards 2035"**, eventually providing the mechanism for a preferred future for the FIR.

In the **"Future Vision of the FIR in South Africa towards 2035"**, the FIR in South African has been transformed, through innovation, co-operation and education, from an industry for the few to an industry that embraces all stakeholders and inhabitants of the country. This FIR transformation is based on:

- the recognition of FIR-specific issues with the relevant responses;
- improved co-operation and communication among all stakeholders, striving for a shared vision and future;

- the advancement and execution of innovative technologies leading to improved environmental and social performance;
- greater productivity and cost reduction as a result of technological innovation;
- a world of consultative social, technological, environmental and commercial innovation;
- the introduction of new best practices to meet community needs and expectations;
- the advancement of sustainable economic growth and socio-economic improvement;
- improved governance, strengthened by competitive legislative and operating environments; and
- the implementation of a stable labour environment through ground-breaking social and labour programmes.

Therefore, the primary objective of the research study has been achieved: to formulate a **"Future Vision of the FIR in South Africa towards 2035"**, based on the alternative scenarios.

5.9 RELEVANCE AND CONTRIBUTION OF THE RESEARCH

The relevance of such a study is constantly increasing - as the FIR gains momentum and grows exponentially, the need for improved management and strategies from all stakeholders to embrace this ubiquitous phenomenon is becoming more relevant to a future-orientated research methodology. At present, South Africa as a whole has not totally embraced the FIR and, if current trends continue, the country faces the possibility of being a late entrant into the technological space; this will mean that the country will not be competitive and will be disadvantaged in vying for the FDI dollar. Thus, the relevance of this study can benefit South Africans by further highlighting the significance of accepting the FIR.

The role of the research was to add theoretical, methodological and practical value:

- **Theoretical value:** The research enabled a review and assessment of an assortment of literature resources on the methodologies and pillars of futures

studies, the various stages of scenario planning, CLA and strategic visioning, respectively. The aim was to contribute to the existing pool of knowledge with the comprehensive combination of these futures approaches.

- **Methodological value:** The research reflected on the future of the FIR in a South African context by applying the six pillars method and framework of futures studies. This gave rise to the creation of a set of scenarios applicable to the future of the FIR in South Africa and further identified the preferred future for the FIR.
- **Practical value:** The scenarios created will offer various FIR industry stakeholders different insights and analyses into a number of interpretations of the potential roads that could be embarked upon in the FIR future. The scenario application resulted in the formulation and creation of a **"Future Vision of the FIR in South Africa towards 2035"**, delivering the basis for the public and private sector affected by the FIR to grasp and employ the opportunities offered and to realize sustainable, all-inclusive progress.

5.10 STRENGTHS AND WEAKNESSES OF THE RESEARCH

A detailed environmental scan, which included an in-depth literature review, was undertaken to identify the present forces, drivers and trends that impact the future of the FIR. The scan and review was utilised to indicate the current status of the FIR and its likely direction. The environmental scan was further enriched by the views and assessments of various FIR experts.

The 'win-win' scenario is more difficult to formulate but, if successful, may be one of the most influential and powerful tools in realising a change in the national mind-set. Unfortunately, it is not so simple to place reliance on government and leaders to facilitate the change, especially in a country suffering extensively at the hands of corruption, inefficiency and nepotism - there is no single 'silver bullet' that will deliver the necessary requirements for a preferred future. Leaders will need to intercede at some point and implement the strategies necessary to ensure the sustainable and continued embrace of the FIR. Local and global leadership will need to ensure that the FIR is implemented and secured for generations to come, along with continued socio-economic and economic development. This study was motivated by the disruptive economic, technological and socio-economic capabilities of the FIR on South Africa's

future, and by how these might benefit all inhabitants. The strategies contain alternative ideas that were derived to assist all South African policy-makers (private and public sectors), as well as to direct the manner in which the FIR is managed as it moves towards creating positive solutions.

Another possible weakness of the research is that the FIR and its related impacts on the public and private sectors have not sufficiently lent themselves to detailed academic studies by scholars and other researchers. There is thus a dearth of academic studies and FIR industry leaders' expertise from which to draw.

5.11 OPPORTUNITIES FOR FUTURE RESEARCH

The challenge of embracing and establishing the necessary infrastructure to accommodate the resounding impact of the FIR in South Africa is not one that can be resolved overnight. This study aimed to take small steps towards change in South Africa's technological mind-set. It is hoped that the results of the research will engender an understanding of the complications should technology not be elevated to the levels that are necessary for the fulfilment of the **"Future Vision of the FIR in South Africa towards 2035"**.

The **"Future Vision of the FIR in South Africa towards 2035"**, grounded and developed on the "Fifth Element" scenario for the FIR in South Africa, offers some possible practical recommendations which acknowledge and propose actions required by the collective stakeholders of the FIR in South Africa. It is important that these stakeholders are involved in supervising and monitoring the implementation of the **"Future Vision of the FIR in South Africa towards 2035"**, in order to guarantee that the envisioned outcomes are provided along the path to a preferred future.

A practical framework will be required to include all public and private sector stakeholders, thereby integrating the results and the successes of programme and policy interventions in creating an all-encompassing positive technological impact; an outcome-based monitoring framework is suggested with clear, measureable targets of anticipated outcomes, maintained by clearly defined objectives. The execution of the vision, with a differentiated range of actions and stakeholders, will necessitate the

formation of a strategic, co-ordinated capability, to carry out the acknowledged activities, including co-ordinated policy research to perfect procedures for realising the vision, provide technical support for effective activity application, and create a think-tank competency for all related activities. Co-ordination of the complete range of tasks under the implementation plan is critically reliant on a strategic management function.

5.12 CONCLUSIONS AND RECOMMENDATIONS FOR THE FUTURE OF THE FIR IN SOUTH AFRICA

The embrace of the FIR by the public and private sectors in developing a preferred future for South Africa necessitates more than scenario planning, although it is a desired methodology that creates fresh insight and knowledge regarding the industry and its range of futures. What is required, above all, is commitment and dedication from all stakeholders embracing the FIR to effectively change the future through the design of an action plan and strategy that can realise the **"Future Vision of the FIR in South Africa towards 2035"**. Moving resolutely towards the **"Future Vision of the FIR in South Africa towards 2035"** will require all South African stakeholders to participate more closely, working together as an inclusive group to ensure that the embrace of the FIR is complete and can be beneficially realised by all.

The **"Future Vision of the FIR in South Africa towards 2035"** encapsulates the objectives and ambitions of all South African public and private sector stakeholders, including companies, society, government, local communities and labour. Even though the realisation of the vision may seem impossible, the researcher believes that, through resolute stakeholder effort and by aggressively addressing the identified FIR issues and challenges, it is indeed realisable, for the benefit of not only the select few but the country as a whole. Indeed, there is no alternative, because to take a back seat and wait for the FIR to happen will be disastrous. The country will unquestionably be left behind the rest of the world when it comes to embracing technology and will lose out on the positive effects that it can have on the collective of the country.

Through innovation, a stable regulatory environment, the sharing of the same values, and the establishment of an environment of trust, shared purpose and benefits, the **"Future Vision of the FIR in South Africa towards 2035"** is attainable. The FIR is

able to facilitate positive progress and change in South Africa through social, technological and environmental innovation. Through this process it can address the challenges that handicap productivity in the industry and take the lead in environmental and social sustainability issues, crucial to the protection of South Africa's potential position as a key player in the global technology landscape leading up to 2035. A collective vision, exceptional leadership and a desire for innovation will ensure that the acceptance and implementation of the FIR by the public and private sectors continue to drive social and economic development for South Africa into the future towards 2035 and beyond.

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