UNIVERSITY OF KWAZULU-NATAL

ANALYSING THE ETHEKWINI GREEN ECONOMY ACCORDING TO ITS DYNAMIC AND COMPLEX COMPONENTS FOR IDENTIFYING LEVERAGE POINTS

By

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DECLARATION

I, Magashen. K. Naidoo, declare that

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A journey into the unknown is seldom embarked on in solitude. This journey tested my endurance, sanity, critical thinking and I conclude all the more stronger and resolute, albeit only through the support of my well-wishers.

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DEDICATION

This Doctorate is dedicated to all my high school teachers who were certain that I was going to fail Matric.

GLOSSARY

- Anthropogenic activity: Human activity that results in the emission of greenhouse gases.
- Complex Adaptive Systems: A type of system that is made up of more than two components that have the ability to learn and adapt to stimuli, from other components and the broader environment, within which the component is embedded.
- Climate change: Long term change in climate patterns that often results in natural disasters, such as flooding, droughts and severe storms.
- Climate change mitigation: Activities or interventions that either seek to decrease the amount of anthropogenic greenhouse gas emissions or sequestrate emissions from the atmosphere.
- Energy efficiency: The reduction in consumption of energy, often electricity, for the same level of output.
- Fossil fuels: Sources of energy that are derived from extraction of natural material from below ground.
- Renewable energy: Energy that is derived from renewable, often natural sources that have the ability to replenish itself, such as solar energy, hydro power or wind power.

LIST OF ABBREVIATIONS AND ACRONYMS

- ABM: Agent-based Modelling.
- ACE: Agent-based Computational Economics.
- ACEGES: Agent-based Computational Economics of the Global Energy System.
- BASA: Banking Association of South Africa.
- C40: C40 Cities Climate Leadership Group.
- CAS: Complex Adaptive Systems.
- CH_4: Methane.
- CO_2: Carbon dioxide.
- COP: Conference of Parties.
- DCCS: Durban Climate Change Strategy.
- EMA: EThekwini Municipal Area.
- GDP: Gross Domestic Product.
- GHG: Greenhouse gas.
- GVA: Gross Value Added.
- GWh: Gigawatt hour.
- HFC: Hydrofluorocarbon.
- IDP: Integrated Development Plan.
- IEP: Integrated Energy Plan.
- INDC: Intended Nationally Determined Contribution.
- IRP: Integrated Resource Plan.
- KSEF: KwaZulu-Natal Sustainable Energy Forum.
- LTMS: Long-Term Mitigation Scenarios.
- N_2O: Nitrous oxide.
- NDC: Nationally Determined Contribution.
- OD: Organisational Development.
- PFC: Perfluorocarbon.
- SASA: South African Sugar Association.
- SDF: Spatial Development Framework.
- SDG: Sustainable Development Goal.
- SF_6: Sulphur hexafluoride.
- tCO_2e: Tons of carbon dioxide equivalent.

ABSTRACT

It is widely accepted that climate change is taking place as a result of anthropogenic activities. The rapid rate of the current bout of climate change being experienced is unprecedented. Climate change results in disastrous consequences for humankind. However, climate change also offers opportunities which include the potential for developing a green economy. A green economy is a concept that will result in actions for enhancing the growth of an economy, while simultaneously protecting the environment and spurring progress towards social equity. This study was of the position that the eThekwini green economy is not well understood in terms of its dynamic and complex characteristics. Specifically, the core focus of the study was to identify the components that make up the eThekwini green economy, highlight the characteristics of the components, determine the manner in which those components interact, pinpoint leverage points in the system and develop a framework to depict the eThekwini green economy from the findings. Pragmatism was the guiding philosophical worldview for this research, which resulted in a mixed methods approach being adopted. Data collection tools included surveys, focus groups and interviews. The population and sample for this research consisted of sixteen purposely identified individuals for interviews. In addition, four hundred and ninety seven individuals were identified for survey participation and a total of twenty two for focus groups. It was noted during the study that many businesses that provide green related goods and services, do not view themselves as being part of the green economy. It is widely accepted that the eThekwini green economy does exist, albeit it has stemmed as organic growth from the broader economy. A total of seven key components were identified through the research, with a total of forty two sub components. In addition, a total of ten leverage points have been highlighted, the principal of which is that without addressing unemployment, discretionary income, inequality and Gross Domestic Product (GDP) per capita, the eThekwini green economy will not grow. It was further found that no component operates in isolation. Characteristics of components were broadly found to be made up of similar elements, but to differing degrees. A plethora of indicators were raised and synthesised into a matrix of five core indicator segments. All information gathered through the study resulted in the development of a framework that depicts the manner in which the eThekwini green economy operates.

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CHAPTER ONE: INTRODUCTION

1.1 Introduction

This research aims to dissect the eThekwini green economy to identify the components that make up the eThekwini green economy, the characteristics of the components and the manner in which components interact with other components. Thereafter, Agent-based Computational Economics (ACE) will be utilised as a theoretical underpinning to develop a framework that will be based on primary and secondary data that emanates from this research, to illustrate the manner in which the eThekwini green economy operates. The framework will allow insight into the eThekwini green economy by all stakeholders who are not necessarily savvy with the use of modelling tools.

It is important to note that due to the nature of the research and identified methodologies, especially the complexity related theoretical aspects, this research will identify and discuss a multitude of different thematic areas. Those varying thematic areas are critical for a thorough analysis of the eThekwini green economy, which would then yield a clearer understanding of the eThekwini green economy. While there are a plethora of scientific, economic and social aspects in this thesis, it has been structured in a manner that begins with the root causes and then disaggregates the line of research from that point.

There is verifiable proof that climate change is occurring (Oppenheimer and Antila-Hughes, 2016; Riebeek, 2010; Ross et al., 2016; Myers et al., 2015). This is supported by the Intergovernmental Panel on Climate Change (2014) which states that not only is climate change occurring but it is as a result of anthropogenic causes. Salinger (2005) further adds that from 1000's to the early 1900's worldwide surface air temperature has varied by 0.5°C, however from the early 1900's the average temperature has risen by 0.6°C. The increase in temperatures are supported by Intergovernmental Panel on Climate Change (2013) who states that a warming of between 0.65°C and 1.06°C from 1880 to 2012 has occurred for land and ocean surface temperatures. The National Aeronautics and Space Administration (2016) further supports the notion that temperatures have risen by 1°C from the late 1800's.

According to the World Economic Forum (2016) the failure of climate change mitigation and adaptation is ranked as the highest risk in 2016, for the coming future, ahead of 'weapons of mass destruction' in second place and the 'water crisis' in third place. The notion that climate change is the biggest entrenched risk, which is currently being experienced, is supported by He (2016) and Frankhauser and Stern (2016) who also state that it could result in severe feedback loops. A critical failure of business leaders to acknowledge that climate change presents imminent challenges is further raised by the World Economic Forum (2016). However, Dietz et al. (2016) observes that businesses are becoming more cognisant of the potential impacts of climate change.

The 2017 Global Risks Report published by the World Economy Forum (2017) takes into account the alarming discontent in various countries, such as the United Kingdom and the United States of America, that have given rise to nationalist agendas and champions. It should be noted that according to the World Economy Forum (2017) climate change mitigation and adaptation has shifted from the highest impact risk to the fifth highest, in terms of impact; but with the vast majority of the highest risks having direct environmental linkages. A critical point highlighted by the World Economic Forum (2017) is that a systemic approach should also take into account risks that will emerge from the initiatives that seek to address environmental issues.

In an ever-increasingly complex world the linkages between climate change and business are growing stronger and more powerful. This is supported by Hoffman (2016) who states that businesses approach climate change as an evolving matter with demands from various sources such as government, consumers, financial institutions and suppliers, to name a few. Hoffman (2016) goes on to state that the implications of climate change on various businesses will be diverse, but businesses have a unique opportunity to drive climate change actions, as they are the producers of the bulk of the goods and services that humans consume. The position that businesses will be affected by climate change is supported by Gasbarro and Pinkse (2016) and Amran et al. (2015).

There is ultimately a perilous nexus between risks faced by the broader population and businesses. It should be acknowledged that consumers and employees, amongst other stakeholders, come from communities which would be impacted by climate

change, along with critical infrastructure, this will have a substantial effect on the ability of companies to continue their operations (United Nations Global Compact, 2011).

In addition to businesses, the Carbon Disclosure Project (2015) states that cities are critical for climate change mitigation initiatives. This is due to approximately 75% of greenhouse gas (GHG) emissions emanating from cities. The United Nations Habitat (2011) supports this by stating that cities can contribute up to 70% of GHG emissions. However, Dodman (2009) states that cities are often accused of emitting the bulk of emissions, but the per capita emissions of cities can be lower than per capita national GHG emissions. Dodman (2009) also adds that cities have substantial potential for decreasing emissions. Satterthwaite (2008) supports the counter argument that cities should not be blamed for the bulk of emissions. However, it is not disputed that cities are still a substantial source of GHG emissions and have vast potential to decrease those emissions.

As can be gleaned from Hoffman (2016) and Carbon Disclosure Project (2015) there are a variety of stakeholders that are imperative for the successful implementation of climate change initiatives. It should be further noted that these stakeholders will have to work in tandem with each other and the relationships amongst them should be comprehensively understood, to allow for targeted stimulation initiatives.

While climate change has a myriad number of negative consequences, it also presents a number of opportunities such as South Africa's vast resources of solar and wind (Montmasson-Clair, 2012). Montmasson-Clair (2012) further adds that the green economy has the potential of delivering economic growth, jobs and environmental and social benefits. This is supported by Cosbey (2011) and Barbier (2016). As a result there are a vast number of opportunities for businesses in the green economy. The opportunities should not be viewed independently of further challenges; Kaggwa et al. (2013) states that South Africa is reliant on industries that have a high carbon intensity and measures taken to reduce emissions will negatively impact poverty levels, increase unemployment and inequality according to Montmasson-Clair (2012). Kaggwa et al. (2013) further adds that South Africa will continue to be reliant on coal for energy. However, this is changing, the contribution of installed capacity of

renewable energy that has been contracted by Eskom, as of March 2016, is 3901MW from Independent Power Producers (Eskom, 2016).

Frankhauser and Stern (2016) state that economic development and climate change actions do not have to be mutually exclusive and pursuing low carbon economic objectives can be achieved while simultaneously reducing poverty. This is supported by Montmasson-Clair (2012).

A pertinent point for this research raised by Frankhauser and Stern (2016, pg. 23) is *"Standard growth theory, general equilibrium and marginal methods will, as ever, have much to contribute but they will be nowhere near sufficient. This is about immense risks and radical change were time is of the essence. We should seek a dynamic economics where we tackle directly issues involving pace and scale of change in the context of major and systemic risks"*.

This is further supported by Chapman et al. (2016) who highlights the importance of understanding systemic features for policy development and in the process of a co-evolutionary approach being utilised to understand cities some fundamental knowledge could be refuted.

There has been numerous pieces of research that seek to explore aspects of a green economy. This has largely been undertaken in a disaggregated approach, where research questions focus on minute aspects of a green economy. It was observed in the literature that there has been few very research attempts that encompass the green economy in totality; even fewer research attempts exist that seek to understand the green economy through a complex systems lens. However, there has been economic research and models developed in Europe and America with a complex systems lens but for the broader economy, such as EURACE and the Aspen models which will be discussed later in the thesis. At a national level, system dynamics has been predominately utilised to research the green economy and largely in one province only of South Africa. No research was found where an African city's green economy is scrutinised and researched through an ACE underpinning to understand the way in which the local green economy operates.

There is a need for ACE theory and models, and related complexity theories and models, to be utilised as a foundation for contributing to the understanding of green

economies, amongst other areas. This lies in the ability of ACE and complexity theory, at large, to incorporate a plethora of various components, or even thematic areas, from which unforeseen aspects can emerge (Gatti et al., 2010; Irwin, 2010). This is often from different thematic areas, for example, in the case of a green economy it would include environmental, economic and social issues (United Nations Environment Programme, 2010; United Nations Economic Commission for Europe and United Nations Environment Programme, 2011). Often the 'adapter' to understand the different thematic areas and to get the thematic areas to link into each other in a coherent manner is sorely missed and deeper insight is missed. This can be solved by ACE and related complexity theories. This is not to say that there are no models that can assist, but rather complexity offers the ability for the unseen to become visible (Tesfatsion, 2003; Levy, 2009). This means the emergent qualities start to become apparent with simulations or framework assessments, and can then be traced to leverages points, which would have the ability to catalyse any effort or any system. The inherent complications when dealing with large and diverse datasets, components and feedback loops makes developing ACE and complexity models and frameworks are copious. It is the position of this research that developing such models and frameworks, in an African context, at a country level, will become too complex. To demonstrate as an example, South Africa is a very diverse country, there are eleven official languages and incorporating the nuances of each culture or region into a national ACE or complexity related framework and model will not reveal the unseen that we are searching for – as it is unlikely, at this point, that resources and technical abilities will be able to process the sheer complexities. The same can be said for provincial models and frameworks. The best level at which to pitch these models and frameworks is at a Municipal level, not a city level which is at a lower level. This will then allow the appropriate datasets and components to be taken into account, resulting in a complexity based model or framework that is not too complicated and situated at the right level for translation into implementation activities – as Municipalities are generally considered the 'implementation arm' of the three spheres of government in South Africa.

This chapter will provide background and context on climate change which will include the fundamentals of climate change and provide a comparison of GHG emissions against other cities. Thereafter, the Paris Agreement and the Deadline 2020

research will be discussed. The next sub-section will focus on providing an overview of the green economy, traditional sectors of the green economy and then hone in on the broader eThekwini economy. Thereafter, the problem statement of the research will be presented, along with the key research questions, research limitations, assumptions and significance of the research. The penultimate section of this chapter will then provide an overview of forthcoming chapters. A concluding section will round off the chapter.

1.2 Background

1.2.1 Climate change

1.2.1.1 Overview of climate change

According to the Australian Academy of Science (2015) the world has experienced climate change before, however, what makes the current bout of climate change so concerning is the rapid pace at which it is occurring. Oppenheimer and Antila-Hughes (2016) and Riebeek (2010) support the position that climate change has been previously experienced and that the current episode of climate change is being experienced within a shorter timeframe.

There are two approaches to address climate change: mitigation and adaption.

Climate change mitigation, according to the United Nations (2015), seeks to limit the future emissions of GHGs and promote interventions that will remove GHGs from the atmosphere that have already been emitted by anthropogenic activity.

The World Resources Institute et al. (2016) developed a standardised protocol for cities to account and report their GHG emissions. In that protocol the following GHGs are accounted for: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_20), sulphur hexafluoride (SF_6), perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs). While CO_2 is the most abundant of the GHGs, it has a global warming potential of one. CH_4 is by far not as abundant but is twenty eight times more harmful than CO_2 (Myhre et al., 2013; World Resources Institute et al., 2016). It should be noted that GHGs are emitted through natural phenomenon and anthropogenic activities (Tian et al., 2016; Sahely et al., 2006).

Carbon that is added to the natural carbon cycle by anthropogenic activities causes the carbon cycle to go off balance, this change in the natural cycle results in a contribution to the greenhouse effect (Riebeek, 2011; Malhi et al., 2002). Anthropogenic activity that contributes to GHG emissions and as a result cause the carbon cycle to go off equilibrium, include forest degradation (Pearson et al., 2017), agricultural activities (Vetter et al., 2017; Bennetzen et al., 2016), fossil fuel derived electricity (De Gouw et al., 2014; Pfenninger and Keirstead, 2015), transportation (Pålsson and Kovács, 2014; Velazquez et al., 2015) and manufacturing (Yan and Fang, 2015; Ramli and Munisamy, 2015).

Anthropogenic emissions are effectively added to the carbon cycle and this increases the total amount of GHG emissions in the atmosphere, or cycle, which contributes to the ferocity of the greenhouse effect. According to Solomon et al. (2007) and Myhre et al. (2013), the greenhouse effect is a natural phenomenon, which sustains the Earth's warmth. However, the emitting of GHGs, which accumulate in the atmosphere, leads to a greater degree of warming. This is depicted in Figure 1.1. The sun emits energy which is absorbed by the earth's landmass, oceans and atmosphere, while reflecting some of the energy (heat) back into space. The GHGs that have accumulated in the atmosphere are responsible for containing some of the heat within Earth's atmosphere. As the amount of GHGs increase so too will the amount of heat that is retained in the Earth's atmosphere. According to Oppenheimer and Antila-Hughes (2016) and Demarée and Verheyden (2016), without the greenhouse effect life would not be possible on Earth as the temperate would be far below freezing, this is supported by Anderson et al. (2016).

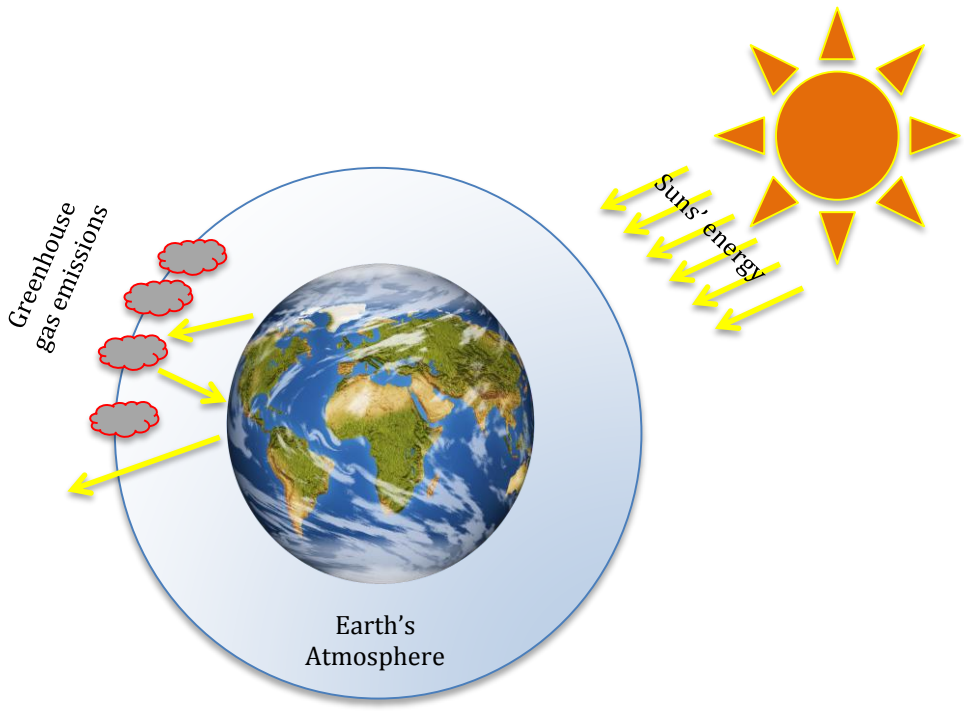

Figure 1.1: The greenhouse effect

Source: Author.

According to Pachauri et al. (2014), there is an extremely high degree of certainty that anthropogenic activity, which leads to the emitting of GHGs and ultimately an increase in the greenhouse effect, results in global warming, this is supported by Cook et al. (2016).

According to Naqvi and Seijan (2011, pg. 20), *"Global Warming defined as the increase of the average temperature of earth as the earth is getting hotter with disasters like frequent hurricanes, droughts and floods"*. Anyona and Rop (2016, pg. 127) add *"Global warming is a climate-related hazard that affects atmospheric and ocean processes in any given ecosystem"*.

The Intergovernmental Panel on Climate Change (2007, pg. 30) defines climate change as *"... a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity"*.

The Intergovernmental Panel on Climate Change (2013) go on to highlight that each region and locality will face different impacts as a result of climate change, which is confirmed by Arnell et al. (2016). The broad impacts that cities can anticipate are droughts (eThekwini Municipality, 2014a; Salinger, 2005), floods (eThekwini Municipality, 2014a; Douglas et al., 2008), increase in severe storms (eThekwini Municipality, 2014a; Roberts and O'Donoghue, 2013), sea-level rise (Oppenheimer and Antila-Hughes, 2016; eThekwini Municipality, 2014a; Yang et al., 2014) and negatively impacted food security (Wheeler and von Braun, 2013; Roberts and O'Donoghue, 2013).

According to the Intergovernmental Panel on Climate Change (2014), adaptation seeks to negate the negative impacts of climate change. This can be further supported by Noble et al. (2014, pg. 836) *"Adaptation needs arise when the anticipated risks or experienced impacts of climate change require action to ensure the safety of populations and the security of assets, including ecosystems and their services"*.

1.2.1.2 Climate change mitigation measures

As mentioned briefly in the previous section of this chapter, there are two methods of mitigating GHG emissions from anthropogenic activity. These are discussed below.

The first method is the reduction of GHGs emitted from anthropogenic activity. It should be noted that while a reduction in emissions is sought, the fundamental value that human's derive from these activities should remain constant or must be enhanced while undertaking mitigation measures.

The most common mitigation interventions to reduce GHG emissions include the utilisation of renewable energy (Dechezleprêtre et al., 2011; Ludig et al., 2011; Panwar et al., 2011), energy efficiency (Dechezleprêtre et al., 2011; Bauer et al., 2016; Fujimori et al., 2014), non-motorised transport (Gouldson et al., 2016; Kusakabe et al., 2015; Ramachandra, 2016), retrofitting buildings (Santamouris, 2016; Gouldson et al., 2016) and recycling (Ali et al., 2013; Cadez and Czerny, 2016).

The second approach that is utilised for climate change mitigation interventions is sequestrating carbon from Earth's atmosphere. Specific measures include engineering based solutions, such as carbon-capture and storage (Szulczewski et al., 2012; King

and Gutberlet, 2013) and low-technology solutions such as planting trees (Bäckstrand and Lövbrand, 2006).

1.2.1.3 EThekwini greenhouse gas emissions

There are various methodologies and protocols that guide the calculation of GHG emissions. According to eThekwini Municipality (2017a), the eThekwini Municipality has adopted the 'Global Protocol for Community-Scale Greenhouse Gas Emissions Inventory', developed by World Resources Institute et al. (2016), to guide the compilation of the eThekwini Municipal GHG emissions inventory.

Since 2010, the eThekwini Municipality has been updating its inventory on an annual basis (eThekwini Municipality, 2017a), however records date back to as early as 2002. Figure 1.2 indicates the GHG emissions for the eThekwini Municipality as an organisation, i.e. from the local government operations in dark blue and all other emissions that occur within the eThekwini Municipal Area (EMA), in light blue (eThekwini Municipality, 2017a). When the two categories are added, the total amount of GHGs emitted from within the EMA emerges. As can be seen in Figure 1.2, total emissions during the 2010 calendar year amounted to 27,066,285 tCO_2e (tons of carbon dioxide equivalent) with a marginal increase in 2011 to 27,649,400 tCO_2e (eThekwini Municipality, 2017a). However, there was a substantial increase in 2012 to 29,360,395 tCO_2e, with the increase primarily attributable to the improved quality of data collection (eThekwini Municipality, 2017a). There was a slight decrease in total emissions in the 2013 calendar year, from 2012, to 28,741,558 tCO_2e, a slight increase in 2014 to 29,092003 tCO_2e and a substantial reduction in 2015 to 27,067,912CO_2e (eThekwini Municipality, 2017a).

An important point to note is that since 2011, GHG emissions from local government operations only decreased from 1,551,420 tCO_2e, to 1,526,431 tCO_2e in 2012 and to 1,450,928 tCO_2e in 2013 but increased to 1,586,674 tCO_2e in 2014, and 1,715,259 tCO_2e in 2015 (eThekwini Municipality, 2017a).

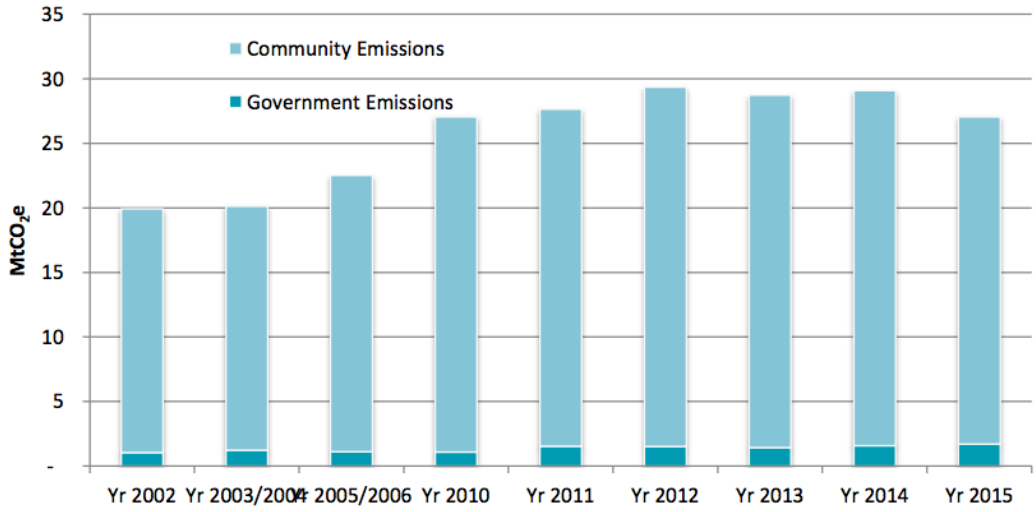

Figure 1.2: Historic greenhouse gas emissions of the eThekwini Municipal Area

Source: eThekwini Municipality (2017a, pg. 11).

During the 2014 calendar year, total per capita emissions equated to 8.26 tCO_2e (eThekwini Municipality, 2016), a slight decrease from 2013 per capita emission of 8.35 tCO_2e (eThekwini Municipality, 2015a); this is for all activity within the EMA. This has decreased further to 8.08 tCO_2e in 2015 (eThekwini Municipality, 2017a). It is important to note that the updating of the GHG inventory is undertaken in retrospect. As a result the 2016 eThekwini GHG inventory will start in mid-2017 and will only be completed in mid-2018.

According to Sustainable Energy Africa (2015), the per capita energy emissions (not total emissions) of various cities through the world differ substantially, these figures are indicated in Table 1.1.

City	Per capita tCO_2e
Sao Paulo	1.4
Delhi	1.5
Barcelona	4.2
Tokyo	4.9
Nelson Mandela Bay	5.3
Johannesburg	6.4
EThekwini	7.7
Cape Town	7.8
London	9.6
New York	10.5
Shanghai	11.7

Table 1.1: Energy per capita emissions of cities

Source: Sustainable Energy Africa (2015, pg. 32).

As can be seen from the Table 1.1, eThekwini Municipality's per capita emissions is only slightly lower than some cities that are a lot more developed (Sustainable Energy Africa, 2015).

1.2.1.4 Paris Agreement

After years of futile negotiations on a global climate change agreement, a major milestone was achieved with the Paris Agreement in 2015 (Dimitrov, 2016; Rajamani, 2016). According to Clémençon (2016), the Paris Agreement was reached during the Conference of the Parties (COP) 21, but COP17 hosted in eThekwini Municipality (Durban) was a key catalyst for the Paris Agreement. Clémençon (2016) goes on to highlight that some countries have made voluntary pledges towards the Paris Agreement, which the countries will be responsible for achieving.

According to the United Nations (2015), the parties to the agreement are cognisant of a number of fundamentals on which the agreement rests. These include the linkages between climate change and sustainable development, common but differentiated roles amongst the different types of countries and development of jobs within relevant national objectives. The three key elements of the Paris Agreement are: limit temperature increase to within 1.5°C pre-industrial temperature levels, enhance adaptation and resilience in a manner that protects food security, and ensure that relevant finances allow for the implementation of responses which endeavour to limit temperature increases and enhance resilience.

The South African national government did submit an Intended Nationally Determined Contribution (INDC) in the lead up to COP21, but the INDC was very broad and implications for cities remained vague. The INDC became referred to as Nationally Determined Contribution (NDC) after the Paris Agreement came into effect. It is important to note that the Paris Agreement was agreed upon by national governments throughout the world. The translation of this agreement for specific impacts to cities remained unknown for quite some time.

1.2.1.5 Deadline 2020

Deadline 2020, developed by C40 Cities Climate Leadership Group (C40), sought to translate commitments by national governments to the Paris Agreement into implications for cities and what responses cities need to pursue (C40, 2016).

According to C40 (2016), major findings of the Deadline 2020 research included that average per capita emissions would need to decrease to 2.9tCO_2e. The latest eThekwini Municipality per capita emissions for the 2015 calendar year stands at 8.08 tCO_2e (eThekwini Municipality, 2017a). A total investment of over $ 1 trillion is needed for C40 member cities to meet the stated objectives of the Paris Agreement.

In addition, one of the main aspects developed through the Deadline 2020 research are four emission trajectories that different types of C40 cities should follow. These four trajectories are a function of GDP per capita and GHGs per capita. They are: steep decline (high GDP, high GHGs), steady decline (high GDP, low GHGs), early peak (low GDP, high GHGs) and late peak (low GDP, low GHGs). EThekwini Municipality would fall into the early peak trajectory. The research identifies a few priority areas that cities should focus on. These are: urban planning, transportation, energy, buildings and waste (C40, 2016).

1.2.2 Green economy

The United Nations Environment Programme (2010, pg. 5) defines a green economy as that which culminates in *"improved human well-being and social equity, while significantly reducing environmental risks and ecological scarciti*es*"*.

In terms of the physical environmental linkage with the economy, the green economy 'principle' essentially advocates for the decoupling of economic output and environmental impacts, usually measured in GHG emissions – in essence making the

economy more efficient in its use of fossil fuels (Schandl et al., 2016; Lorek and Spangenberg, 2014). According to Green Growth Knowledge Platform (2013), the transition to a green economy is one that is complex in nature and involves a multitude of aspects. Figure 1.3 depicts what needs to be seen, with the blue line indicating continuous growth in GDP and the red line a consistent decrease in GHG emissions; or more broadly according to United Nations Environment Programme (2014, pg. 2) *"The transition to a green economy can occur successfully by investing in areas that decouple economic growth from resource use and environmental impacts"*.

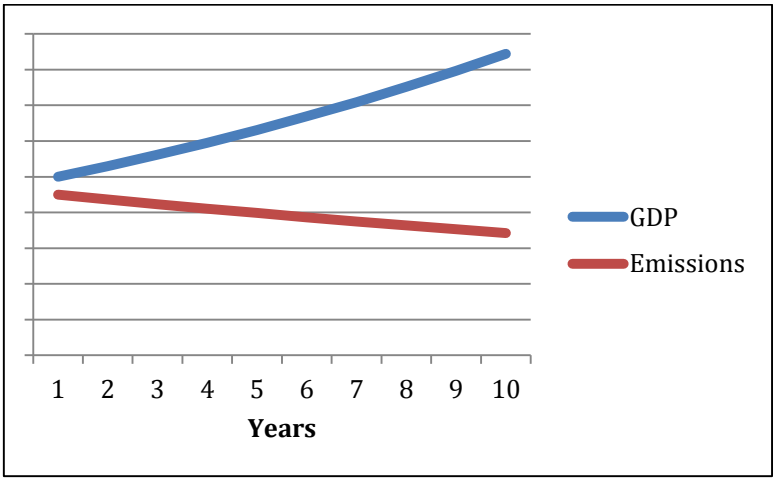

Figure 1.3: Decoupling of gross domestic product and greenhouse gas emissions

Source: Constructed by the author.

According to Burkart (2009), there are six main sectors which together form the green economy. These are: renewable energy, green buildings, sustainable transport, water management, waste management and land management (Burkart, 2009). However, it should be noted that the 'services' sector is notably absent. The services sector would include tourism – which for eThekwini Municipality is critical. In addition, Bailey and Caprotti (2014) identify the following domains of the green economy: financial, institutional, regulatory and green cultural economy.

Maia et al. (2011) provide figures as to the South African national job creation potential in the green economy for various sectors and sub-sectors in the medium and long term, as can be seen in Table 1.2. There is vast growth potential for green job creation in South Africa. There was an unemployment level within the EMA of 20.2%

in the third quarter of 2016 (Statistics South Africa, 2016). As a result, the development of the eThekwini green economy is critical for job creation.

Sector	Sub-sector	Long term direct employment potential (number)
Energy generation	Renewable energy (non fuel based)	22,280
	Renewable energy (fuel based)	55,014
	Liquid fuel	52,729
Energy and resource efficiency	Green buildings	26,236
	Transportation	41,641
	Industrial	100
Emissions and pollution mitigation	Pollution control	15,472
	Carbon capture and storage	251
	Recycling	15,918
Natural resource management	Biodiversity conservation and ecosystem restoration	121,553
	Soil and land management	111,373
	Total number of jobs	462,567

Table 1.2: Long term employment potential for select sub-sectors

Source: Maia et al. (2011, pg. 8).

Borel-Saladin and Turok (2013) cautions that the definition of a green job is not readily available and depending on the breadth of the definition utilised, it can lead to a very different appraisal on the current or potential number of green jobs. Borel-Saladin and Turok (2013) further cautions on the timeframe of green jobs, e.g. construction related jobs are short-lived.

EThekwini Municipality (2013a) undertook a scoping study to determine the number of 'green' companies operating in the EMA. The study yielded a total of 359 companies (eThekwini Municipality, 2013a). Of those 359 companies, only 210 companies provided employment data of 6,107 employees. The average number of employees per company of sub-sectors are displayed in Table 1.3. There is a vast difference between national employment potential provided by Maia et al. (2011) and the actual employment figures provided by eThekwini Municipality (2013a), even if we use a crude 10% of the national potential figure, 46,256, to gauge the eThekwini job creation potential. As a result, we can see that there is still a lot more potential for the development of the eThekwini green economy.

Sector	Sub-sector	Average number of employees
Energy	Energy efficiency products	34
	Manufacturing	24
	ESCO general	22
	SWH supply and installation	13
	Other energy related services	10
Waste management	Recycling	120
	Waste management services	82
	Products from waste	39
General services	Other environmental services	39
	Environmental management	20
	Legal services	16
	Alternate technology advisors	1
Natural resources	Indigenous plant nurseries (retail)	23
	Indigenous plant nurseries (bulk)	21
	Bulk and landscapes	10
	Landscaping (indigenous)	8
Retail/ wholesale	Specialist retail (plumbing)	14
	Cleaning products	5
	Retail market	5
	Specialist retail (personal care)	3
	Organic products	2
Property	Construction	12
	Building materials	9
	Professional services	5
Agriculture	Agricultural services	41
	Organic retail/bulk	23
	Input supplier	7
	Organic farming	3
Water	Water management services	15
	Water treatment equipment	10
	Water treatment services	7
	Water purification	3
	Water conservation	1
Manufacturing	Green products	3
Skills development	Solar system installation	50
	Community	1

Table 1.3: Average number of employees per green company in the eThekwini Municipal Area

Source: eThekwini Municipality (2013a, pg. 10-11).

In order for an economy to be stimulated and the unemployment rate decreased, it is critical that a thorough understanding of an economy is first developed. A thorough understanding will come about not only by looking at aggregated information, but by understanding the interaction of the economic stakeholders, which will then point to strategic leverage points of an economy.

The green economy will be discussed in more detail in chapter two.

1.2.3 EThekwini Municipality

1.2.3.1 Overview of eThekwini Municipality

EThekwini Municipality is located within the South African province of KwaZulu-Natal, along the east coast of the country, as can be seen in Figure 1.4. The Metropolitan Municipality encompasses notable localities such as Durban and Umhlanga. Situated on the Indian Ocean, the Municipality covers an area of 2,555km^2 and is home to approximately 3,700,000 people with the figure projected to increase to close to 3,900,000 by 2020 (eThekwini Municipality, 2017b).

Figure 1.4: Location of eThekwini Municipality

Source: eThekwini Municipality (2017b).

The number of illiterate people in the Municipality has been steadily decreasing from 431,758 in 2003 to 287,138 in 2015 (eThekwini Municipality, 2017b). According to Statistics South Africa (2012), 4.2% of people have not attended school, 37.6% have completed Matric and 12.1% have attended a Higher Institution. Residents who took part in the latest Municipal Services and Living Conditions Survey raised unemployment as the most important issue of concern (eThekwini Municipality, 2017b).

Approximately 79% of eThekwini residents reside in formal dwellings, 15.6% in informal dwellings and 4.2% in traditional dwellings (Statistics South Africa, 2012). However, eThekwini Municipality (2017b) indicates a larger percentage of the population residing in informal dwellings and a lower percentage residing in formal dwelling, with a total number of households at 945,910. As of the end of 2016, the backlog for basic services according to eThekwini Municipality (2017b) is: water – 54,721, sanitation – 153,257, electricity – 241,976, refuse – zero, with all backlogs anticipated to be eliminated within thirty years.

1.2.3.2 EThekwini economy

According to eThekwini Municipality (2017a), during the 2015 calendar year, the eThekwini GDP was calculated at R 289.3 billion. The main economic sectors included: the financial sector at 26% of GDP, the manufacturing sector at 25%, trade at 21% and transportation at 18% (eThekwini Municipality, 2017b). The latest GDP figure for the EMA is calculated at R 304.4 billion for the 2017 calendar year (eThekwini Municipality, 2018).

Unemployment during the third quarter of 2016 was calculated at 20.2%, which is substantially lower than the City of Johannesburg at 28.2% and the City of Cape Town at 23% (Statistics South Africa, 2016). The gini coefficient was 0.64 during 2014, a 0.01 change from the previous year (eThekwini Municipality, 2017b) and further decreased to 0.62 in 2017 (eThekwini Municipality, 2018). According to eThekwini Municipality (2017b), the per capita GDP for 2015 was R 61,419, substantially lower than that of Tshwane Municipality at R 83,626.

EThekwini Municipality is home to the busiest and biggest port in sub-Saharan Africa. According to eThekwini Municipality (2015b), the eThekwini port saw 87.7

million tons of cargo pass through it in the 2013/2014 financial year. As a result, transportation and warehousing are sizeable industries in the EMA.

Most of the electricity, 99.9%, that is consumed within the eThekwini boundary is sourced from Eskom and all liquid fuel (diesel and petrol) is imported. While there are oil refineries within the EMA, the crude oil is imported. It should be noted that the implication is that a large percentage of the eThekwini GDP will flow directly out of the eThekwini economy. According to eThekwini Municipality (2015a), a total of 11,402GWh (Gigawatt hours) of electricity was consumed within the EMA in the 2013 calendar year, 11,295GWh during 2014 (eThekwini Municipality, 2016) and 11,015GWh during 2015 (eThekwini Municipality, 2017a), a steadily decreasing trend.

The Department of Energy (2017) disclosed that a total of 1,330,700,505 litres of diesel was purchased within the EMA in the 2015 calendar year, 1,309,726,923 litres of diesel during 2014 (Department of Energy, 2016a) and 1,401,491,264 during 2013 (Department of Energy, 2015). In addition, the Department of Energy (2017) lists the sale of petrol during 2015 at 967,359,815 litres, 929,572,087 litres of petrol during 2014 (Department of Energy, 2016a) and 943,428,091 during 2013 (Department of Energy, 2015).

1.3 Problem statement

According to the United Nations Economic Commission for Africa (2012, pg. 11), *"The region should therefore have a process of using its own experts to examine the concept, and come up with recommendations that can be used in practical ways to make decisions and take action on the green economy"*.

It is the position of this research that the functioning of the eThekwini green economy is not well understood in terms of its dynamic and complex nature. As a result, any initiative that is undertaken by business to capitalise on opportunities and safeguard against threats will be based on a relatively imperfect understanding of how the system works. In addition, the same basis will apply to government when it seeks to develop an enabling environment for business to benefit from the green economy and environmental justice and social equity to be promoted.

Nwaobi (2011) states that there is a dire need for development of the rules that govern ACE models in Africa. While not referring to ACE specifically, Frankhauser and Stern (2016) expresses the need to understand economies according to their complex nature. In addition, Chapman et al. (2016) articulates that there is a lack of understanding of cities from an evolutionary perspective, which he further adds could completely replace currently accepted knowledge.

The transitioning of an economy to a sustainable low carbon economy is critical, not just for the performance and sustainability of business, but also for the physical environment (United Nations Environment Programme, 2012; Stern, 2006). This transition to a low carbon economy will ensure that products and services from business, which are in instances exported, are not prejudiced against because of its origin from a carbon intensive area or economy (Cohen and Vandenbergh, 2012; McAusland and Najjar, 2015). This research will assist in honing in on leverage points that can mitigate against the risk of eThekwini exports of services and goods being prejudiced, while stimulating the green economy.

In addition, according to Musvoto et al. (2015, pg. 6), *"A green economy does not operate in isolation. The green economy is fundamentally about managing the interaction of humans with the biophysical environment, in a complex social ecological system. Human and biophysical factors must therefore be considered in an integrated manner, with particular attention given to the relationships between them"*.

The simulation of certain systems, in this instance the eThekwini green economy, is out of reach for many people because such exercises normally require extensive computer programming experience and is often difficult to interpret. As a result, this research aimed to develop a framework that can be easily understood by practitioners and stakeholders of the eThekwini green economy and was based on ACE.

1.4 Study aim and research questions

The aim of this research was to develop a framework that would enable business and government to internalise the implications of their decisions on their objectives, the other components of the eThekwini green economy and on the eThekwini green economy at large. This aim was to be achieved by answering the following key research questions:

1. What are the components of the eThekwini green economy and their key characteristics that affect business growth and the reduction of GHG emissions?
2. How do the components interact with other components of the eThekwini green economy and what are the leverage points?
3. Can a framework be developed to depict and set the basis for simulating the components of the eThekwini green economy and the manner in which they interact?

1.5 Limitations of the research

Most types of research have intrinsic limitations. This research is no different. The following key limitations were identified.

During the period that this research was being undertaken there was an extremely small number of people that could be considered knowledgeable about the eThekwini green economy. Another limitation, somewhat linked to the previously mentioned limitation, is that the bulk of private sector stakeholders that, from a green economy definition perspective, operate in the eThekwini green economy are extremely focused on the provision of specific goods and services and do not realise that they are actually part of the green economy. This resulted in a severe case of unwillingness to participate in the survey by many respondents.

In addition, the organisations that make up the eThekwini green services industry were identified by previous research undertaken by the eThekwini Municipality. From the time that research was completed, and list compiled, to the time the list was utilised for respondents for this research, a large number of companies had closed or become uncontactable.

Large institutions such as banks do not have their headquarters in the EMA. This results in a lot of the expertise being located outside of KwaZulu-Natal which caused two key limitations: the first being that the banking sector stakeholders were reluctant to participate in the research and secondly the Banking Association of South African (BASA) indicated that this research's focus was so niche that there will inherently be a small pool of people that could meaningfully contribute.

Some of the largest private organisations in the eThekwini sugar industry were unwilling to participate in the research, even though the South African Sugar Association (SASA) provided assistance to coordinate some interaction with industry stakeholders. The reason for the reluctance is unknown.

1.6 Assumptions of the research

Most, if not all, research is predicated on assumptions. Some assumptions are to make the research tractable. The key assumptions of this research were kept to a minimum.

The eThekwini green economy is still in its infancy and offers substantial opportunities for job creation and economic development. A thorough understanding of the eThekwini green economy, by stakeholders, does not exist due to the eThekwini green economy not being scrutinised through a theoretical framework that can better process the dynamic and complex nature of the eThekwini green economy.

1.7 Significance of the research

The theoretical contribution of this research will be input into developing the basis on which 'rules' can be developed for an ACE model, through a mixed method research design, for an African city's green economy. This is in response to Nwaobi (2011), who advocates ACE for African economies, but also states that a critical aspect is to determine what rules to create for the components of the system. In addition, according to Musyoki (2012, pg. 13) *"The paper shows that for the green economy to succeed, there is a need for regionally specific research…"*.

The practical contribution of this research was the understanding of how the eThekwini green economy operates. This then allowed the leverage points of the green economy to be identified. In addition, a framework was developed that allows the key green economy stakeholders to identify the effects of their actions on other stakeholders and on the economy as a whole. This will contribute to more informed decisions being made. A framework is being opted for, instead of a simulation tool, as it is assumed that a simulation tool will not be utilised as widely due to the barriers of use, such as computing skills.

1.8 Overview of chapters

This research saw the convergence of three very different, but related, thematic areas. These are: climate change, green economy and ACE. To keep the readability of this

research as easy as possible, the standard thesis, at doctoral level, format is adopted with modifications to accommodate the emergent complexity of combining the various thematic areas mentioned above.

Chapter one provided an introduction to climate change and some of its challenges and opportunities. Climate change mitigation measures were briefly discussed and the eThekwini GHG emissions were detailed. The Paris Agreement and Deadline 2020 were then presented. The concept of a green economy was introduced and covered job creation potential. An overview of eThekwini Municipality was provided, which included the eThekwini economy. Thereafter, the problem statement, key research questions, limitations, assumptions and significance of the research were presented.

Chapters two and three focus on the literature aspects of the research. Chapter two will first provide a definition of economics. Thereafter, the green economy will be defined and discussed according to the ways in which it can be framed. Sectors that make up the green economy will then be presented. International and local level indicators will be discussed, followed by the Sustainable Development Goals (SDGs). South African national, provincial and local key green economy enabling laws and documents will be discussed, followed by business and climate change risks. Chapter three will include a discussion on various potential theoretical frameworks that could underpin this research, which will then be analysed for suitability. A detailed discussion of the most appropriate theoretical framework, ACE, will conclude chapter three.

Chapter four includes a discussion on the research methodology that guided this research. This will be followed by the findings from primary data collection, which will be contained in chapter five. The analysis of collected data and preparation of findings for input into the development of the framework and the actual framework is undertaken in chapter six. All elements of the thesis are rounded up and concluded in chapter seven.

1.9 Conclusion

Climate change is one of the largest challenges currently facing mankind and the planet, largely caused by mankind's own actions. While climate change poses serious risks that can jeopardise life as we know it, it also presents some opportunities.

The green economy is one of these opportunities. It offers a way to balance economic growth, protection of the environment and stimulate social development. However, the eThekwini green economy is not, currently, well understood.

A thorough understanding of the green economy has to first emerge, before it is stimulated, to achieve maximum benefit. This research sought to discover some of the complex and dynamic ways in which the eThekwini green economy can and should function.

The next two chapters of this thesis provides a discussion of the key literature on which the research is founded on.

CHAPTER TWO: LITERATURE REVIEW: GREEN ECONOMY

2.1 Introduction

This chapter is the first of two literature chapters contained in this thesis and its primary focus will be on existing South African frameworks, policies, strategies and indicators that all initiatives at the local government level would have to align to, relating to the green economy. The second literature chapter, chapter three, will focus on the theoretical foundation of this research.

This chapter first discusses the definition of economics, which is followed by the definition of the green economy. Thereafter, the ways in which the green economy can be conceptualised are presented. The major sectors of the green economy are discussed. The existing methodologies and some key international work on green economy indicators are presented, which also includes the SDGs. The applicable South African national, provincial and local government documents for the green economy are deliberated upon, followed by risks that businesses face as a result of climate change. The need for Organisational Development (OD) is presented as a means to enable businesses to transition to a green economy, which concludes the chapter.

2.2 Definition of Economics

It would be prudent to first provide a definition of Economics, even though according to Backhouse (2002) and Winter (2016) it is extremely challenging to provide a definition of Economics. However, Robbins (1932, pg. 15) states *"Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses"*. This definition is supported by what Economics aims to achieve, as stated by Black et al. (1997, pg. 3) *"Economics tries to strip aside the detail in order to lay bare the underlying structure of the economic world. Economists attempt to understand those forces which motivate man as an 'economic animal', and to spell out the implications of these forces"*.

Definitions are important, as we can often ascertain the deeper fundamental mechanism of that which it seeks to define. In the definition provided by Robbins (1932) reference is made to 'human behaviour', which according to Šebalj et al.

(2016) and French et al. (2011) can be categorised as complex and dynamic in nature. In addition, Black et al. (1997) makes reference to the underlying structure of the economic world – perhaps it is only through going down a tractable path that we can now interpret that as meaning the nature in which the components of an economy structure themselves, interact, respond and learn and not assume people are fully rational and have access to all available information. Nevertheless, the emphasis and goal of economics is to elicit an understanding of transactions.

It is important to note that both definitions of economics presented, largely relate to understanding the fundamentals of interaction and behaviour of humans. These definitions seem to be linked to classical schools of economic thought. Neo-classical economic schools of thought have diverged substantially from some of the foundations of the principles of 'fathers of economics' towards a more mechanistic outlook (Dugger, 1979; Bresser-Pereira, 2018). It appears that the most apparent reason for this subsequent divergence is that for centuries economists did not have the computational ability to develop complex processes in terms of interaction and behavioural nuances that drive economies, i.e. computing power and ability to run simulations that could incorporate elaborate algorithms and had to settle for eloquent equations. As a result, the tools available at the time severely constrained the ability of academics to develop theoretical models that took the 'principles' of classical economics into consideration. This then resulted in literature that had at its core, mechanistic characteristics with limited variables and overly simplified assumptions taken into account. It must be noted that those models and theories that have been utilised for decades have been useful to an extent. At the same time, however, one should not forget the occasional economic meltdowns and recessions that are experienced.

2.3 Green economy

2.3.1 Overview and definition

The green economy is not a new concept, but has recently gained an increasing level of attention (Musango et al., 2014; Faccer et al., 2014). According to Musango et al. (2014), the Global Green New Deal developed by the United National Environment Programme in 2009 was a strategic push to respond to the financial crisis being experienced at the time and focused on the nexus between the socio-economic and

environmental objectives, this is supported by Kaggwa et al. (2013) and Smit and Musango (2015a). According to Musango et al. (2014), the Global Green New Deal, jointly developed by a plethora of countries, includes three interlinked goals: economic recovery, the reduction of poverty and limiting GHG emissions and environmental destruction.

According to Cock (2014) and Faccer et al. (2014), the 'Rio+20' conference and subsequent publications have been the initial catalyst for the green economy. According to Lutz et al. (2017, pg. 2), *"The meeting concluded with a UN resolution "The Future We Want", in which the international community officially acknowledged for the first time that a green economy can enhance our ability to manage natural resources sustainably and with fewer negative environmental impacts, increase resource efficiency and reduce waste"*. This was followed by the publishing of the 'Green Economy Report: Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication' by the United Nations Environment Programme (Cock, 2014; Musango et al., 2014).

One of the most commonly utilised definitions of a green economy was published in the 'Green Economy Report: Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication', *"an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities"* United Nations Environment Programme (2010, pg. 5). Furthermore, *"a policy focus that emphasizes environmentally sustainable economic progress to foster low-carbon, socially inclusive development"* (United Nations Economic Commission for Europe and United Nations Environment Programme, 2011, pg. 1). In addition, the Southern African Development Community holds the following view of the green economy, *"the green economy will help to overhaul economies in a way that synergises economic growth and environment protection. Building a green economy will facilitate investments in resource savings as well as sustainable management of natural capital that will drive growth"* (Southern African Development Community, 2013, pg. 5).

It should be observed, however, that while there are different definitions of the green economy, it is plain to see that there is underlying consensus of the fundamental aspects of the green economy. This includes the focus of environmental and socio-

economic opportunities, particularly with regards to stimulating broader economic growth. However, Pahle et al. (2016) contends that the green economy concept is still rather opaque. This notion is supported by Faccer et al. (2014) who states that there are multiple overlapping perspectives of the green economy.

As a result, there is a need to unpack the concept. Bowen and Hepburn (2014) differentiate between two types of green growth, the first being a standard green growth whereby it is anticipated that strategic green interventions will initially hinder economic growth, but will increase growth in the long term. The second type of growth identified by Bowen and Hepburn (2014) is a type of strong growth which is able to stimulate economic growth from the short term, albeit under specific conditions.

Faccer et al. (2014) provide three worldviews, which are not comprehensive but serves as a good way to frame the divergent views, with which the green economy can be approached. The three positions are: Incrementalist, Reformist and Transformative, which are summarised in Table 2.1. In essence, according to Faccer et al. (2014) the Incrementalist generally strives for reduction of harmful environmental impacts through market based solutions that are largely based on the current dominate systems. The Reformist approach is more comprehensive than the Incrementalist approach, where the three pillars of the green economy, socio-economic and environmental aspects are actively pursued. Lastly, the Transformative approach seems to be the most radical, with subscribers against the capitalist concept of growth and calls for a re-definition of growth and perhaps the replacement of GDP as an indicator of development or progress and has societal interests at the core.

Worldview	Distinguishing Features
Incrementalist	Pro-growth, consistent with the prevailing economic paradigm.
	Environmental cost avoidance (e.g. emission taxes) will provide insurance against slowed growth and crises over the medium term.
	GDP as an unchallenged and appropriate measure of progress.
	No clear comment on environmental limits (although efficiencies are emphasised).
	Job opportunities through manufacturing and technology associated with environmental efficiencies.
Reformist	Pro-growth with improvements to (but still within) the existing economic paradigm.
	Costs of inaction important (as above) for the long term and new sources of wealth (e.g. ecosystem services available for advanced growth).
	Additional indicators of value needed in addition to what is in current use (e.g. 'beyond GDP').
	Recognition of some environmental limits (e.g. imperative of fossil fuel reduction) and supportive of decoupling (mostly relative).
	Social returns with an emphasis on green jobs including through natural resource management and lifestyle changes (e.g. green cities and products).
Transformative	Pro-development (broadly defined, beyond simply GDP growth) for developing countries; zero/de-growth most appropriate for developed countries.
	Demands more attention to human rights, including voice of minorities in green economy debate.
	Emphasis on absolute rather than relative decoupling.
	Suggest alternative measures of progress, including a consideration of a broader conception of societal well-being.
	Caution against technology as a panacea, highlighting risks of overconsumption and risks to social and ecological communities.

Table 2.1: Distinguishing features of the three green economy worldviews

Source: Faccer et al. (2014, pg. 645).

The three discourses highlighted by Faccer et al. (2014) somewhat align to the four worldviews presented by Cook et al. (2012), which are Market Liberal (Incrementalist), Institutionalist (Reformist), Social Green and Bio Environmental (both of which have elements that link to the Transformative worldview).

It is the position of this research that from a theoretical perspective, the widely adopted international definition of the green economy from the United Nations Environment Programme (2010) makes complete logical sense, i.e. grow the

economy, while minimising the negative impacts on the physical environment and delivering social equity. However, the translation of this definition into widespread practices that actually result in delivering all three elements would be interesting to witness and interrogate. It is acknowledged that specific programmes and initiatives will address different aspects of green economy elements and deliver on succinct objectives. However, owners of capital, that is financial and other physical resources except labour, required for value added activity will see the most benefit from any green economy activity. It is argued that trickle down benefits will flow to communities, but the fundamental development requirements of communities are unlikely to be thoroughly addressed. Environmental indicators have been development in a crafty manner to focus largely on GHGs and a limited set of other indicators. This research therefore argues that it appears that the green economy has been engineered as an avenue to create, largely, economic opportunities for owners of capital, which can include some companies and countries, while utilising the façade of altruism, i.e. environmental protection and social equity. It must be noted, however, the environmental benefits remain tangible.

2.3.2 Sectors and components of the green economy

As highlighted in the first chapter, according to Burkart (2009) there are six sectors that make up the green economy, these are: renewable energy, green buildings, sustainable transport, water management, waste management and land management. In addition, Bailey and Caprotti (2014) identify the following domains of the green economy: financial, institutional, regulatory and green cultural economy.

There have been additional studies and papers written on the green economy that covers sectors of the green economy that are not explicitly included in Burkart (2009) but could perhaps be classified in one of the domains highlighted by Bailey and Caprotti (2014). In addition, there are many more aspects that can be broadly defined as components of the green economy that need to be highlighted for a robust picture of the green economy to begin to emerge.

According to Pegels (2010) and Rockström et al. (2017), renewable energy technologies have a significant GHG emission reduction potential. However, Pegels (2010) goes on to caution that there are still substantial barriers to wide-scale deployment of the renewable energy technologies in South Africa and include natural

barriers (such as availability of water), lack of research and development and cost factors. According to Gasparatos et al. (2017), there are multiple renewable energy technologies and have highlighted biological impacts of renewable energy implementation as a concern.

Sustainable transport generally involves focusing on using energy for transportation more efficiently (Farid, 2016; Eliasson and Proost, 2015). According to Maclean et al. (2018, pg. 5), sustainable transport can be described as *"Shifting to more environment-friendly means of transport and improving vehicle and fuel technology to reduce negative effects, such as depletion of resources and pollution, are the priorities in greening the transport sector"*.

According to the United States Environmental Protection Agency (2016, pg. 1), a green building can be described as *"... may incorporate sustainable materials in their construction (e.g., reused, recycled-content, or made from renewable resources); create healthy indoor environments with minimal pollutants (e.g., reduced product emissions); and/or feature landscaping that reduces water usage (e.g., by using native plants that survive without extra watering)"*. The notion that a green economy can be supported by pursuing green buildings is further supported by Gibbs and O'Neil (2015) and Gulati (2016).

There is a substantial portion of the population that is currently engaged in the South African informal economy. According to Smit and Musango (2015a, pg. 2), *"The notion of a green economy has a similarly inspired a number of ideological, geopolitical and institutional responses, yet a review of the dominant approach indicates the propensity to undervalue or ignore the informal economy. Within the context of sustainable development and poverty eradication, connecting the informal economy with the green economy is imperative"*. Research conducted by Smit and Musango (2015b) has found that the informal economy also includes elements that can be considered green, however these have mainly been initiated by non-commercial organisations. In addition, Smit and Musango (2015b) highlight the primary green activities that are being undertaken in the South African informal green economy, these are: farming, organic material management, recycling, composting, water harvesting and renewable energy. According to Davies and Thurlow (2010) there are definite feedback loops between the formal and informal sectors, especially

within the context of South African policies that are geared for the creation of formal sector jobs. This has a converse impact on informal jobs that can potentially be developed and can to an extent rationalise the relatively small South African informal sector – when compared to other countries.

A pertinent point, particularly with South Africa's strong labour structures, raised by Cock (2014) and Musyoki (2012) is the potential benefit for labour that the green economy can provide. Cock (2014) goes on to state that labour unions have attempted to develop their own environmental positions. Labour is one of the key partners of the South African Green Economy Accord. Naturally, the focus of labour has been on green job creation, with concerns around the potential numbers of green jobs that can realistically be created, the quality of green jobs that are eventually created and the potential job losses in other sectors.

While labour is highly organised, environmental activists do not currently have an integrated or representative forum for all environmental activist stakeholders (Cock, 2014). Cock (2014) further adds that the environmental activists are largely arranged into two categories, those that advocate for 'sustainable development' and those that focus on 'environmental justice'. According to Cock (2014), the stronger element is the activist that seeks environmental justice.

According to Kaggwa et al. (2013) and Mithas et al. (2010), technology will play an important role in the development of a green economy. For South Africa, as Kaggwa et al. (2013) continues, the choice of specific technologies has to be made with due consideration to a plethora of factors that include: life-cycle cost benefit analysis and the potential to include rather than exclude people in the production processes due to unavailability of required skills.

A rather peculiar observation in the literature is that of Montmasson-Clair (2012) and Unmüßig et al. (2012) who state the likely probability that mining jobs can be increased through pursuing the green economy – as a result of adopting renewable energy and mining metals and minerals that are required for the manufacturing of green technologies. As per the South Africa President's State of the Nation Address on the 16th of February 2018, the mining sector is going to be one of the priorities of the South Africa government going forward (Republic of South Africa, 2018); what approach will be adopted remains unknown and at this point in time can go either

towards the promotion of the green economy, or undo environmental progress with the promotion of traditional mining activities.

According to Musvoto et al. (2015) and Donnik et al. (2016), agriculture has the potential to assist with achieving objectives of the green economy. The notion of green economy based agriculture revolves around production efficiency and reducing poverty, amongst other aspects. However, Musvoto et al. (2015) adds that agriculture will undoubtedly experience challenges such as lack of resources for subsistence farmers, low value of produce and possible impact of climate change on agricultural activities.

According to Bricker (2017, pg. 1), *"Eco-tourism is tourism done in a specific way that follows a set of principles promoting social, environmental and economic sustainability"*. The importance of eco-tourism to the green economy is the potential to increase both revenue of the tourism industry and the positive impact on job creation (Gheorghe and Pârvu, 2016; Pan et al., 2018).

Anvar and Venter (2014) undertook a study to determine the attitudes of Generation Y towards green products. The major findings of the study was that important aspects that have an impact on perceptions of green goods are: social influence, environmental awareness, gender and price. Furthermore, Liverani (2009) highlight three important areas that need to be addressed to bring about behavioural change, these are: communications, institutional measures and social norms.

As can be seen from this section, there are a number of sectors that form part of the green economy. Even the widely recognised six sectors of the green economy identified by Burkart (2009) have missed out some important sectors, as demonstrated by this section. While the green economy will contain obvious sectors such as renewable energy, waste management and eco-tourism there is huge potential for the green economy to include sectors that are not so obvious. An example of this is focusing the traditionally environmentally unfriendly mining sector towards mining of material that would be critical for stimulating the green economy – such as lithium that is needed for the manufacture of batteries. An aspect that was not widely seen in the literature is the possibility of utilising the green economy to enhance the informal sector and vice versa.

There is no denying that the green economy encompasses a plethora of sectors (Burkart, 2009; Bailey and Caprotti, 2014). The literature, included in this section, did not factor in specific green processes or practices that can be practiced in even more sectors and industries, this was to keep the complexity of the wide variety of literature to a minimal. It is the position of this research that it is apparent that the green economy is being theoretically positioned as an addition to the current mainstream economy, like how the South African informal economy operates in parallel to the regulated and mainstream economy. Whether this is advantageous or not would need further research. However, in the long term the green economy, at least its principles, should be the dominant manner in which all activity is mandated to follow or intertwine with mainstream economic activities.

2.3.3 Green economy indicators

There has been a number of activities by, amongst others, international organisations that include Organisation for Economic Co-operation and Development, United Nations Environment Programme and the World Bank that seek to develop processes, indicators and guidance for measuring the green economy (United Nations Environment Programme, 2014; Dual Citizen LLC, 2016; Green Growth Knowledge Platform, 2013).

According to United Nations Environment Programme (2014, pg. 9), an indicator can be thought of as *"an instrument that provides an indication, generally used to describe and give an order of magnitude to a given condition. Indicators provide information on the historical and current state of a given system and are particularly useful to highlight trends that can shed light on causal relations among the elements composing the system"*.

It is critical to highlight the discussions and interventions that are taking place internationally which often focuses on national reporting indicators, as there needs to be a level of alignment between national indicators and local indicators. This is even more relevant when there are additional goals that are brought into the picture, such as the SDGs which will be discussed in a subsequent section of this chapter.

Vitally important for measuring the green economy is to ensure that the correct indicators are utilised for relevant purposes. The United Nations Environment Programme (2014) differentiates between four types of indicators that are utilised in a

phased approach. Indicators for issue identification are indicators that essentially measure primary concerns or challenges which serves to frame particular issues. Indicators for policy formulation revolve around providing information on the efficacy of potential interventions. Indicators for policy assessment are developed to measure the actual impact, taking into account any possible feedback, of the interventions of policies implemented. Indicators for policy monitoring and evaluation essentially utilises the indicators from the previous three phases and looks at assessing the success of environmental aspects, leveraging of investment and enhancement of well-being. However, it is important to note that this is presented in a manner to promote and enhance integrated policy development, in a cyclical process. While United Nations Environment Programme (2014) provides some examples of indicators across the different types of indicators, it is centred on providing a methodology that will allow countries to develop their own indicators to take into account their unique contexts.

Dual Citizen LLC (2016) assessed the performance of eighty countries on their national green economies. The index developed by Dual Citizen LLC comprise four primary categories: leadership and climate change, efficiency sectors, markets and investments and environment. Amongst the four categories, a further total of thirty two specific indicators are included, as partially illustrated in Figure 2.1.

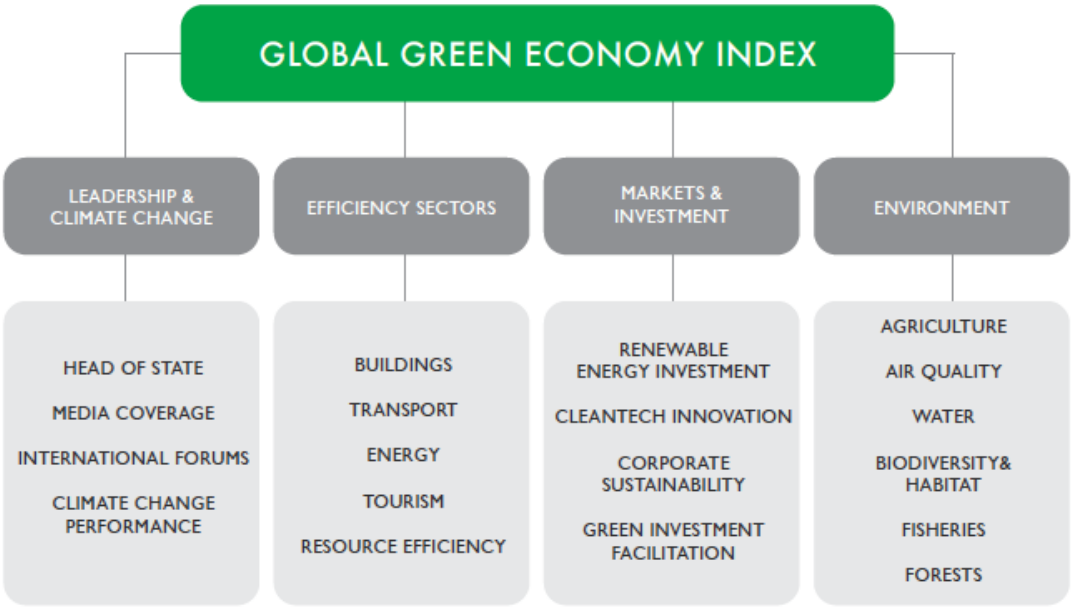

Figure 2.1: Global Green Economy Index Indicators

Source: Dual Citizen LLC (2016, pg. 8).

There has been numerous models and sets of indicators developed to monitor 'sustainability' at a city level. One such example is Siemens (2015), Green City Index, which assessed over one hundred and twenty cities from around the planet, including Durban (eThekwini Municipality). The report concluded that Durban, amongst Cape Town and Johannesburg, were particularly adept at climate change policy and implementation of some projects. The assessment of cities by Siemens (2015) is based on eight categories, which are CO_2, energy, buildings, transport, waste and land-use, water, air quality and environmental governance. These eight categories are further comprised of a total of thirty specific indicators, as depicted in Figure 2.2, which is specifically for the European region but slightly adapted for other regions.

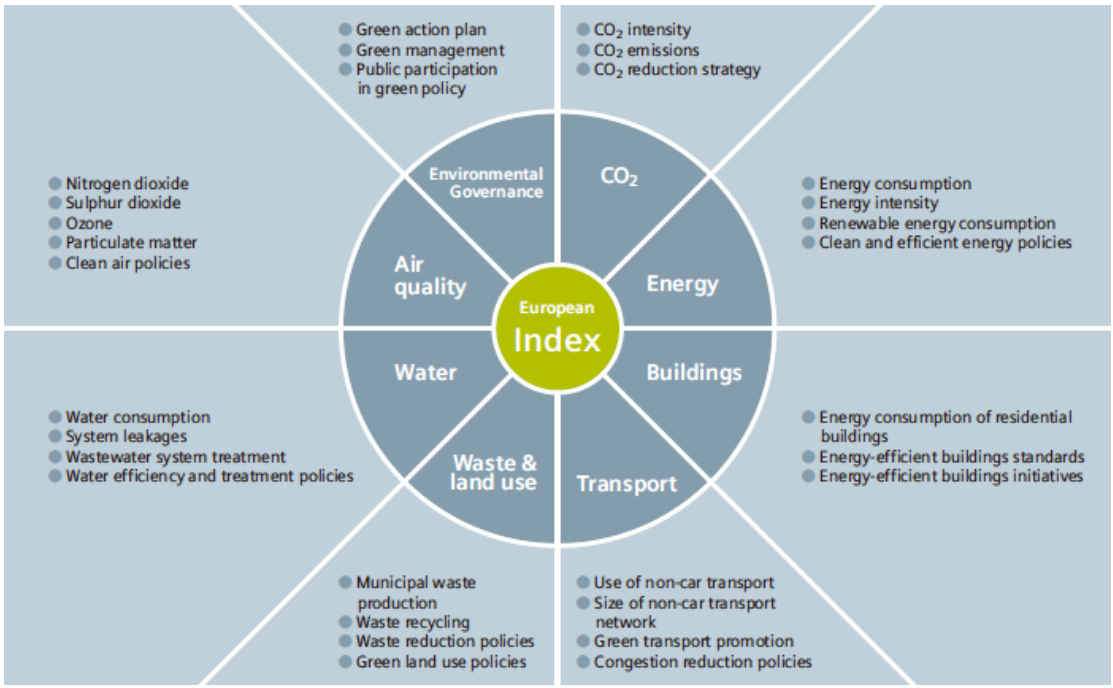

Figure 2.2: Green City Index: European Region

Source: Siemens (2015, pg. 9).

While Dual Citizen LLC (2016) focus on country level indicators and Siemens (2015) at a city level there remains some common elements. These common elements are that both methodologies have broad categories that then comprise sub-categories. There is a mix of quantitative and qualitative indicators, with the majority of indicators being quantitative in nature. There appears, however, to be sectors of the green economy that do not have indicators. When the above methodologies are cross-referenced with the discussion in the previous section on components of the green

economy it becomes noticeable that there are gaps. As an example, purchasing attitudes or consumer buyer behaviour are not included as indicators.

It does appear that there are adequate general frameworks through which data can be collected and presented (Dual Citizen LLC, 2016; Siemens, 2015). It is argued that there are a few pressing issues that need to be raised, the first is that any indicator framework needs to be tailored for different types of Municipalities or localities, due to inherent nuances. However, the data needs to be structured in a manner that will easily allow for feeding into national and international reporting processes. These frameworks need to collect data through automated processes, and not manually – human error is rife in certain datasets. This data needs to be collected at the most disaggregated level possible and as frequently as possible. This then allows Big Data approaches to be adopted. It is also the position of this research that there appears to be a huge opportunity that is being missed, especially by Municipalities, in terms of not adopting Big Data initiatives.

2.4 Sustainable Development Goals

According to the United Nations Development Programme (2016), the SDGs came into force in 2016 as a replacement for the Millennium Development Goals which began in 2000 and ended in 2015.

According to United Nations Development Programme and United Nations Research Institute for Social Development (2017), there are a total of seventeen SDGs, or goals, which are indicated in Figure 2.3. Each SDG has a number of specific targets, which in turn are linked to indicators. While there are a multitude of possible cross linkages with the green economy, for the purposes of this research the indicator components that are part of SDG 7, 8, 11, 12 and 13 will be focused on. It is also important to note that only objectives and indicators that are relevant for cities, at a disaggregated level, will be discussed in this section.

Figure 2.3: Sustainable Development Goals

Source: United Nations Development Programme and United Nations Research Institute for Social Development (2017, pg. 1).

According to the United Nations General Assembly (2017), the objective of SDG 7 is to ensure access to affordable, reliable, sustainable and modern energy for all, which essentially advocates for universal energy access with a large portion being derived from renewable sources. There is also an emphasis on energy efficiency and international collaboration on research. The specific indicators primarily revolve around the proportion of a population with access to energy and renewable energy. In terms of energy efficiency, an intensity figure is taken as a function of energy and GDP. The collaboration on research is measured in terms of funds received by developing nations. Lastly, investment in energy as a share of total GDP will provide an indication of sustainable energy investment.

SDG 8 aims to promote inclusive and sustainable economic growth, full and productive employment and decent work for all (United Nations General Assembly, 2017). The majority of the objectives in SDG 8 relate to economic growth broadly, not necessarily specific to the green economy. As such, only two objectives, 8.4 and 8.9, will be discussed respectively, as they have direct relevance to the green economy. The prior objective relates to decoupling economic growth from the degeneration of the environment. The latter objective seeks to achieve the development and implementation of sustainable tourism policies that enhance job creation. Specifically, indicators for measuring objective 8.4 include the amount of

raw material that is extracted (known as material footprint within the SDGs) and material footprint per capita and GDP. Objective 8.9 indicators includes the portion of GDP of sustainable tourism, tourism jobs contribution to total employment and accompanying growth rate.

The third relevant SDG is 11: Make cities inclusive, safe, resilient and sustainable (United Nations General Assembly, 2017). This SDG essentially focuses on the provision of safe and sustainable housing, green spaces and transportation particularly for vulnerable people. In addition, the SDG focuses on decreasing the negative impact of natural disasters. The SDG then moves on to minimising the negative environmental impacts, with specific attention to air quality and waste. Being a rather broad SDG, it also focuses on regional planning, integrated policies and collaboration between developed and developing countries. Not all indicators will be discussed, only the indicators with the most perceived relevance for this research. These indicators aim to measure the percentage of the population that has access to public transportation. As disasters are often due to natural causes, the measurement of deaths and people that are affected, per one hundred thousand people, is included. Related to disasters is the calculation of economic loss and impact on infrastructure and services. Mainly relating to air quality, this SDG also seeks to measure particulate matter.

SDG 12 seeks is to ensure sustainable consumption and production patterns (United Nations General Assembly, 2017). Only objectives that can potentially be measured or are relevant at a city level will be briefly presented. This SDG aims to substantially decrease the amount of food waste and food loss by 2030. The sustainable management of the life cycle of chemicals and all waste by 2020 is also listed as an objective. Furthermore, to properly manage the waste life cycle, the SDG seeks to drastically minimise total amount of waste through prevention, reduction, recycling and reuse. As production largely rests with private companies, an objective is to increase the number of companies that subscribe to sustainability principles and report such interventions. On the flip side of the coin, the SDG endeavours to ensure that the population, in general, have access to information on sustainability. It is widely accepted that government's procurement practices can have a positive impact on industry. As such, another objective is to ensure that those practices and policies incorporate sustainability. Lastly, a key objective of SDG 12 is to minimise incentives that promote fossil fuels. Moving on to the indicators, the global food loss index

provides a mechanism to measure food loss and waste. In terms of waste, the indicators revolve around the composition of hazardous waste, hazardous waste generated per capita and tons of material that is recycled. Companies that subscribe to sustainability are simply measured by a count of companies that are reporting on their sustainability responses. Regarding the incentives for fossil fuels, this is to be measured against GDP and aggregated spending on fossil fuels.

Finally, the last SDG to be discussed is SDG 13: Take urgent action to combat climate change and its impacts (United Nations General Assembly, 2017). It is important to note that the bulk of this SDG is specifically related to the national level, the only possible objective that will be relevant for cities will be the focus on education, awareness and capacity building on climate change. The objective is written in a manner that suggests that focus should be on aspects of adaptation and impacts. The indicator that is linked to this objective is completely designed for national level reporting.

The SDGs are ambitious and are goals that every single organisation and individual should be working towards, so that a sustainable way of life can materialise. This is based on the notion that all micro actions, will largely contribute to macro outputs. It is the position of this research that people's base mental models and cultural nuances are excluded, perhaps some aspects could fall under Goal 4. Are people still under the impression that 'the world owes them' or are we moving to a fundamental consciousness shift of 'sacrifice for the greater good'. The SDG indicators on the other hand, seem to be largely developed for reporting at a national government level. It is possible to disaggregate some of the indicators as a basis for the local level. However, it appears that there will be some indicators that will not be possible to report on from a local level.

2.5 South African legislation, frameworks, plans and strategies

This section aims to provide an overview of the enabling South African government documentation for the green economy and a few documents that focus more broadly on climate change, which by pursuing the objectives results in the development of a green economy. There are a plethora of national level governmental documents that have set the foundations and basis for the establishment of the green economy, both directly and indirectly (Montmasson-Clair, 2012; Kaggwa et al., 2013; Smit and

Musango, 2015b). An important point raised by Montmasson-Clair (2012) is that there is no single national government department responsible for the green economy, as many departments have their own laws and strategies that form a complex web of documents. As such, the resulting discussion could be construed as messy and being all over the place but this decentralised situation could be to the benefit of the green economy, particularly from a complexity perspective. This section presents documents in hierarchy, from the constitution to enabling local strategies.

One of the fundamental legal pillars on which the pursuit of climate change and green economy activities is based on is Chapter Two: Bill of Rights of the South African Constitution. According to the Republic of South Africa (1996, pg. 9) *"Everyone has the right – (a) to an environment that is not harmful to their health or wellbeing; and (b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that – (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development"*.

According to the National Planning Commission (2012), the South African National Development Plan is a broad framework that seeks to focus on nine core challenges that plague the country, which are often interwoven. The primary objectives are to eliminate poverty and decrease the gini coefficienct to 0.6 by 2030. It is envisaged that all South Africans should take ownership of the plan and contribute to it while being led from the Office of the South African President. There are thirteen objectives, ranging from health and security to economy and training aspects (National Planning Commission, 2012), making the National Development Plan a truly integrated plan that would seek to guide all facets of the country. As a result of the plethora of categories, included in the plan, there could be linkages in various categories to the green economy, however, those with direct objectives which are listed under Environmental Sustainability – An equitable transition to a low-carbon economy will be highlighted. The objectives include developing indicators for natural resources, however this seems rather narrow in terms of the actual scope that accompanies the green economy. In terms of GHG emissions, the plan reaffirms the trajectory of peak plateau and decline, with peak emissions being anticipated to occur in 2025. Critical leverage points for the green economy include carbon pricing into

the mainstream economy and developing carbon neutral building regulations by 2030. On the waste sector, the objective is to reduce the amount of waste that is being deposited into landfills. In terms of renewable energy, it is envisaged that by 2030 at least 20,000MW will be installed. Improvements to protect against climate change induced natural disasters will be made, as well as increased investment into food security. It should be noted that the National Development Plan has, and should, influence all subsequent government decision making processes and policy or strategy documents, which was the initial intention.

Another critical plan is the Integrated Resource Plan (IRP) (2010 – 2030), which is intended to provide broad guidance for the South African electricity sector in terms of forecasting the demand for electricity and generation mix that will appropriately respond to electricity demand (Department of Energy, 2011). The second IRP is still in draft format and the 2010 IRP was utilised for the purposes of this research. While the IRP does not directly make any reference to the green economy it does incorporate climate change considerations in the scenarios that have been modelled.

Whereas the IRP focuses on electricity, the Integrated Energy Plan (IEP) takes a broad look at the sustainability of South Africa's energy sector, across all sectors, specifically with regards to provision of supply and options for expansion of supply (Department of Energy, 2016b). Modelling exercises and scenarios have also been utilised in the IEP to provide strategic information and guidance for sector specific energy policies. It is important to note that the IEP does not mention the green economy, but rather focuses on issues of climate change broadly. As a result, renewable energy is thought of as an important part of the 'energy mix' of South Africa. These sources of renewable energy include: solar, wind, biomass and hydrogen.

The New Growth Path was developed by the South African government with the primary goal of creating five million jobs by 2020, particularly to support efforts to address inequality (Department of Economic Development, 2011a). In addition, the framework identified five key sectors that could offer the required job creation potential, these are: green economy, agriculture, mining, manufacturing and tourism.

Emanating from the New Growth Path, are a number of Accords for priority sectors. The Green Economy Accord was developed and entered into by the South African

government and stakeholders, which includes labour unions and various social organisations and is structured around twelve commitments towards creating 300,000 jobs by 2020 (Department of Economic Development, 2011b). The commitments span a number of thematic areas that contribute to the development of a green economy. These commitments are: rollout of solar water heaters, investment in the green economy, rollout of renewable energy, energy efficiency, waste recycling, re-use and recovery, biofuels, clean coal initiatives, retrofitting, reducing carbon emissions on our roads, electrification of poor communities and reduction of fossil-fuel open fire cooking and heating, economic development in the green economy: promotion of localisation, youth employment, cooperatives and skills development and cooperation around the COP17 and its follow-up. For the purposes of this research, and while all commitments will have a positive role in the development of the green economy, focus is only directed to Commitment 2: investment in the green economy and Commitment 11: economic development in the green economy: promotion of localisation, youth employment. Commitment 2 is primarily aimed at making available funding that can be tapped into and at the same time support bankable projects in the green economy. A number of pertinent aspects were raised in commitment 11, these include developing local capacity for the manufacturing of green goods, not just for the South African market, but also for export and while doing so focus on creating employment opportunities for youth. According to Department of Economic Development (2011b), this is to be supported by increasing the prominence of skills required for the stimulation of the green economy at a national level.

According to the Department of Trade and Industry (2017) the Industrial Policy Action Plan (IPAP) seeks to address South Africa's industrial growth, while addressing issues of inequality and employment development challenges. Key focus areas in the 2017/18 – 2019/20 IPAP include radical economic transformation, supporting local goods and focusing on exports. Under focus area 2 of the current IPAP, it is intended that the development of a policy roadmap for ensuring sustainable industrial development will be pursued. In addition, a smart grid vision for the South African electricity distribution grid will contribute to the expansion of green industries.

According to the Department of Environmental Affairs (2011a), the National Climate Change Response White Paper presents the South African government's vision on climate change responses and the green economy. There are two primary goals contained in the white paper: the first entails developing a resilient society, environment and economy that will be able to adequately respond to climate change impacts, the second goal revolves around the reduction of GHG emissions in a manner that will enable a sustainable economy, society and environment.

The Renewable Energy White Paper acknowledges that while the current electricity system is driven by inherent lock in from coal-based electricity, it is also cognisant of the need to reduce GHG emissions and the unexplored potential of South Africa's renewable energy sources (Republic of South Africa, 2003). Four key elements have been identified to achieve 10,000 GWh of new renewable energy generation by 2013, these are: financial mechanisms, legal tools, technological research and development, and awareness, education and capacity building.

Another important document, or more accurately, research undertaken, was the Long-Term Mitigation Scenarios (LTMS), which was intended to assist with future decision making. The LTMS took into account South African GHG emission reduction commitments and developed a number of possible outcomes and interventions (Energy Research Centre, 2007). As can be seen from Figure 2.4, under the various scenarios achieving reduction targets required by science will still remain elusive. The x-axis represents years, up until 2050, and the y-axis is million tons of carbon dioxide equivalent ($MtCO_2e$). According to Kaggwa et al. (2013), the LTMS was approved by the South African Cabinet in 2007.

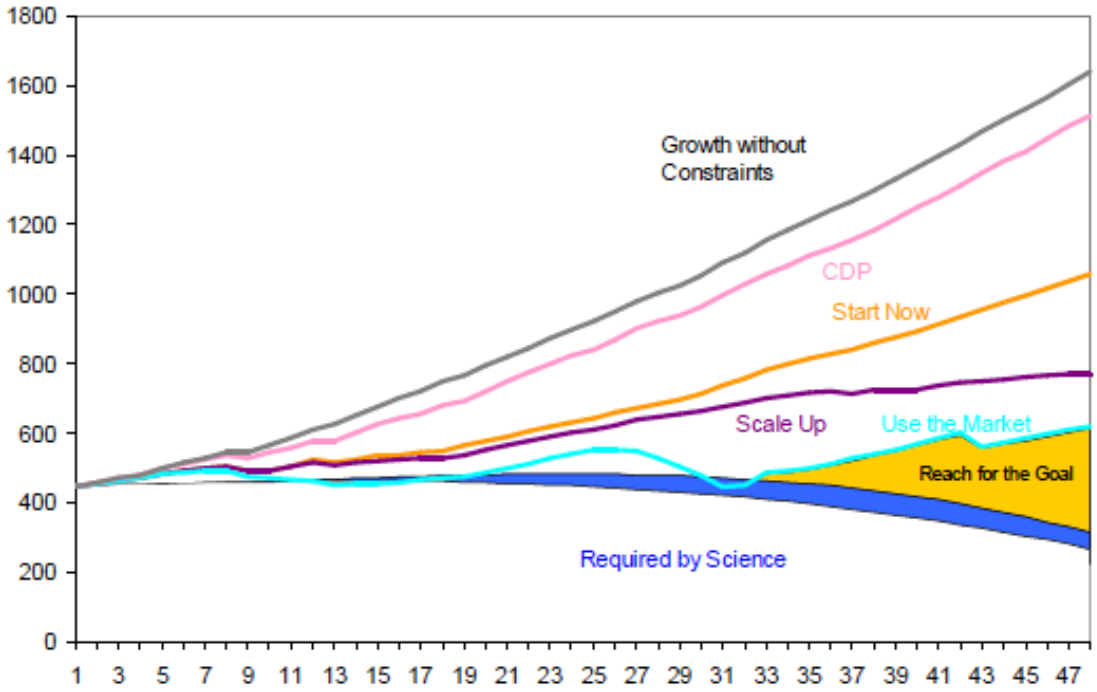

Figure 2.4: South African Long-Term Mitigation Scenarios

Source: Energy Research Centre (2007, pg. 10).

Developed under NEDLAC, the framework for South Africa's response to the international economic crisis while trying to respond to a crisis, highlighted the opportunity that the green economy can contribute to the larger economy. An excerpt from the framework clearly highlights this, *"The parties recognise the opportunities in industries that combat the negative effects of climate change and believe that South Africa should develop strong capacity in these green technologies and industries"* (Republic of South Africa 2009, pg. 11).

The Medium Term Strategic Framework (2014 – 2019) reaffirms the South African government's desire to develop a sustainable and resilient low carbon economy (Republic of South Africa, 2014). In the current period, focus will be directed to the development of plans and piloting of a green economy with a focus on, amongst other aspects, regulatory hurdles and carbon tax. In addition, attention will be spent on the protection of various terrestrial and aquatic eco-systems and an integrated waste management approach.

According to the Department of Environmental Affairs (2011b), the National Waste Management Strategy is comprised of a number of goals, eight in total. Goal 3

specifically highlights the intention of growing the proportion of the waste sector's contribution to the green economy. This is in addition to including elements such as increasing recycling, waste reduction and energy recovery. It is important to note that the target for job creation was to be achieved in 2016, but no updated strategy or achievement of the targets could be found on the Department of Environmental Affair's website.

According to the Department of Environmental Affairs (2011c), the National Strategy for Sustainable Development and Action Plan (2011 – 2014) aims to provide strategic direction to not just government, but also private sector stakeholders. The strategy consists of five priority areas, each consisting of their own specific interventions and indicators. For the purpose of this research Priority 3: Towards a green economy will be discussed and especially aspects that will be relevant for local government. There are three goals that are relevant, these include: developing local expertise around high performance technologies, developing investment opportunities and financing mechanisms and creation and sustainability of jobs. The indicators utilised are rather ambitious considering possible data issues. Also included are: a number of publications in technological areas, number of graduates in relevant fields, increase in share of GDP of research and development, number of patents granted, number of relevant programmes and employment creation.

The second edition of the National Water Resources Strategy seeks to ensure that water resources are managed in a manner that is consistent with assisting to achieve South Africa's development goals. This revised strategy is intended to align with the National Development Plan. The details of the strategy will not be discussed, but it will suffice merely to point out the that strategy does include elements of water recycling, cautions on the use of water for cooling in energy applications and highlights the potential of generating electricity from hydro sources. Furthermore, the strategy acknowledges that climate change will have material impacts on rainfall patterns and will focus on developing the needed capacity to respond.

An updated National Energy Efficiency Strategy is currently being worked on by the National Department of Energy (Department of Energy, 2016c), but the strategy currently endeavours to create a unified notion of what energy efficiency means for the country, including opportunities. The strategy focuses on six sectors, each

containing a number of targets and goals, these sectors are: public, residential, commercial, industry and mining, agriculture and transportation. It is important to note that the strategy looks at energy in terms of its broadest possible definition and is not limited merely to electricity.

According to the Minister of Finance (2018), who delivered the South African 2018 Budget Speech, *"Parliament is currently considering the draft Carbon Tax Bill, which will assist South Africa to meet its climate change commitments to reduce our carbon emissions. The tax will be implemented from 1 January 2019. As with GHG emissions, the polluter-must-pay-principle must also apply to other activities which harm the environment, like the dumping of plastics into our oceans and threatening of marine life"*. According to the Republic of South Africa (2017), the Carbon Tax intends to impose a tax on all taxpayers, the amount of which will be determined by the quantity of GHGs emitted from fuel combustion, industrial processes and fugitive emissions. The rate of each tCO_2e will be R 120. With thresholds stated per sector, i.e. minimum amount above which a tax will be payable, it is important to note that some sectors do not have a threshold, such as iron and steel production. It is also important to note that a maximum offset of 10% has been incorporated into the Bill, this means that polluters will be able to purchase carbon credits to offset their tax burdens. However, according to National Treasury (2013) there has been a tax incentive from as early as 2013 which can be claimed relative to the amount of energy saved within a year, against a specified baseline.

At a KwaZulu-Natal provincial level, the 2035 Provincial Growth and Development Strategy embeds the green economy into it and has a focus area to achieve a number of national government's objectives (Provincial Planning Commission, 2016). The green economy was identified as a key sector to be supported through enhanced awareness and mechanisms to improve programmes. There are two relevant aspects under Strategic Objective 1.2, they are: include the growth in investment of the green economy and renewable energy and increase in employment opportunities created in the green economy. Furthermore, under Objective 1.6, it is the intention of provincial government to support and enhance research and development initiatives of green economy technologies and government's contribution to such research and development. It is important to also highlight that while not mentioning green economy directly, there are numerous other objectives that seek to pursue elements of

a green economy, such as Objective 4.5 (energy provision, and alternative base load) and Objective 4.6 (waste management and recycling). Strategic Goal 5 has a key indicator of reducing GHG emissions, while Objective 5.2 relates to an increase of small scale decentralised renewable energy generators.

It should be noted that reference to a Green Economy Strategy for KwaZulu-Natal was made in a number of documents. However, the strategy could not be found on any website. In addition, Trade and Investment KwaZulu-Natal was contacted, they also indicated that they do not have the document.

The latest iteration of the eThekwini Municipality's Integrated Development Plan (IDP) prominently includes matters of climate change and the green economy (eThekwini Municipality, 2017b). The IDP lists six priority areas, in addition to a number of specific plans, the sixth priority area is: 'Environmentally Sustainable City'. The crux of this priority is to ensure that the environment is utilised in a manner as to enhance the health and wellbeing of its citizenry, with a specific principle on developing green jobs. Programme 8.17 of the IDP includes the pursuit of financial mechanisms, developing enabling policies and promoting decentralised renewable energy in the EMA. Other relevant aspects that fall within the ambit of the green economy includes recycling and non-motorised transportation.

The Spatial Development Framework (SDF) is to be framed as a critical element of the IDP. According to eThekwini Municipality (2017c, pg. 10), *"The SDF therefore guides the desirable spatial distribution of land uses within a Municipality in order to give effect not only to the spatial vision, goals and objectives of the Municipality but by directing where the city should intervene in space to achieve its transformational objective"*. The SDF includes the promotion of eco-tourism and the green economy, not only as a means of creating jobs but also as a means of preserving open spaces. It should be highlighted that climate change and its associated impacts have been taken into account in the formulation of the SDF, including both climate change mitigation and adaptation.

The Durban Climate Change Strategy (DCCS) was approved by the eThekwini Municipal Council in 2014. It is essentially a climate change response strategy, including both mitigation and adaptation, for the Municipality (eThekwini Municipality, 2014b). It is important to note that the DCCS was developed in a

collaborative and consultative approach. The strategy revolves around five adaptation themes (water, sea level rise, biodiversity, food security and health), three mitigation themes (energy, waste and pollution and transportation) and two cross cutting themes (economic development and knowledge generation and understanding). In terms of this research only the economic development theme will be briefly discussed. However, it must be acknowledge that when the remaining themes are pursued, they do contribute to the development of the green economy. The specific goal of the economic theme, according to eThekwini Municipality (2014b), is *"Durban transitions to a low-carbon economy that is socially responsible and environmentally sustainable, provides diverse economic opportunities and increases the capacity to adapt to the impacts of climate change"*. There are two objectives that focus on short and long term responses for the development of a low carbon economy. In the short term, focus should be directed to local manufacturing, promotion of micro organic food businesses, sustainable use of open spaces, developing platforms for business to network to reuse waste streams as input into other processes and ensuring the design of big infrastructure projects imbue climate change considerations. In the long term, responses will be geared around developing scenarios for climate change that will be utilised as a basis to determine economic opportunities, creation of a mechanism where the convergence of climate change and the economy can be researched, develop policies that will promote low carbon development, creation of incentives and development of indicators that can measure the transition to a low-carbon economy.

It is important to note that eThekwini Municipality also has an Energy Strategy of 2008, however, the contents of the DCCS seem to be inclusive of a number of fundamental objectives and as a result the Energy Strategy will not be discussed.

Furthermore, the Economic Development and Job Creation Strategy, according to eThekwini Municipality (2013b), clearly acknowledges the negative risks that climate change presents but also highlights the fact that there will be benefits, particularly in the creation and installation of green technologies. Ensuring that environmental principles are integrated into economic development, while leveraging opportunities that the green economy presents falls under Outcome 4 of the strategy.

The eThekwini Municipality also has a number of internal policies that aim to support the green economy. These include the inclusion of green procurement into the eThekwini Municipal Supply Chain Management Policy (eThekwini Municipality, 2017d).

It is important to note that the South African national and local governments have numerous specific projects and programmes in place that directly and indirectly contribute to the development of the green economy. These projects and programmes will not be discussed due to the large number of projects and programmes and the focus of the research is more on structural matters of the eThekwini green economy.

This section provided a broad overview on the South African government documents that support the development of the green economy. As noted by Montmasson-Clair (2012), the discussion reinforces the notion that there is no one central point from which the green economy is being driven from, particularly with the plethora of documents from various government departments. What is noticeable is that most of the documents take their lead from the National Development Plan and New Growth Path and try to align from a bureaucratic perspective depending on what level of government they are representative of. It should be noted that while this section was being written very little evidence, and number of documents, could be found on the attainment of the existing targets. In certain instances strategies are reviewed, without providing an update for prior periods and in certain instances strategies and plans have long past their achievement dates with no sign of a revision or even update on progress. This is likely to contribute to an environment of policy misalignment and uncertainty and it will be difficult to highlight likely contradictory actions and plans.

As raised by Montmasson-Clair (2012); Kaggwa et al. (2013) and Smit and Musango (2015b) there are many South African national government departments that have directly and indirectly laid strategic, legal and regulatory foundations for the establishment and growth of the green economy, at large, not just for the eThekwini green economy. From a green economy definition stand point and according to complexity theory, this is good – as relevant national government departments are working on aspects that relate to their core mandates and developing relevant standard, strategies, regulations and laws. The literature review appears to indicate that the social aspect of the green economy has received the least attention when

compared with the economic and environmental aspects of the green economy. This then appears that even government is party to the promotion of creating a sector or industry where the owners of capital become the largest beneficiaries of the green economy, while there not being equivalent benefit for social equity aspects – which is one of the main purposes of the green economy and vital for the eThekwini Municipality and South African contexts. The decentralised approach, however, is fantastic, especially from a complexity theory perspective. A review of the literature did not yield any official government documentation that emanated from the literature review, that identifies the possible overlap, gaps, contradictions and dynamic and complex aspects that need to be addressed holistically. It is vital for implementation that gaps and contractions be urgently identified and rectified, so that certainty is provided for all stakeholders.

2.6 Business risks

United Nations Global Compact (2011) makes a very pertinent assertion, businesses do not exist in isolation of their broader environments. As a result, any negative effect of climate change on a community or the physical environmental will have a knock-on impact on business activities, this is supported by Gasbarro and Pinkse (2016). To provide an example, if a small manufacturing town is hit by a tornado and flooding severely damages the town's infrastructure; manufacturing businesses will not be able to operate due to the pieces that employees (the town's residents) have to pick up at their homes. In addition, there will be non-delivery of raw materials due to damaged roads and electricity outages due to cable damage. Even if the manufacturer can get access to other sources of supply for raw material and electricity, and assuming all the manufacturers goods are sold locally and are considered luxuries, customers will be focused on rebuilding what has been damaged and on procuring essential goods only. This will naturally affect the company's sales.

The United Nations Global Compact (2011) list the critical direct risks to businesses as a result of climate change, the risks are: physical and operational, regulatory and legal, financing, market, political and reputational. It should be noted that these risks are compounded in developing countries. While seemingly aggregating risks into a few categories, Edwards et al. (2016) broadly supports the notion that business will experience climate change risks, which they highlight as: physical risk (e.g. direct impacts from climate change events), transition risks (changes associated with a shift

to a low carbon economy) and legal risks (e.g. litigation from stakeholders that have suffered losses).

There will likely be substantial financial impacts as a result of climate change, these include: cash flow and operating impacts (this can occur on the debtors and creditors categories), asset impacts (the value of assets can be written down due to transition to other technologies, and actual assets may be at risk of actual climate change impacts, e.g. coastal properties), financing impacts (businesses that are not well geared against climate change, might be prejudiced against) and directors and officer liability (Edwards et al., 2016).

Another key risk, according to Cohen and Vandenbergh (2012), is the real possibility of products that have a high carbon intensity being boycotted, or substituted according to Štreimikienė and Mikalauskienė (2007). This can be linked to the market and reputational risks identified by United Nations Global Compact (2011). This risk of boycotts is also just as real for the entire economy. The shift to maximize output, whether number of products or GDP and reduce GHGs emissions is critical.

A number of projections on the impacts of climate change, identified by Kahn (2015), are: there will be an increase in the death toll from natural disasters, under investment in climate change adaptation measures by coastal property owners and localities that experience an increase in temperature will also see an increase in air-conditioning investment, agricultural output will become increasingly volatile and interruption of global supply chains.

The important point to note from the above business risks that emanate from climate change is that whether one impact only occurs or they happen in tandem, is that ultimately whatever effects the stability of the broader environment or context within which an economy and company operates, and depends on, will have an impact on the economy and company. It is imperative that business start contributing to the reduction of GHGs especially from their direct operations and as a result limit climate change. At the same time business needs to take appropriate action to insulate their business from the eventualities of climate change disasters.

Bureš and Tučník (2014, pg. 152) eloquently provide a response for companies in the face of uncertainty, *"... in practice the pace of change and existing uncertainty about*

the way in which markets will evolve has made it increasingly important for companies to be aware of modelling techniques, which would enable support of decision-making processes". They go on to highlight two critical shortcomings of traditional modelling tools: the models are analytically tractable which offers validity based on narrow assumptions and traditional models cannot handle complexity as well as Agent-based Modelling (ABM), this is supported by Farmer et al. (2015). As a result, Bureš and Tučník (2014) and Furtado et al. (2015) advocate for ACE to be utilised as a theoretical platform to overcome limitations from traditional economic research.

The research has revealed that it is therefore unwise, not strategic and practically impossible for business to see themselves as being immune or not possibly impacted by climate change. This can be further supported by the United Nations Global Compact (2011) and Edwards et al. (2016). While it is in their best long term interests to adopt green economic principles, especially the social aspects, business are too often focused on annual and quarterly profits. This situation, at times, leads to investments and decisions that are past over as those benefits only materialise in the long term. It appears that an overhaul in the remuneration system for business executives are needed, that are linked to longer term 'green' or 'sustainable' deliverables. This is supported by Kolk and Perego (2014) and Damert and Baumgartner (2018). This would perhaps involve new remuneration packages or bonuses, based on the outcome of future deliverables and impacts from current decisions, but there are numerous complexities with this suggestion. It is the further position of this research that addressing the social aspects will likely yield far greater long term financial returns for business, as a whole – the system, i.e. as people and society progress, there will be a larger demand for all goods and services.

2.7 Organisational Development

As highlighted in the previous section, climate change will result in a plethora of unprecedented risks for businesses and on the economy more broadly, but it is critical to note that numerous opportunities also present themselves in the 'green economy' (Edwards et al., 2016; Dechezleprêtre et al., 2016). The capability of organisations, whether government institutions or businesses, to continue to prosper and mitigate risks stemming from climate change impacts will largely depend on the ability of the

organisation to learn, adapt and respond to ever increasing complexity. OD can make the development of this capability possible.

According to Burnes (2004), OD is an activity of repetitive learning within organisations, which seeks to achieve change according to the goals of an organisation. This is supported by Theodore (2014). Furthermore, Rana et al. (2015, pg. 1) states *"The underlying principle of Organisational Development is to support the broad organisational change, so as to [be] able to alter the formal and informal suit of each individual in total, along with the entire organisation"*. Some of the OD focus areas include: organisational (and individual) learning, knowledge management, and adaptation of organisation culture. There have been various advocates for classifying organisations as Complex Adaptive Systems (CAS) (Macbeth, 2002; Stacey, 2007; Burnes, 2004). In addition, without directly stating that organisations are CAS, Rana et al. (2015, pg. 1) states *"Organisational Development argues that every part of the organisation is fundamentally linked to a basic super system that influence and [are] influenced by the national and global environment as a whole"*.

As a result of organisations being classified as CAS, it is important that methodologies, with a CAS underpinning be utilised to assess, analyse and understand their operations and the environments within which they operate in. Furthermore, once such a methodology is utilised, for the above purposes, there will be a critical need for such innovative approaches and mind-sets to be woven into the fabric of organisations.

2.8 Conclusion

This chapter began with the provision of a definition of economics, the focus being specifically on definitions for the green economy. While there seems to be various definitions of the green economy, the most common definition is that of the United Nations Environment Programme (2010). It was noted that amongst the various definitions there are a lot of commonalities. Thereafter, the worldviews which the green economy can be approached with were discussed.

The sectors that make up the green economy were then presented. This began with Burkart (2009) who highlighted six sectors and then proceeded to various pieces of research that revolve around specific sectors that contribute to the green economy.

Indicators for the green economy were then presented, followed closely by the SDGs. Relevant SDGs, their objectives and indicators were highlighted.

This was followed by relevant South African legislation, strategies, frameworks and plans at the national, provincial and local level. It was observed that the linkage to a green economy and environmental protection is rooted in the South African Constitution. Furthermore, the National Development Plan plays an integral role in guiding the country's development. In essence, the appropriate enabling strategies, frameworks and plans are in place. It is important to note that specific government owned and driven projects were not discussed. The green economy is not driven by any one government department, or by any one government document, rather it is being pursued by a legion of documents and government departments making it decentralised in nature.

Climate change risks that businesses are exposed to were then presented, these risks relate specifically to risks faced as organisations such as: legal, reputational and financial. It was raised, albeit most importantly, that businesses do not operate in a vacuum and that any risk faced by a region that the business depends on will ultimately impact the organisation through various knock-on effects, some more direct than others. There is also a real risk of economies and businesses being boycotted against if the carbon intensity of the economy, or products and goods, is not decreased. The importance of OD for facilitating the necessary learning within organisations or businesses, to then enable the organisations or businesses to be able to transition to a green economy was then briefly discussed. The other major point raised was that organisations can be classified as a CAS.

The following chapter, chapter three, will discuss the theoretical underpinnings that were considered for this research, including the chosen theory.

CHAPTER THREE: LITERATURE REVIEW: THEORETICAL BASIS

3.1 Introduction

A particular problem, topic or system, within various disciplines, can be analysed utilising a myriad number of theoretical foundations (Maduliat et al., 2015; Bailey and Caprotti, 2014). According to Dolores Sánchez-Fernández et al. (2014) and Armiger (2015), it is important for appropriate theories to be utilised for certain types of research. This would imply that the theory being utilised should be able to fully accommodate the research question and if there is a mismatch, any outcome will likely be outright wrong or lack a thorough appreciation of the richness of the solution or understanding of the system.

As a result, it is critical that an appropriate theoretical underpinning be identified to guide this research in its quest to understand the eThekwini green economy and develop a framework for the eThekwini green economy according to its dynamic characteristics, without making the research, process or framework tractable to generalised assumptions. Relevant theoretical underpinnings will be critiqued for relevance and appropriateness, in this chapter, for this research.

It should be noted that Information Technology's advancement over the past few decades has been on a continuous compounded growth curve (Schmit, 2017; Leveratto, 2016). This was to be expected based on Moore's Law. Moore's Law is the concept that microprocessors and electronic circuits double in performance every two years (Moore, 1975). The rapid and continuous advancement of Information Technology and computing power made a plethora of aspects possible and opened so many new doors, which would not have been a reality without Information Technology (Cohen and Lloyd, 2014; Minica, 2016; Harper et al., 2011). One of these doors is ACE.

A discussion is presented on various schools on economic thought, as potential options to underpin this research. CAS is introduced and the critical foundations of CAS are discussed. The bulk of the chapter will be allocated to ACE literature, which will include an overview, applications, advantages and disadvantages, previous research is a key focus and the need for further ACE research.

3.2 Discussion of various theoretical foundations for this research

This section will discuss various economic and related theoretical underpinnings in order to identify a suitable discipline for this research.

3.2.1 Economic schools of thought

'Economic equilibrium' is reached when supply and demand is matched (Wing, 2004; Barzilai, 2016). Economic equilibrium models are simulation exercises that intertwine principles of equilibrium with empirical data to determine when demand and supply reaches equilibrium (Konnov, 2015; Wing, 2004). Wing (2004) further adds that economic equilibrium models are intended to analyse aggregate impacts of interventions. Key characteristics of traditional economic modelling include: being built from the top-down and is based on the foundation of fixed rules, homogenous components and market equilibrium (Tesfatsion, 2002). A key shortcoming of general equilibrium theory is the assumption that all agents make completely rational decisions (Wolpert and Tumer, 1999; Whittle et al., 2014). In addition, the equilibrium approach is made tractable to allow the analysis of its structure and implications (Arthur, 2006). Arthur (2006) further adds that the tractability arises out of many assumptions, such as components being homogenous and utilise all available information. The implication of imposing such limitation, according to LeBaron and Tesfatsion (2008), is that critical empirical factors are not intertwined. As a result, some of the robustness that actually takes place in reality is overlooked and not incorporated into the development of a comprehensive understanding of the aspect that is being researched.

Marchant and Snell (1997, pg. 3) states that microeconomics is *"The branch of economics that deals with the behaviour of the individual producer and consumer, particularly as decisions are made with respect to the allocation of limited resources"*. In essence, microeconomics is concerned with behavioural nuances of individuals and organisations use of resources (Dominique, 2017; Manuel, 2006). According to Black et al. (1997), some of the key concepts of microeconomics include: opportunity cost which is the cost associated with a waivered substitute, demand function states that the demand of a good or service will increase as the price of the item decreases, supply function states that the quantity of a good supplied and its price is positively related to demand and equilibrium brings together the supply

and demand functions and results in so-called optimum state when supply equals demand.

"Macroeconomic policy is primarily aimed at addressing the problems of unemployment, inflation and cyclical instability. Its overall aim is to create a business environment that is conducive to achieving and sustaining economic growth under conditions of certainty" (Black et al., 1997, pg. 289). This is broadly supported by Dacheux and Goujon (2011) and Mankiw (2010).

Microeconomics and macroeconomics address two very different aspects of an economy, with microeconomic activity giving rise to macroeconomic phenomenon.

The various branches of economics that could potentially be utilised as an underpinning theory for this research will now be discussed.

This research requires a theoretical underpinning that does not simplify a system, the economy, to better understand it and that does not inherently claim to be able to predict the future. The rationale of requiring a theoretical foundation that can deal with the complexity of a system is critical for bringing about an understanding of a system that is new, or in its early development stages and will also allow leverage points in the system to emerge, be identified or observed. The identification of these leverage points would be the first step in further developing and stimulating the system. Predictability in the chosen system is not important, given the path dependence characteristic of complex systems. It will be extremely onerous to even begin to try and predict what a likely outcome can be, however probable outcomes and scenarios might be possible. Levin (1998, pg. 433) defines path dependence as *"... a consequence of nonlinearity, which refers simply to the fact that the local rules of interaction change as the system evolves and develops"*. In addition, the identified theory should be able to incorporate a plethora of aspects, not just economic agents, such as the actual environment and GHG emissions, impacts from climate change, such as flooding, drought and international practices and trends. Most importantly, all of the above needs to be able to be aggregated into an established theory that revolves around agents' micro-interactions, which will give rise to emergent properties. The ability of a theory to lend itself to computer simulation, or be developed around computer simulation, is also vitally important even though this research intended to only develop a framework.

Ecological economics assimilates aspects from natural and social science to solve environmental challenges while ensuring that sustainable development is achieved and viewing the economy as a part of a larger eco-system (Van den Bergh, 2001; Sutton et al., 2016). A definition is provided by Spash and Schandl (2009, pg. 4) *"Ecological economics is concerned with environmental degradation, loss of species, damage to ecosystems structure and functioning, the basic limits on economic activity imposed by physical laws, the role of money in perverting environmental values and the means by which human society can operate in harmony with Nature"*. Faber (2008) points out that ecological economics is still in its infancy and not yet well established, however this leaves a lot of scope for blue-sky thinking. The inability of economics, according to Faber (2008), to conceptualise nature and justice has given rise to ecological economics. Gerber and Gerber (2017) states that ecological economists are ardent supporters of commodification, when the opposite is likely the best possibility. Ecological economics is premised around quantifying the financial value of ecological services (Ricketts et al., 2004; McCauley, 2006; Costanza et al., 1997). The methodology of calculating the worth of ecological services has been strongly rebuked and the validity of calculated figures is questionable (Spangenberg and Settele, 2010; Norgaard, 2010). It is for this reason that ecological economics is not considered as an underpinning theory for this research.

The next possible theoretical underpinning is environmental economics, which is a field that focuses on the relationship between the physical environment and the economy while giving attention to the potential to utilise the physical environment for economic development and giving due consideration to impacts on the environmental by economic activity (Folmer and Johansson-Stenman, 2011; Sandmo, 2015; Andersen, 2007). Beder (2011, pg. 145) highlights a structural problem with environmental economics, *"Rather than being an interdisciplinary expansion of the discipline of economics, environmental economics has adopted the theory, assumptions and paradigms of neoclassical economics and applied them to incorporate environmental problems into economics analysis"*. Spash (1999) supports this and states that environmental economics endeavours to make issues tractable to fit within the developed models. Amongst the differences between ecological economics and environmental economics, the latter 'externalises' the environmental problems to core economic interaction between people. This is different to ecological

economics that sees the economic system as a sub-system with a larger environment. Another key difference is that environmental economics takes an optimisation approach (Van den Bergh, 2001). Environmental economics is not appropriate for this research as it utilises equilibrium models and does not take into account the inherent complexity of which economies operate according to.

Diacon et al. (2013, pg. 28) describes behavioural economics as that which *"... aims to join together and to adapt the basic principles of neoclassical economics with the realities imposed by the complex human nature"*. In other words, behavioural economics seeks to study the individual nuances of financial decisions and the implications for the economy (Lunn, 2013; Whittle et al., 2014). A key tenet of behavioural economics is 'bounded rationality', which means decisions are limited because of imperfect information and time constraints, which is totally at odds with the 'completely logical' decisions in neo-classical economics (Whittle et al., 2014; Never, 2014). Adam Smith did not subscribe to purely rational utility decision making but rather to a realistic conception of the fallibility of Homo sapiens (Ashraf et al., 2005; Viera, 2017). Behavioural economics does closely align with most of the prerequisites for the selection of a theoretical underpinning for this research, however it is not explicitly developed around the issues of complexity and dynamism and there are better suited theoretical options.

The fundamental tenets of evolutionary economics, unlike most other economic theories, cannot be agreed on by academics (Witt, 2008). However, according to Lambooy and Boschma (2001), *"... evolutionary economics has two faces. The first one focuses on the longer term growth-paths, or trajectories, and the second one has an emphasis on human strategies in the struggle to survive, sometimes in adverse environments. This latter one emphasises the ways to improving the properties of the structure, or the conditions or production, in order to raise the productivity of the actors, by influencing the selection environment by well devised strategies of innovation. In general, evolutionary economics does not consider individual decision-making as such"*. Evolutionary economics take into account the inherent heterogeneous characteristics and behaviour of economic agents (Santos, 2017; Robert and Yoguel, 2016). The fundamentals of evolutionary economics is very consistent with what is required for this research, however there are other theoretical

approaches that can better incorporate complexity and dynamic elements as its central pillars and as a result acts as a more appropriate choice.

Undoubtedly, the above mentioned economic schools of thought are rooted in a vast array of reputable theory, such as Diacon et al. (2013); Sutton et al. (2016) and Sandmo (2015). The contention of this research is that the highlighted schools of thought have been developed during simpler times, without the inherent dynamism and complexity that we are currently rooted in. This research also acknowledges that theories and schools of thought evolve over time, with new research. However, the inherent fundamentals of most established economic schools of thought are limited and made tractable to simplify reality (LeBaron and Tesfatsion, 2008). Currently, the world is experiencing multiple unprecedented challenges, all seeming to converge at the same time, this includes climate change and growing nationalist movements (World Economy Forum, 2017). When analysing a current economy, particularly a local green economy, that is made up of economic, environmental and social elements – it is vitally important that theoretical foundations that can incorporate an unprecedented level of data, complexity, dynamism and feedback loops are adopted (Dolores Sánchez-Fernández et al., 2014; Armiger, 2015).

3.2.2 Other relevant theoretical foundations

Game theory has its roots in applied mathematics and is utilised in many disciplines, including economics (Nie et al., 2014; Burguillo, 2010; Arsenyan et al., 2015). Game theory is the research of cooperation and conflict between numerous interdependent agents, which can be individuals or organisations, where the choices of an agent affect other agents (Turocy and von Stengel, 2001; Michael-Tsabari and Weiss, 2015; Camerer et al., 2015). *"The concepts of game theory provide a language to formulate, structure, analyse, and understand strategic scenarios"* (Turocy and von Stengel, 2001, pg. 4). Game theory is also largely developed around the concept of equilibrium and any explanation of a social configuration is in essence related to Nash Equilibrium (Tesfatsion, 2006a). In addition, according to Michael-Tsabari and Weiss (2015) game theory utilises the notion of rational agents, but according to Backhaus et al. (2013) and Camerer et al. (2015) agents can be either rational or bounded-rational. The primary reason that game theory was not selected for this research is due to the larger breadth of this research and involves more than merely cooperation and conflict but is inclusive of it.

United Nations Environment Programme (2013, pg. 14) describes system dynamics as *"The method uses a stock and flow representation of systems and is well suited to jointly present the economic, social and environmental aspects of the development process"*. Jay Forrester developed system dynamics in the 1960's (Feng et al., 2013; Marzouk and Azab, 2014). System dynamics models first seek to understand the system in question and then improve on it (Forrester, 1994). While system dynamics have been utilised in economic research before (United Nations Environment Programme, 2013; Musango et al., 2015; Marzouk and Azab, 2014), it does not take the individual behaviour of heterogeneous agents into account (Maidstone, 2012). A major shortcoming of system dynamics is that all data need to be input into the model and cannot be generated by the model itself (Feng et al., 2013; Sjöstedt, 2015). This implies that the models do not have the ability to evolve of their own accord. Due to the inability to incorporate heterogeneous agents and the requirement to input all data into the model, as opposed to setting the initial parameters and letting the model evolve without any external input, system dynamics is ruled out for this research but would have been the immediate alternate to the chosen theoretical underpinning. It is important to note that research utilising system dynamics has been previously utilised in the Western Cape (Musango et al., 2015; Oosthuizen et al., 2016) and at a national level (United Nations Environment Programme, 2013).

While game theory and systems dynamics incorporate elements of complexity and dynamism. The extrapolation of the theory to develop a framework was not viewed as feasible by the researcher for both theories, as the mapping processes did not lend itself to identify leverage points, specifically for the eThekwini green economy. Furthermore, once the framework is eventually developed further into an actual simulation model, both game theory and system dynamics do not allow for emergence to the scale required. If a simpler explanation of the manner in which the eThekwini green economy was being pursued, system dynamics would have been more than appropriate.

The solution to the shortcomings and inability of existing methods of taking into account the complex dynamic nature of economies can be found in ACE.

3.2.3 Complex Adaptive Systems

Before we delve into the details of ACE it would be beneficial to first briefly discuss CAS, which can be investigated utilising ACE (Kiose and Voudouris, 2015; Tesfatsion, 2002). CAS is a specific type of system that has more than two agents (components) which have the ability to learn and adapt to stimuli from other agents and the entire system, while having an impact on other agents and the entire system (Holland, 1992; McKenzie, 2014; Wollmann and Steiner, 2017).

Discussing the various characteristics of CAS normally provides a good overview of the concept. Some of the characteristics include: Self-organisation: a CAS cannot be controlled or managed by one agent and as a result the system is self-managed in a decentralised manner (Bristow and Healy, 2014; Bale et al., 2015). Co-evolution: when any learning takes place, due to feedback loops the various agents and the system develop simultaneously as a result of the learning (Ellis, 2011; Brady, 2014). Agents with schemata: each agent is unique in that they cannot be considered homogeneous in terms of their behaviour and characteristics (Ellis, 2011; Filotas et al., 2014). Sensitive dependence: even with the smallest deviation in a starting point, or any subsequent change, the result will likely be exponentially amplified at a later stage (Grus et al., 2010; Speakman, 2017). Path dependence: certain options or opportunities and threats will only be available upon making specific initial decisions (Bale et al., 2015; Held et al., 2014). It should be noted that this implies that other opportunities and threats, for different decisions, will then not be available. Emergence: this tenet states that through the interaction of agents a 'unique variable or situation' arises, the variable or situation could not come into being without the interaction of the agents (Bale et al., 2015; Held et al., 2014). This is one of the fundamentals of a CAS, a situation or outcome that cannot be arrived at by merely aggregating the system's parts to get the sum.

Balint et al. (2017, pg. 22) *"The consequences of climate change for human welfare are likely to be enormous, and the intellectual challenges presented by the economics of climate change are daunting. Complex systems science offers flexible tools to analyse the relationship between the physical and the socio-economic system"*. Furtado et al. (2015) further support this by classifying social systems, the economy, environment, cities, education, transportation and legislation as being complex in nature. It is important to note the earlier definition of the green economy, which

highlighted the three aspects that needs to be positively impacted by pursuing the green economy, these are: social equity, economic development and environmental sustainability, all of which can be classified as being complex in nature.

It is the view of the researcher that any complexity based theory is a prerequisite for the understanding of the eThekwini green economy. The interconnectedness, feedback loops, and inherent heterogeneous characteristics of all components of the eThekwini green economy require a foundation that has the ability to incorporate such.

3.3 Agent-based Modelling

3.3.1 Introduction

ABM is a computer based simulation exercise undertaken with an autonomous set of agents, whose behaviour impacts other agents and the larger system (Helbing and Balietti, 2011; Getchell, 2008; Ferson and Sentz, 2016). One of the initial major points raised by Helbing and Balietti (2011) is that ABM is not widely utilised and provide some potential reasons for their scarcity, which include: opaqueness and lacking the ability of prediction. This is further supported by Levy (2009), who points out that economics has also been slow in the uptake of an ABM approach and according to Baptista et al. (2014) the same holds true for the 'business simulation' sector. However, Macal and North (2014) and Lee et al. (2015) counter this position, by stating that ABM has been receiving an increased amount of attention recently.

Some of the main advantages of ABM are being able to model a system from the bottom-up (Helbing and Balietti, 2011; Wellman, 2016). This allows emergent properties to be generated, makes it possible to develop a model where the agents are of a heterogeneous nature (Helbing and Balietti, 2011; Bergerson et al., 2016) and allows agents to be modelled as interdependent and interacting, which allows the dynamic and complex nature of agents to be taken into account (Helbing and Balietti, 2011; Bergerson et al., 2016). There are two major shortcomings of ABMs: the rules that govern the interaction of agents are developed in a makeshift manner and validation of such models remain a challenge (Rai and Robinson, 2015).

Helbing and Balietti (2011) importantly state that ABM allows economics to transcend the notion of *homo economicus* – that of the rational economic man. This

can be broadly supported by Bergerson et al. (2016) who adds that ABM requires fewer assumptions than other models. In addition Gräbner and Kapeller (2015), echo this notion by stating that ABM allows, to a greater extent, unique agent behaviour to be taken into account.

According to Helbing and Balietti (2011) and Levy (2009), ABM can be utilised for a wide variety of disciplines that include: various human social aspects such as cooperation and conflict, business aspects such as cooperation amongst firms or even entire financial markets, both micro and macroeconomics and vehicular traffic dynamics.

One of the first and best known examples of ABM is the 'segregation model' developed by Thomas Schelling (Levy, 2009; Masad and Kazil, 2015). According to Schelling (1969), segregation can stem from a variety of factors that include gender, race and income. While the primary focus of Schelling (1969) is segregation by race in the United States of America, he states that his paper is highly abstracted and as a result can refer to anything that can be described by two differing characteristics, e.g. man and lady or honest citizen and criminal. ABM research has been able to analyse topics that flabbergasts traditional economic models. These include 'Complexity Research Initiative for Systemic Instabilities' and '(FOC) Forecasting Financial Crises' (Li, 2013).

Advances lead to further advances, which the development of the computer has allowed. Utilisation of ABM, which can be considered a marriage of Information Technology and CAS, offers unprecedented opportunities to simulate situations, problems (Helbing and Balietti, 2011; Bergerson et al., 2016) and even stock markets (Cui et al., 2012). The utilisation of cutting edge approaches are inevitability bound to test the validity of existing knowledge. This does not mean that those pieces of knowledge become superfluous, rather it becomes an invaluable step in a journey that leads to new knowledge.

3.3.2 Agent-based Computational Economics

3.3.2.1 Overview

According to Tesfatsion (2003, pg. 1) ACE is *"the computational study of economics modelled as evolving systems of autonomous interacting agents"*. Levy (2009, pg. 1)

adds *"Agent Based Computational Economics is a framework allowing economics to expand beyond the realm of the "rational representative agent"*. ACE can be conceptualised as a mutation of CAS specifically for the field of economics (Chen and Kao, 2016; Tesfatsion, 2002). Economists can utilise ACE to explore economic systems with heterogeneous agents that have bounded rationality (Dilaver et al., 2016; Levy, 2009).

The three fundamental parts of an ACE model are: the agents, interaction rules and the environment (Corredor, 2007; Van Dinther, 2008). However, Li (2013, pg. 5) states that there are four elements: *"The scope of the economic system and its environment", "The interrelation between the economic system and its environment", "Elements of the economic system, i.e. economic agents considered in the economic system"* and *"The structure of the economic system, which is the interrelation among elements of the economic system"*.

The ACE modelling process begins with researchers specifying the structural aspects of agents within an economy and thereafter the characteristics of the agents are included (Tesfatsion, 2003; Gilbert and Terna, 2000). The characteristics of agents can include mental models, behaviour traits and memory. It is critical to set the initial state of the economy before the simulation is initiated. After the initial characteristics of the agents within the economy are specified, behavioural nuances developed and environmental factors set, the model is initiated and there is no further intervention from the researcher until the simulation has run its course. This method sees the agents act as they would in real life, where their actions affect the system, which in turn affects their actions. The feedback loops, whether positive or negative, are critical for the dynamic nature of these models as they will also inform a learning function. Axelrod (2005) contends that simulation, which is the foundation of ACE, is a third way of undertaking science, in addition to induction and deduction.

LeBaron and Tesfatsion (2008) identify three key aspects that need to ideally be present in an ACE model: an empirically based structure and set of agents, the model must be appropriately scaled and the model must be empirically validated.

In addition, Li (2013) makes a good distinction between two types of agents, active economic agents are those that have the ability to make decisions and act on their own

accord. Passive economic agents, on the other hand, do not act on their own accord, such as gold.

It is important to note that through this research only a framework has been developed, not a simulation model. The reasons for this are: emanating from the primary data collection process most, if not all, participants seemed to not be interested in laborious exercises, respondents seem to not have the required skills to perform simulation exercises and it was perceived that the stakeholders of the eThekwini green economy will better internalise information through interacting with a framework that is easy to read.

3.3.2.2 Applications for Agent-based Computational Economics

Tesfatsion (2002) provides eight broad areas that ACE research can be categorised into and utilised for: learning of systems, behavioural evolution, organisation modelling, bottom-up system modelling, development of economic structures, development of agents for automated systems, development of ACE laboratories, and real and computation agent concurrent experimentation.

It is important to note that Tesfatsion (2006b) further synthesis ACE research into four areas, which are differentiated by the goals of the research, these are: empirical understanding of why actual events and occurrences mutate and continue to be present without strategic control, normative understanding that aims to test proposed policies and regulations to determine their effectiveness over a specific duration, qualitative insight and theory generation, which seeks to understand a system through its complex and dynamic behaviour and methodological advancement, which aims to provide the relevant theoretical and computational tools that will allow researchers to essentially confirm a hypothesis, derived from a modelling exercise against empirical data.

In terms of the revised classification, this research will fit perfectly in the third objective, that of gaining a qualitative insight to understand a system.

3.3.2.3 Learning algorithms/systems

According to Tesfatsion (2002), the following are the main types of learning algorithms utilised in ACE: Genetic Algorithm learning, Q-Learning and the Classifier system. This is supported by Blecic et al. (2016).

Q-Learning can be described by Watkins and Dayan (1992, pg. 55), *"… is a form of model-free reinforcement learning. It can also be viewed as a method of asynchronous dynamic programming. It provides agents with the capability of actions, without requiring them to build maps of the domains"*. A Q-Learning system tries various actions in a specific state, assesses the immediate outcome as positive or negative for that particular state and stores this in a memory bank (Watkins and Dayan, 1992; Ye and Xu, 2014; Solferino et al., 2015). Ultimately the system is designed to optimise decisions.

According to Liepins and Hilliard (1989) and Sahu et al. (2013), Genetic Algorithms were developed along the lines of natural selection as an optimisation method. Liepins and Hilliard (1989), supported by Kermani et al. (2016) and D'addona and Teti (2013) go to explain that Genetic Algorithm systems are essentially made up of a population of approximately fifty to two hundred agents and works in a step-by-step fashion. There are three fundamental processes that occur in a Genetic Algorithm, these are: the health of each agent is assessed, there is an establishment of strong 'genes', primarily from stronger agents, or characteristics of agents and combination of genes evolves to form the agents for the next 'generation'.

Classifier systems have been utilised in previous ABM research (Bonarini et al., 2007; Holsapple et al., 1998) and in ACE modelling, or similar research (Beltrametti et al., 1997; LeBaron, 2002; Kirman and Vriend, 2001). According to Booker et al. (1989) and supported by Holmes et al. (2002), a classifier system is a type of reinforcement learning system that is operated in a parallel fashion and functions on fundamental notions of 'messages' and rules that are given credit for success and debited for their failures, while searching of new rules. Classifier systems, as highlighted by Booker et al. (1989), is applicable under certain scenarios that exhibit some or all of the following tenets: unique occurrences that are accompanied by a legion of immaterial information, perpetual immediate actions are needed, esoteric objectives and confirmation of positive or negative reinforcement is only available after a lengthy progression of steps.

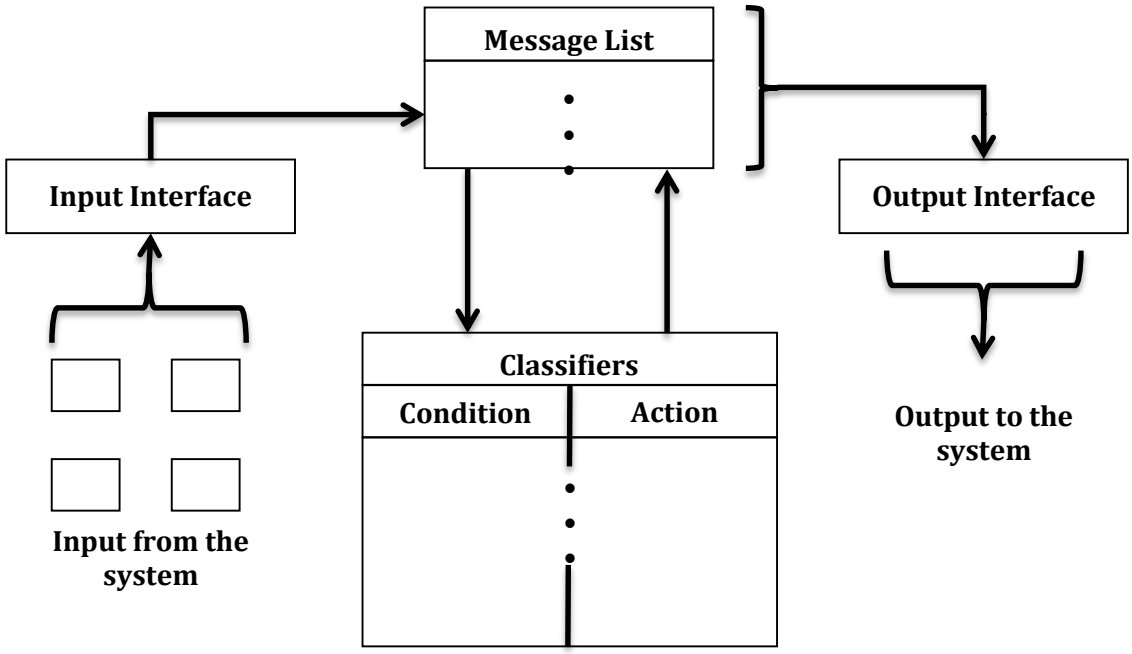

Figure 3.1: Working of a classifier system

Source: Adapted from Booker et al. (1989).

According to Booker et al. (1989) and corroborated by Beltrametti et al. (1997), classifier systems essentially works in the following series of steps, as depicted in Figure 3.1: information from the system are received by the 'Input Interface' and communicated to the 'Message List', the messages are then juxtaposed to the pre-specified conditions of the 'Classifiers', to find matches for each matched message, a specific instruction/action is then posted as a further message, all messages on the 'Messenger List' are then replaced by newer messengers, the message that results as an 'Action' from the 'Classifier' is converted to the requirements of the current sequences output and the process is repeated from the beginning.

3.3.3 Advantages and disadvantages of Agent-based Computational Economics

A drawback of ACE is that such models have to be developed so as to be properly configured, i.e. the model should be able to terminate at the desired point and achieve objectives without external input. This will require that, amongst others, the structure of the model, the agents, the agents' behaviour and feedback loops are appropriately captured (Tesfatsion, 2006a). Another challenge with an ACE model, as noted by Tesfatsion (2006a), is the difficultly of validating ACE research findings. This is countered by an advantage that ACE's and ABM's real value does not lay in the

predictive accuracy but rather in their ability to shed light on the dynamics of a system (Levy, 2009).

More advanced models, in isolation, should not be expected to provide solutions to mitigate against market instability but rather provide insight into the workings of markets that will enable us to be better prepared for threats and challenges (Gatti et al., 2010). The notion that ACE models should not be seen as a replacement for traditional economics but as a good complimentary tool is also advocated by Tesfatsion (2006a).

According to Gatti et al. (2010), modern economics is premised around equilibrium micro foundations, which is fraught with a critical shortcoming that does not allow the study of the fundamentals of macroeconomics, i.e. interaction at a micro level between agents that lead to emergent properties and structures in a given economy (Chen and Wang, 2011). In ACE models, equilibrium is not presumed or imposed and is able to highlight and take into account economic agents' dynamic nature that gives rise to emergent phenomenon (Gatti et al., 2010; Irwin, 2010; Negahban and Yilmaz, 2014). Mass adoption of ACE is still constrained by two factors: the availability of standard models that can be utilised to address various research objectives and the manner in which ACE research can be translated and utilised for the development of policies. ACE agents do not only have to have a utility characteristic but can utilise characteristics that are more representative of reality (Gräbner, 2016). This results in a major advantage, in that ACE allows agents to be rationally bounded in their decision-making (Chan and Steiglitz, 2008). Simulation offers the ability to test varying methods within the same conditions (Weidlich and Veit, 2006). At each stage of a simulation it is possible to observe and monitor the 'interaction' data between the agents (Oeffner, 2008).

Gräbner (2016) further adds that ACE has the potential to provide insights into unanswered questions, also mentioned is that constructing an ACE model is a complex undertaking. As a result, previous research will now be presented that will be utilised as a benchmark and guidance for the development of the framework through this research.

It must be observed that ACE is a relatively new theoretical discipline, it has not been fully adopted and the researcher would go as far to say that it has only be taken up

thus far in academia by innovators. Once tested fully and further models developed, the true value of ACE is likely to become mainstreamed.

3.3.4 Previous relevant research

EURACE was a massive endeavour to simulate the actual European economy, according to its complex nature with dynamic interacting and heterogeneous agents and was developed on the Flexible Large-scale Agent Modelling Environment (Deissenberg et al., 2008; Naciri and Tkiouat, 2016). It should be noted, however, that there is a plethora of platforms that can be utilised for the development of ACE models, these include: Swarm, NetLogo and RePast (Getchell, 2008). Some of the main components of EURACE are as follows (Deissenberg et al., 2008; Cincotti et al., 2011): time and space: EURACE is developed using the spatial boundaries that the European Statistics Office utilises for the European Union. All other regions in the world are considered as a single region. The model utilises 'a day' as the basis for its time construct. It is important to note that not everything occurs on a particular day, for example some activities depend on other activities while varying amounts of time controls others. Households: can fulfil various roles, such as providing labour, as an investor, or a consumer of goods. Firms: there are two types of companies that each produces a specific type of product, one produces 'capital equipment' which is then utilised by the other sector to manufacture 'consumable goods'. Banks: provide loans to other agents but are made realistic in the sense that they first assess 'credit worthiness' and have varying degrees on interest. National government and central bank: are the only passive agents that can only operate according to narrowly defined algorithms. 'Statistical communication agents': essentially act as an information processing and providing agent, when information on the state of the 'markets' or economy is required. There are also various markets, which include: consumption goods, investment goods, labour, credit and financial assets.

It should be noted that Deissenberg et al. (2008) merely provides information on EURACE and specifically only the labour market within the model and can thus be described as a decent introductory to the overall structure of EURACE. For a more in-depth look at EURACE and some of its more salient protocols we turn to Cincotti et al. (2011). According to Cincotti et al. (2011), the following are some of the broad features of EURACE: it is an uncommon agent-based economic model that includes all the critical elements, such as financial stocks and flows that are modelled from the

bottom-up. The agents in EURACE are modelled as ‘bounded rationally’ as opposed to having perfect knowledge and making completely rational decisions. The heuristics that are utilised as a basis to model the agents are borrowed from various other academic disciplines such as management and psychology. The algorithms that the agents are modelled according to are allowed to evolve according to the state of the entire model. There are two types of agents: the first merely makes decisions based on ‘input parameters’ received from other agents and the environment. The second actively learns and evolves and make decisions thereafter. The various markets are based on the manner in which real-life markets are structured and operate. The details of the markets will be discussed further down. A balance sheet format is utilised in EURACE to ensure that all financial flows are accounted for. Various agents’ decision making is based on time scales that are observed in real life. Interactions between agents are modelled as asynchronous to ensure that the agents do not interact in the same manner with the same agents. However, some interactions or activities are scheduled and synchronised to reflect institutional operations.

According to Cincotti et al. (2011), there are two types of manufacturers: capital manufacturers and consumption goods manufacturers, which make up the production sector. The capital manufacturers are modelled as less complex than consumption goods manufacturers. Capital manufacturers can produce unlimited goods, of one technology, in addition they don’t need to carry any inventory or require credit facilities. The only inputs required by capital manufacturers are energy and raw material. The price of the capital goods is determined by a simple percentage increase on the energy price. All of the capital manufacturers are equally owned by all of the households. Consumption goods manufacturers are modelled to utilise capital goods and labour, provided by households, according to a Cobb-Douglas production function. The quantity and price levels of stock are determined according to typical rules. Consumption goods manufacturers have the ability to access credit from banks in order to finance production and cover any other financial commitments. An important feature built into the model, is that if or when consumption goods manufacturers cannot access credit when it is needed then the manufacturer will be closed. The manufacturers financial position is based on the parameters described in Table 3.1.

Classification	Parameter	Updating schedule
Assets	M^f: Cash deposited in the bank	Daily
	I^f : Inventory	Daily
	K^f : Physical capital	Monthly
Liabilities	$D^f = \Sigma_l \lambda^{f,i}$: Total debt	Monthly
	E^f : Equity	Monthly

Table 3.1: Parameters of manufacturers in the EURACE model

Source: Cincotti et al. (2011).

$$E^f = M^f + p^C I^f + p^K K^f - \sum_{b \in \{banks\}} D_b^f$$

p^C refers to the price of consumption goods and p^K is the price of capital goods.

The consumption goods manufacturer calculates the quantity of goods that is to be produced in a specific month and the corresponding price level. The planned amount of goods to be produced, taken together with inventory from the previous month determines the amount of labour and capital. If the capital held by the firm, taking depreciation into account, is less than that held by the manufacturer then an investment into capital is needed.

The manufacturer also calculates, monthly, the amount of interest to be paid for loans taken out. The equation for this is:

$$B_\tau^f = \sum_i \frac{r^i}{12} \lambda_{\tau-1}^{f,i}$$

Consumption goods manufacturers also pay Tax (T) on a monthly basis. This is calculated at a fixed percentage (ξ) of the previous months gross profit (Π). The equation is denoted as:

$$T_\tau^f = \xi \Pi_{\tau-1}^f$$

Revenue of the consumption goods manufacturer is calculated as price (p) multiplied by quantity (q) follows:

$$R_{\tau-1}^f = p_{\tau-1}^f q_{\tau-1}^f$$

The cost of labour is calculated as wage per employee (w) multiplied by number of employees (N), $w_{\tau-1}\mathrm{N}_{\tau-1}^{f}$.

Taking the previously mentioned parameters, we arrive at total liability of a consumption goods manufacturer by adding all debt, taxes and manufacturing costs, this is captured in the equation:

$$L_{\tau}^{f} = B_{\tau}^{f} + \mathrm{T}_{\tau}^{f} + p\sum_{i}\lambda_{\tau-1}^{f,i} + E^{f}\widehat{D}_{\tau}^{f} + w_{\tau}\widehat{N}_{\tau}^{f} + p_{\tau}^{k}\hat{I}_{\tau}^{f}$$

Cincotti et al. (2011) further discuss how the production quantity and price level decisions, for consumption goods manufacturers, are arrived at:

$$\tilde{Q}_{f,t} = \begin{cases} 0, & I_{f,t} \geq \hat{Q}_{f,t} \\ \hat{Q}_{f,t} - I_{f,}, & I_{f,t} < \hat{Q}_{f,t} \end{cases}$$

The quantity required for the coming month ($\tilde{Q}_{f,t}$) is determined by the anticipated demand ($\hat{Q}_{f,t}$), from which current inventory level ($I_{f,t}$) is deducted.

The anticipated demand is calculated based on a simple linear regression calculation, which is as follows:

$$\hat{Q}_{f,t} = \hat{a}_{f,t} + (\tau-1)\hat{b}_{f,t} + \bar{q}_{1-x}\cdot\sqrt{\hat{\delta}_{t}^{2}}$$

where $\bar{q}_{1-x}$ represents that standard distribution, where

$$\hat{b}_{f,t} = \frac{\tau\Sigma_{s=1}^{\tau}\, s\hat{S}_{f,t-\tau+s} - \frac{1}{2}(\tau(\tau+1))\Sigma_{s=1}^{\tau}\hat{S}_{f,t-\tau+s}}{\frac{1}{6}(\tau^{2}(\tau+1)(2\tau+1)) - \frac{1}{4}(\tau^{2}(\tau+1)^{2})}$$

and

$$\hat{a}_{f,t} = \frac{1}{\tau}\sum_{s=1}^{\tau}\hat{S}_{f,t-\tau+S} - \frac{1}{2}\hat{b}_{f,t}(\tau+1)$$

with the variance (δ^{2}) being

$$\delta^{2} = \frac{1}{(\tau-1)}\sum_{s=1}^{\tau}(\hat{S}_{f,t-\tau+s} - (\hat{a}_{f,t} + s\cdot\hat{b}_{f,t}))^{2}$$

In order to prevent massive variations in the quantity produced in the current month the manufactured quantity is adjusted, this is denoted as:

$$\bar{Q}_{f,t} = \xi \cdot \tilde{Q}_{f,t} + (1-\xi) \cdot \frac{1}{T} \cdot \sum_{k=t-T}^{t-1} Q_{f,k}$$

The sales price of all manufactured consumption products is set according to the following calculation:

$$p_{f,\tau} = \frac{\bar{c}_{f,\tau-1}}{1 + 1/\varepsilon_f^e}$$

where the cost per unit ($\bar{c}_{f,\tau-1}$) is calculated taking into account the current manufacturing ($\tilde{c}_{f,\tau}$) and existing stock:

$$\bar{c}_{f,\tau} = \frac{\bar{c}_{f,\tau-1} I_{f,\tau} + \tilde{c}_{f,\tau} Q_{f,\tau}}{I_{f,\tau} + Q_{f,\tau}}$$

The consumption goods manufacturer amasses physical capital according to the following rule:

$$K_{f,t+\tau} = (1-\delta) K_{f,t} + I_{f,t}$$

Each individual employee has two skills sets, a general skills set (b_w^{gen}) and more specific skills set ($b_{w,t}$), which dictates how effectively an employee can utilise technology. The rule according to which an employee's specific skills set evolves take place is:

$$b_{w,t+1} = b_{w,t} + \chi(b_w^{gen}) \cdot (A_{f,t} - b_{w,t})$$

where $A_{f,t}$ is the average quality of capital stock.

The quantity of consumption goods manufactured by a manufacturer is calculated according to the following rule. Where $B_{f,t,}$ is the average specific skills set and $\alpha + \beta = 1$

$$Q_{f,t} = \min\left[B_{f,t,} A_{f,t}\right] \times L_{f,t}^{\alpha} K_{f,t,}^{\beta}$$

The above rule makes use of a Cobb-Douglas production function, where the investment quality and specific skills set for utilising a specific type of technology is complimentary and where $B_{f,t,}$ represents the average specific skills set.

According to Cincotti et al. (2011), households in the EURACE model set a pre-determined consumption level for the month.

$$c_{\tau}^{h} = \bar{y}^{h} + \phi^{H}(W_{\tau}^{h} - x\bar{y}^{h})$$

where: $\bar{y}^{h}$ is the average income of a household for the previous five month period, ϕ^{H} is an adjustment speed; W_{τ}^{h} is the wealth of the household at the specific time. As a result households will alter consumption levels according to a specific wealth level.

The decision of households to purchase consumption goods is randomised according to a logit regression model, which is taken from standard marketing literature. Where F_h is all the goods that the household as sampled. The decisions to purchase a specific good is dependent on price, since there are no quality differences built into the model and where ∧ represents the level of market competition.

$$Prob_{h,f} = \frac{\exp(-\lambda \log p^{f})}{\Sigma_{f \in Fh} \exp(- \wedge \log p^{f})}$$

The banking sector in the EURACE model provides loans to firms and is dependent on the level of risk versus reward of that specific request. The following denotes the manner in which the probability that a firm will default on a loan (π^{f}), i.e. creditworthiness:

$$\pi^{f} = 1 - \exp(-\frac{D^{f} + \lambda^{f}}{E^{f}})$$

where: D^{f} is the amount of existing total debt, λ^{f} is the amount of the loan requested by the firm and E^{f} is the equity of the firm. The interest rate that the bank will then charge the firm ($r^{b,f}$) is denoted in the following equation. Where r^{cb} is the prime interest rate set by the central bank; and γ^{b} spread sensitivity which is dependent on the credit worthiness of the firm.

$$r^{b,f} = r^{cb} + \gamma^{b}\pi^{f}$$

As can be seen, EURACE is a comprehensive model with important agents in the normal functioning of the European economy. There are numerous important aspects that will serve as a basis for this research, especially to demonstrate precedence. The EURACE model is conceptualised from spatial and time constructs, importantly the model views all other continents and regions outside of the European economy as one agent. Agents can fulfil various roles, but belong either to active or passive classifications and it is critical for an independent agent to act as a communicator between other agents. Importantly, the model includes two types of manufacturers with one more complex than the other – which is also partly based on a standard production function. The important point that needs to be raised here is that existing functions can be utilised when developing ACE models. This will be critical if a more generalised approach is needed for certain agent's behaviour. To date EURACE, arguably, is the most comprehensive ACE model of an actual regional economy and learning and operations from this model will be utilised for the development of the framework, to supplement primary data collection.

The Sandia National Laboratory developed the Aspen model in the mid 90's (Pryor et al., 1996). The Aspen model utilised the Monte Carlo approach combined with time periods to model a rudimentary market economy, but not rudimentary at the time. Households, companies in a single sector, and government form the three types of agents incorporated into the model. The agents intermingle via different types of 'transactions', as can be seen in Figure 3.2. At the beginning of each day, in the model, the agents' condition are given. Throughout the day agents undertake decisions that are based on learning models or probabilities. The conditions of agents are updated at the end of the day, which is a function of all their transactions taken during the day. Government collects taxes from the other two types of agents and distributes unemployment benefits to households. The companies produce goods that are consumed by the households. Hiring and firing of employees, by companies, is a function of their stock levels. In addition, there is competition between firms, who vary their selling prices.

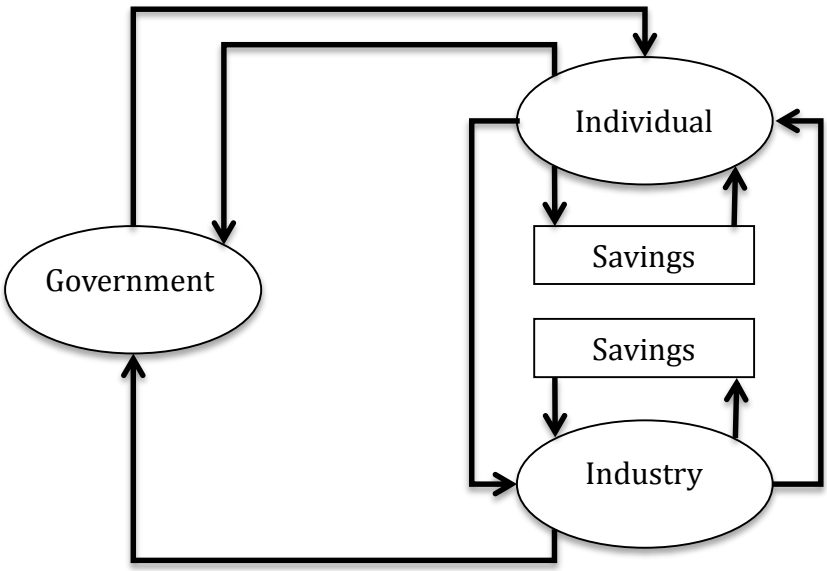

Figure 3.2: Interaction between agents of Aspen Model

Source: Adapted from Pryor et al. (1996, pg. 4).

Demand from households is dependent on income and size of family. Pryor et al. (1996) conclude that the model has the ability to predict economic-like cycles.

Basu et al. (1998) further developed the Aspen simulation model. The number, type and refinement of the agents included in this model are more advanced than the previous Aspen model. The households function in the same manner, with the addition of being able to buy four different types of goods, save money or invest surplus money. Companies have been increased dramatically in this newer model, where they produce four different products, which are: cars, real estate, food and other non-durable goods. All types of goods are derived by the utilisation of labour and the addition of equipment. The government agent functions in a similar manner collecting tax and distributing unemployment benefits and now incorporates a social security system, a government administration and has the ability to issue bonds. A major inclusion in this version of the model is the financial sector which incorporates a reserve bank that is responsible for monetary policy, banks that collect households' savings, issue loans and buy bonds and a financial agent that acts as an exchange for bonds that are bought and sold. The different agents are clustered into two groups, the first group encompasses those agents that are more than two, the second group is made up of agents where there is only one type of that agent, e.g. reserve bank. As with the initial model, the model revolves around a day and agents that belong to a

specific group where all utilise the same instructions. All agents are represented on nodes and have channels to communicate through, with other agents. All received messages are placed in an ‘inbox’, when a message is sent to another agent if the agent is on the same node the message is sent instantly, otherwise the message gets placed into an ‘outbox’ for sending at the end of a day. All messages in the ‘outbox’ are sent as one packet of data to specific nodes, it is then disaggregated and sent to relevant agents who then read the messages.

The Aspen model has been further utilised to model market forces on the United States of America’s electricity grid and critical infrastructure (Barton et al., 2000) and knock-on effects of terrorism on the economy (Sprigg and Ehlen, 2004).

Riccetti et al. (2015) developed a macroeconomic system modelled from the bottom-up of diverse agents. The agents include: government, central bank, firms and households. The agents interact in four specific markets, which are: goods market, labour market, credit market and the deposit market. Through the model, Riccetti et al. (2015) observes macroeconomic phenomenon that arise out of the micro complex and adaptive interaction of economic agents. These phenomenon include GDP growth and bank defaults. Due to Cincotti et al. (2011) discussing similar aspects in their research on EURACE in a more in-depth manner, the details of the research by Riccetti et al. (2015) will only be briefly discussed. The agents in the model developed by Riccetti et al. (2015) are rationally bounded and operate according to simple rules. These include: household agents buy the cheapest goods from firms, while firms try to increase profits by selling their goods to households. Household agents endeavour to supply their labour to firms that offer the highest salary, while firms try to hire the most inexpensive labour. Households deposit all surplus funds into commercial banks, banks then use those funds to offer loans to firms, where the firms look for commercial banks offering the lowest interest rates. Government hires public servants, oversees taxes and controls public debt. The central bank supplies funds to government and commercial banks, when required. Riccetti et al. (2015) utilise a ‘matching mechanism’ in the four markets that are present in the model. This mechanism functions, fundamentally, in the following manner: at the beginning a random set of two types of agents are generated, one that acts as the supplier and the other as the demand, thereafter an agent chooses a suitable agent from the opposite side, where the choice will depend on a predefined rule or parameter, thereafter, the

second agent on the same side will repeat point two above; and point three will repeat until all agents, in at least one side, are satisfied.

Čech et al. (2013) developed an ACE model that consists of four categories of agents. These are: consumer, manufacturer (factory), miner and transporter. All agents endeavour to either maximise profit or some type of utility. In addition, agents are allowed to form structures while seeking to maximise efficiency in terms of supply and demand. However, Čech et al. (2013) highlight that the model is a simplified version due to traditional key economic agents not being included in the model, such as banks and government. The agents operate in the following manner: consumers buy goods and services and provide labour. The wealth level of a consumer is determined by their work and qualification. Consumers also have to decide between gaining a qualification and buying goods and services. There are three types of consumers: low, middle and high income. There are also three types of goods included in the model: necessity, normal and luxurious. Manufacturers convert input to goods that is either bought by consumers or by other manufacturers. Each miner extracts one type of raw material, stored and sold to transporters. The cost of the raw material is determined by energy costs and technology utilised. The transporter procures material from the miner and sells it on to the manufacturer. The distance from the miner to the manufacturer directly relates to the transportation cost and as a result the transporter seeks to find the most efficient way to transport goods. The model is structured by Čech et al. (2013) where all the above agents, with the exception of the miner, forms a colony. Colonies have two tenets, location and population size. In addition, each colony competes with other colonies for resources (i.e. output from miners). The productivity of each colony is measured in terms of the wealth per agent, this allows the direct comparison between colonies that inherently have different population levels.

Bureš and Tučník (2014) further develop the research and model by Čech et al. (2013). The four agents initially part of the model, as mentioned by Čech et al. (2013) i.e. consumer, manufacturer, miner and transporter. Each agent is represented as a vector that consists of a number of parameters and is described below.

Agent = (pos, w, k, s, con, e, pro, mob, a), where

‘pos’ refers to the exact physical position of the agent in the model;

‘w’ calculates the wealth of each agent, it is important to note that it is not possible for agents in the model to accumulate debt;

‘k’ is the speed of the relevant agent;

‘s’ in essence is storage space for goods or material;

‘con’ refers to either:

consumption of end goods or services by a consumer; or

utilisation of capital by miners and transporters; or

consumption of input material and labour for manufacturers.

‘e’ refers to the efficiency of each agent in its core function;

‘pro’ is relevant only for miners and manufacturers and is a production function;

‘mob’ enables mobility of an agent, i.e. transporter; and

‘a’ refers to the specific colony that an agent belongs to.

Taking the above into account, Čech et al. (2013) highlights that the parameters of each category of agent can be represented as: consumer = (pos, a, w, s, con, e), manufacturer = (pos, a, w, s, con, e, pro), miner = (pos, w, s, con, e, pro) and transporter = (pos, a, s, con, e, mob). In addition, a colony has the following parameters: Colony = (pos, s, w, cw, CP), where cw is the creditworthiness of the relevant colony and CP is the number of agents in the colony.

The research by Janssen and Vries (1998), which focuses on the economy-energy-climate nexus, and is an extension of Janssen and Rotmans (1995) that did not include an agent-based element, is undertaken with an ABM approach through a Genetic Algorithm foundation. The core focus of the research is anthropogenic climate change. The model is an elementary construct that encompasses three types of outlooks on the world: Hierarchist, Egalitarian and Individualist, which is based within a triangle, whose outlook occupies a point of the triangle. Agents in the system, depending on their outlook, are then located accordingly. In essence, Janssen and Vries (1998) demonstrate that agents ability to learn and adapt to changing

preferences and policies, could have a marked impact in reality where people are rationally bounded.

Nadal et al. (2003) detail a simple model, that of a decision by an agent to either buy or not buy a product in a monopoly system, where the agent's decision is influenced by social factors, i.e. other agents' choices to buy or not buy a product. The corresponding supply strategy is essentially either one that incorporates a small number of clients at a high price or a large number of clients at a low price, which is dependent on the choices that agents make. The salient aspects of the model developed by Nadal et al. (2003) are discussed below. The set of agents (N) is constructed according to an 'idiosyncratic willingness-to-pay', where individual agents have the ability to either purchase ($w_i = 1$) or to abstain from purchasing a single item. Essentially, the agent endeavours to maximise the individual 'surplus function' (V_i), which is represented in the following equation:

$$\max_{w_i \in \{0,1\}} V_i = \max_{w_i \in \{0,1\}} w_i (H + \sum_{k \in \vartheta_i} J_{ik}\, w_k - P)$$

where H_i represents the preference and P represents the price of a single good. Each agent (i) has a neighbour (k), which influences the decisions of i, through k's own preference w_k and where J_{ik} is the weighted impact of k on i.

H_i can be determined in two ways, one is based on the psychological Thurstone Model while the other is based on the McFadden model which is purely economic in nature and does not vary the 'willingness to buy', of one agent, over time. One of the primary findings of Nadal et al. (2003, pg. 13) is "... *when the social influence is strong enough, there is a regime, where, upon increasing the mean willingness to pay, or decreasing the production costs, the optimal monopolist's solution jumps from one with a high price and a small number of buyers, to one with a low price and a large number of buyers".*

Zibetti et al. (2016) developed the ACACIA-ES simulation model, which seems to be based on earlier work undertaken by Beltran et al. (2009) who developed the ACACIA model. The model incorporates elements of a physical 'resource scarce' environment and social nuances, to analyse individual decision-making. The simulation incorporates two types of agents: those that are cooperative and those that

are uncooperative. All agents have to gather a resource to ensure their survival, the cooperative agents essentially are willing to share some of the resources that they have gathered and the uncooperative agents are unwilling to share the resources that they have gathered. The fundamental finding from the simulation is that cooperative agents are more resilient, especially when resources are scarce, than uncooperative agents.

Voudouris et al. (2011) proposes an agent based model for exploring energy policy, particularly oil production. The model is termed 'Agent-based Computational Economics of the Global Energy System' (ACEGES). ACEGES essentially demonstrates the value and applicability for understanding future oil production. Voudouris et al. (2011) contends that the oil system is better understood when modelled as a CAS, with the ACEGES consisting of five equations that have been modified from Hallock et al. (2004). Voudouris et al. (2011) highlight the fact that while this model is primarily a 'resource-constrained' one, it features two important concepts: oil demand and oil production growth is autonomous from each other and the manner in which 'trade' occurs is simplified. Further discussion of Voudouris et al. (2011) is not necessary as the equations utilised, will not be relevant for this research. However, Voudouris et al. (2011) is included here to demonstrate the applicability and previous research on economic topics utilising an ACE foundation.

Kirman and Vriend (2001) present another example of ACE being utilised to understand dynamic and complex system that of a Marseille fish market. There are two key characteristics of the market: buyers exhibit a high degree of loyalty to sellers and constant wide ranging price levels. In essence, the main points of the model are: sellers choose the quantity of fish to sell, sellers also decide on how to handle faithful patrons, buyers have to choose which sellers to frequent and as a result acceptable price levels and reinforcement provides the learning mechanism.

Cui et al. (2012) state that an innovative research and development platform, based on modelling technology, for the Shanghai Stock Exchange was launch over five years ago. As a result a complex adaptive modelling system needed to be developed. Examples of agent-based stock markets already developed include LeBaron (2002), but Cui et al. (2012) developed an innovative model of a stock market where individual investor agents have unique investments and learning methods. According

to Cui et al. (2012) there are still two critical aspects of these modelling tools that need to be addressed. These are: the manner in which investors utilise and learn from market news and the manner in which investors learn to maximise profits. To begin overcoming the above limitation Cui et al. (2012) developed and proposed the Intelligent Agent-assisted Order Simulation System, as depicted in Figure 3.3.

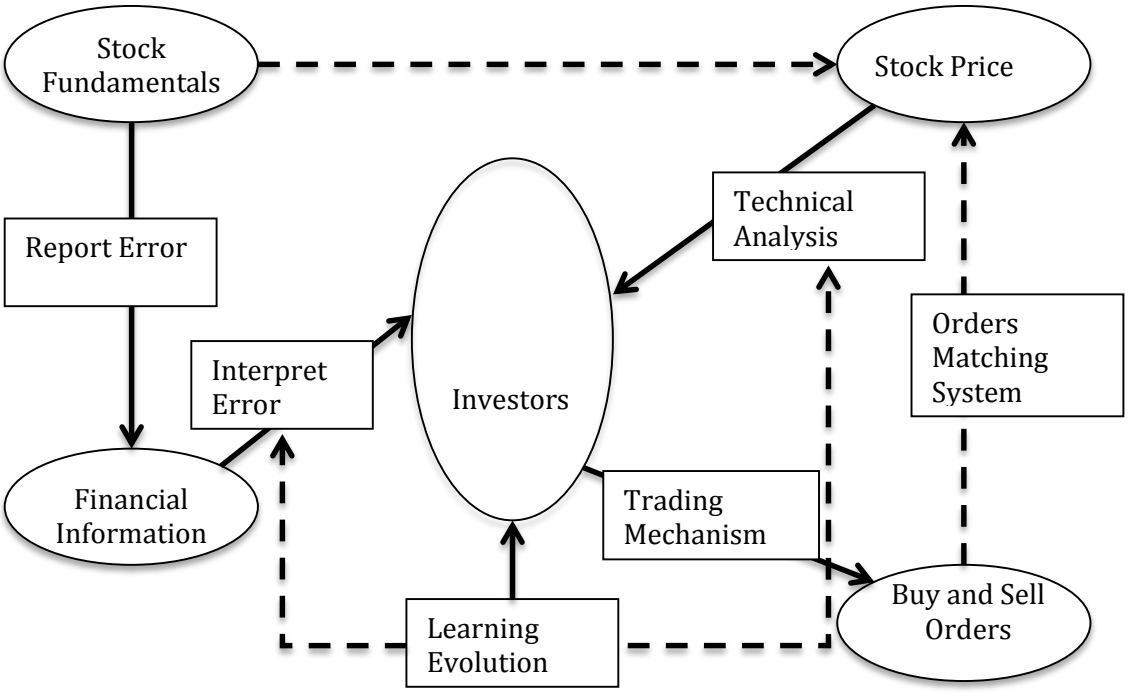

Figure 3.3: Intelligent Agent-based Order Simulation System

Source: Cui et al. (2012, pg. 8892).

In the event of no stock being traded, the stock's price will be dependent on its fundamentals. When stock is traded, supply and demand of the stock in question will determine the price. These prices will emanate from the orders matching system. The investment strategy of individual investor agents is determined by fundamental analysis strategy, which is determined by future cash flow discount and as a result the worth of the company. This is done by taking into account market related information and news but is risky. As a result, the model has a report and interpret error built in and technical analysis strategy determines the strategy of the investor and consequently trades, by taking into account trade volume and price. Cui et al. (2012) further state that a critical part of the model is the ability of investors to learn from their historic trading activity, but based on the fundamental and technical analysis strategies.

Silvestre et al. (2016) have developed an ABM that integrated microeconomic and macroeconomic aspects, which incorporates a neighbourhood that can include either a social or spatial dimension. The model built by Silvestre et al. (2016) is an advanced iteration of previous research by Martins et al. (2009). According to Silvestre et al. (2016), their model incorporates agents, whose decision in a period, are able to generate concepts in subsequent periods. These agents are given the ability to make the choice of whether to study or not. The decision is essentially based on a net-income consideration, over the agent's lifespan, to become better educated and on being influenced by what other agents', in its neighbourhood, attitude towards education is. The second decision-making ability results in the appearance of constellations of both educated and uneducated agents, as a result a spatial element has been incorporated to take into account what Silvestre et al. (2016) call 'neighbourhood effects'. Skilled agents that have invested in education and unskilled agents have a finite satisfaction level. Individual agent's level of satisfaction involves two aspects: the comparison of the individual agent's income versus the income of other agents and the progression of the agents' own income, with the two aspects contextualised in space and time, relevantly. These two aspects are independent, but the combined levels results in the agent's overall satisfaction level and involves a 'convex coupling'. As a result, there is a finite number of possibilities for the agent's satisfaction levels.

The equations below describe the model developed by Silvestre et al. (2016):

The decision of agents on whether to study or not is undertaken according to:

$$nS_t^S > nS_t^u$$

where nS_t^S is the number of satisfied skilled workers in the model, and nS_t^u is the number of satisfied unskilled workers, both during a particular period (t).

Production is a function of the ideas generated from skilled workers and normal work produced by unskilled workers, which is denoted as:

$$Y_t = A_t U_t + \varepsilon_t$$

where Y_t is the production (Y) at a period (t), A_t are the ideas in period t, U_t is the number of unskilled workers in period (t) and ε_t is a productivity shock (with a uniform distribution between -0.5 and 0.5) in period (t).

The stock of ideas progresses according to:

$$\Delta A_t = A_{t-1}\delta S_t + \gamma D_t$$

where δ is a parameter for the productivity of skilled workers S_t is skilled workers, γ is a parameter to denote the efficacy of the team and D is the physical distance between skilled workers. D is as follows:

$$D_t = \frac{1}{S_t}\sum_{i,j=1}^{S}\frac{1}{|i-j|}$$

Total income is determined by income of skilled and unskilled workers:

$$Y_t = Y_t^U + Y_t^s$$

where Y_t is the total income; Y_t^U is the income for unskilled workers and Y_t^S is the skilled workers income.

Income of skilled workers is based on the generation of ideas, and unskilled workers income is calculated, from a previous period, on the basis for that period's production of ideas. As a result the income function for unskilled and skilled workers are as follows:

$$Y_t^U = A_{t-1}U_t + \frac{\varepsilon_t}{2}$$

and

$$Y_t^S = (A_t - A_{t-1})U_t + \frac{\varepsilon_t}{2}$$

Individual wages are calculated by dividing the relevant total income for each type of worker, by the total number of unskilled and skilled workers:

$$w_t^U = \frac{A_t U_t}{U_t} + \frac{\varepsilon_t}{2U_t} = A_t + \frac{\varepsilon_t}{2U_t}$$

$$w_t^S = \frac{Y_t^S}{L_t} + \frac{\varepsilon_t}{2L_t} = (A_t - A_{t-1})\frac{U_t}{L_t} + \frac{\varepsilon_t}{2L_t}$$

Satisfaction equations for individual workers are given in the following equations. It is important to note that satisfaction of individual works are based on individual income in time and space and as the influence of other workers income increase to the individual work, the influence of the workers own income on satisfaction levels decrease. Initial expectations of satisfaction is also taken into account. Expectations for each worker is random and is a static cost, the higher the expectation set, the more difficult it will be to satisfy the expectation. Skilled workers have a level of satisfaction, $\propto$, purely for being skilled. The individual satisfaction level for skilled and unskilled workers are as follows:

$$F_{i,t}^S = \propto -c_i + (1-w)(w_t^s - \frac{w_t^u}{\beta(\rho)}) + w(w_t^s - w_{t-1}^s)$$

$$F_{i,t}^u = c_i + -(1-w)(w_t^s - \frac{w_t^u}{\beta(\rho)}) + w(w_t^s - w_{t-1}^s)$$

This section has presented existing ACE models that have, primarily, focused on modelling entire economies as a set of interact agents. Various models have been developed from as early as the mid 1990's and span two continents. Attention was drawn to the manner in which the models are constructed and the manner in which some of the models utilised existing functions, this was to display precedence for incorporating such principles into the framework for this research. Critically, however, no literature has been found that deals with a local green economy and particularly in an African city.

It is the position of this research that it has been confirmed that it is possible to utilise ACE for the development of a number of economic related aspects. Thus far, no literature has been found of a full model or framework developed for an African city green economy, based on ACE. From the preceding discussion it is obvious to note that the manner in which models have been developed have incorporated a lot of existing other theories, such as the Cobb-Douglas production function (Cincotti et al., 2011). It is also the position of this research that the incorporation of tested theories should actually advance the reliability of ACE models. The challenge with the development of the ACE models seems to be largely around the manner in which the

components are structured and interact with each other, i.e. their behavioural aspects. However, there are existing examples where empirical data is incorporated (Wolf et al., 2015; Bastardie et al., 2013 Mazzanti and Rizzo, 2017). The actual data that is utilised becomes another aspect that requires consideration. The quality of data utilised will largely also impact on how reliable the outputs of the model are, depending on what the model is intended to do. It is virtually impossible to develop such models on simple Microsoft Excel sheets, the researcher has attempted this. As a result, powerful computers and algorithms are needed to properly develop a simulation model.

3.3.5 Need for Agent-based Computational Economics

According to Nwaobi (2011), African countries have major economic reform tasks to accomplish and have traditionally applied linear models. He further highlights that there is a critical need for an ACE approach in the African context. Nwaobi (2011) goes on to state that economics has neglected the interaction and heterogeneity of economic agents and that ACE offers a solution for a greater understanding on the interface between agents where system wide phenomenon arise. However, a cautionary note on a key challenge from Nwaobi (2011) is on developing the rules for the agents that are included in the models, which is currently not well established for the African context. The need for these rules, based on an African perspective, can be broadly supported by Čech et al. (2013, pg. 468) *"Real data are a crucial part in multi-agent modelling and simulation. It is necessary to have [a] model that is reflective of reality as much as possible"*.

Izumi and Ueda (2001) have already begun addressing such concerns and challenges by collecting primary data through interviews and questionnaires. This research intends to build on the precedence set by Izumi and Ueda (2001) and others in collecting primary data for the development of rules.

In addition, Gräbner and Kapeller (2015) go on to highlight some critical arguments and, literally, according to the sub-title in their research make a plea, for the use of an ABM approach in economics. These are: as the modelling tools are based on computer programmes experiments can be conducted with various changes in variables to determine implications on the model. ABMs are not developed utilising analytical methods which results in models becoming tractable, but takes an approach

that allows the model to be developed according to the complex and dynamic characteristics of the actual system in question. Individual agent's behaviour can be taken into account and the interdependent nature of the agents and the system can be taken into account, which will result in emergent aspects that would otherwise have gone unidentified and unquantified.

African cities are faced with many challenges (Dodman et al., 2017; Akanle and Adésìnà, 2017), particularly after hundreds of years of colonisation. The pressure is mounting on current African leaders to find ways to accelerate development. It is the position of this research that specific areas within systems, especially economic and social systems that offer the ability to deliver maximum development rates are urgently needed to be identified. There are still huge inequality levels in South Africa which is resulting in numerous challenges for individuals (Burns et al., 2017; De Juan and Wegner, 2017) and by extension the fabric of society. ACE modelling offers this opportunity, to identify leverage points and emergent properties, not just for the eThekwini green economy but also for other African city economies.

3.4 Conclusion

The various relevant economic schools of thought, particularly the central tenets of each school, were discussed. Reasons were provided for dismissing all the identified schools, mainly on the basis that most rely on techniques that make the economy tractable and consider components of the economy completely rational and homogenous. The schools of thought that did imbue these characteristics all lack the computational approach of ABM, which was identified as critical for this research, as the economy can be classified as a CAS. CAS was introduced and its characteristics discussed, thereafter ABM was briefly presented.

The crux of the chapter was the presentation of ACE. The workings of ACE were discussed, along with the various applications of ACE, which more than suits this type of research. The different types of learning algorithms were then presented. The advantages and disadvantages of ACE were then juxtaposed, with the advantages outweighing the disadvantages.

Previous ACE models that were developed specifically for entire economies were discussed, with the working of some of the models presented in detail. It is important to note that working ACE models of entire economies have been in existence from the

mid 1990's, in the United States of America and later in Europe. Most of these models were generalised to economies with a standard set of agents that included households, banks, firms, government and a communication mechanism. Some of the models have been extended to research specific aspects within economies. A few other ACE models that focus on decision making were included to better inform this research. It was however highlighted that no ACE model has been developed for a green economy at a city level in Africa.

The need for ACE was, lastly, presented. In essence, Africa is faced with a huge developmental challenge and an approach that can analyse the complexity to provide catalytic answers is sorely needed. In addition, the rules that govern ACE within an African context are not fully established yet.

The next chapter focuses on the research methodology that was utilised for this research.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

This chapter provides insight on the research methodology that was utilised for the research.

The formulation of ABMs which is based on empirical data collection methods, has been gaining increased attention (Smajgl and Barreteau, 2014; Janssen and Ostrom, 2006). Examples that incorporate empirical data into such research include Wolf et al. (2015) which assessed the adoption of electric vehicles in Berlin, Germany; Bastardie et al. (2013) which investigates energy efficiency in the fishery industry in Denmark; and Mazzanti and Rizzo (2017) provides an analysis on reducing GHG emissions within the European Union within the green economy. A persisting challenge is the manner in which to convert empirical mental models and structure of systems into agent-based models (Filatova et al., 2013; Klabunde and Willekens, 2016). While the challenge is noted, it is not insurmountable. There are numerous empirical methods that can be utilised for agent-based models which include lab experiments, interviews and surveys (Janssen and Ostrom, 2006) and can be corroborated by the research where primary data has been collected (Wolf et al., 2015; Bastardie et al., 2013; Mazzanti and Rizzo, 2017).

Furthermore, Izumi and Ueda (2001) have developed an agent-based model of a foreign exchange market that was based on data collected from interviews and triangulated by questionnaires (survey) to a large sample. This research collected empirical data in a similar manner, as Izumi and Ueda (2001), by interviewing subject matter experts while triangulating the data with a survey to a broader audience that are involved in the eThekwini green economy, in addition to focus groups.

Developing an appropriate research methodology that is aligned to the type of research being conducted and aspects under investigation is critical for valid outcomes. When there is misalignment, the quality of the research, validity and reliability is compromised and could render the findings invalid.

The chapter will begin by discussing the various philosophical worldviews and then identify the most appropriate worldview for this research. Secondly, the three types of research strategies of inquiry will be presented and a rationale will be formed for the

selection of a mixed methods approach. This will be followed by a section on the population and sample for the research. Thereafter, the data collection tools that were utilised during the research will be presented. The processes utilised for the collection and transcription of data will then be briefly discussed. The manner in which both quantitative and qualitative data was analysed is contained in the following section. The remaining aspects of validity, reliability and ethical considerations will form the last part of this chapter, with the conclusion section rounding off the chapter.

4.2 Philosophical worldview

A worldview can be thought of as a fundamental manner on which everything operates, how it can be interpreted and lays the basis for the development of a research methodology and as a result research (Creswell, 2014; Hussein, 2015; Wright et al., 2016).

The choice of a worldview is critical for the success of any research and the main attributes that are required of a worldview for this research include: the ability to triangulate data through various data collection methods, be able to frame research in the larger temporal contexts and be flexible enough to allow the research to utilise as many data collection tools as needed to focus on the research problem. It is important to note that the worldview remains less observable but does have an impact on the entire methodology (Wahyuni, 2012; Christ, 2013).

There are four worldviews: postpositivism, constructivism, participatory and pragmatism (Creswell, 2014). Other researchers have presented varying numbers and classifications of worldviews and have termed the concept slightly differently (Wahyuni, 2012). For the purposes of this research, the four worldviews as highlighted by Creswell (2014) will be referenced. From an epistemological perspective, quantitative worldviews are of the notion that the world operates according to strict rules and that reality is objective, qualitative worldviews on the other hand hold the view that reality is subjective and there can be multiple realities (Johnson and Onwuegbuzie, 2004; Krauss, 2005).

Historically, research has subscribed to the postpositivism paradigm that has been most appropriate for quantitative or qualitative research (Tashakkori and Teddlie, 1998, Wahyuni, 2012). This worldview is of the position that credibility of information is only possible through empirically noticeable experiences and situations

(Wahyuni, 2012). However, the researcher's biases often has an impact on the research (Tashakkori and Teddlie, 1998, Wahyuni, 2012). Testing of the manner in which the world works is of central importance, so that there can be an incremental increase of understanding of how the world functions. As a result, data is collected and analysed to either confirm or disprove a theory (Christ, 2013). The postpositivism worldview is not appropriate for this research for a number of reasons: there is no existing theory or the manner in which the green economy in eThekwini operates, so there is nothing to test. In addition, the worldview largely supports quantitative research, this research will not be able to achieve its key research objectives as a more qualitative approach is needed to interrogate the questions more robustly. The focus of this research was not on ensuring that findings are applicable to other contexts but to bring about an understanding of a very specific context.

The social constructivist worldview is normally utilised for qualitative studies (Johnson and Onwuegbuzie, 2004; Krauss, 2005). This worldview advocates that people create subjective meaning of the contexts in which they operate, due to this subjectivity their approach is to look at the broadest possible views rather than stymie findings into a single reality (Tashakkori and Teddlie, 1998; Wahyuni, 2012). The subjective reality is based in time and on social interaction. This worldview is inherently inductive, as opposed to the postpositivist deductive approach. This worldview would have been an appropriate foundation for this research, save for the focus on qualitative studies only as this research intends to triangulate data across qualitative and quantitative methods to improve the validity of the data.

The participatory worldview can incorporate either qualitative or quantitative research, though mainly with the former (Creswell, 2014; Johnson and Onwuegbuzie, 2004). It was developed out of the position that postpositivism was too rigid and did not incorporate marginalised individuals and social equity issues. This worldview approaches research with the notion that politics needs to be incorporated. In essence, this worldview focuses on groupings that have been side-lined and endeavours to deliver some sort of beneficial change. This worldview was not suitable for this research, as this research seeks to first generate an understanding of the eThekwini green economy. In addition, the worldview relies either on a qualitative or quantitative approach, not an integrated approach.

The remaining philosophical worldview is pragmatism, which is suited to mixed methods research (Christ, 2013; Johnson and Onwuegbuzie, 2004). Mixed method research is research that incorporates both qualitative and quantitative aspects and is able to generate a more robust outcome (Wahyuni, 2012; Johnson and Onwuegbuzie, 2004). It allows a lot of flexibility to the research when choosing specific methods and processes. This worldview acknowledges the fact that research occurs in larger settings and that there will be multiple strings of reality, which can be synthesised for a richer outcome.

The philosophical worldview that was utilised for this research is pragmatism, for the following reasons: pragmatism did not constrain the research to merely qualitative or quantitative tools, it allowed for mixed methods as a strategy of inquiry to be utilised. This allowed the researcher greater flexibility when collecting data, this flexibility was critical for this research as it was needed when bringing about the development of new information and knowledge. The main consideration was that the eThekwini green economy is made up of a plethora of interacting heterogeneous components, i.e. the green economy materialises from the interaction of many different facets of life, pragmatism offered the theoretical platform from which to process and synthesise those complexities.

4.3 Strategy of inquiry

According to Creswell (2014, pg. 12), *"Research designs are types of inquiry within qualitative, quantitative and mixed methods approaches that provide specific direction for procedures in a research design"*.

Quantitative research is defined by Yilmaz (2013, pg. 311) as *"... research that explains phenomena according to numerical data which are analysed by means of mathematically based methods, especially statistics"*. The specific types of these strategies include surveys and experiments (Creswell, 2014). Quantitative research is founded on numerical and statistical methods and that the research and researcher's subjectivity should not mix, so that subjectivity is removed from the process (Williams, 2007). There are three general types of quantitative research: descriptive, experiments and causal comparative (Williams, 2007).

According to Noyes et al. (2015, pg. 2), qualitative research is *"... intended to penetrate to the deeper significance that the subject of the research ascribes to the*

topic being researched. It involves an interpretive, naturalistic approach to its subject matter and gives priority to what the data contribute to important research questions or existing information". In other words, qualitative research is a process that is able to generate and discover meaning (Krauss, 2005). Qualitative strategies include: ethnography, grounded theory, case studies, phenomenological research and narrative research (Creswell, 2014; Williams, 2007).

It is important to note that due to pragmatism being selected as a worldview for this research, utilising either a qualitative or quantitative approach on its own would not have been academically prudent. The third strategy of inquiry, mixed methods, is a hybrid approach, incorporating both qualitative and quantitative aspects.

Mixed methods is defined by Venkatesh et al. (2013, pg. 21) as *"... an approach that combines quantitative and qualitative research methods in the same research inquiry. Such work can help develop rich insights into various phenomena of interest that cannot be fully understood using only a quantitative or a qualitative method"*. The perspective that mixed methods can generate a robust research process and outcome is further supported by Johnson and Onwuegbuzie (2004). This approach is also suitable for intricate research (Lingard et al., 2008).

There are three main types of mixed methods strategies: convergent parallel mixed methods, explanatory sequential mixed methods and exploratory mixed methods. The specific mixed method strategy of inquiry that was utilised is the convergent parallel strategy, which has only one data collection phase, i.e. both qualitative and quantitative data is collected at similar time (Creswell, 2014). It usually entails juxtaposing the two datasets to determine convergence or disparity. The weighting of the datasets are equal. The triangulation of the data takes place during the analysis and interpretation of collected data (Creswell, 2014).

4.4 Population and sampling strategy

This section will discuss the population and sample size that had been identified for this research. It should be noted that this research was based on a mixed methods approach and as a result, a population had initially been identified for the qualitative (interviews and focus groups) and quantitative (survey) aspects.

However, the response rate to the initial sample of the survey was not optimal and amendments were made to broaden the population in an attempt to gather more data and insight into the eThekwini green economy. This will be discussed in sub-section 4.4.3.

4.4.1 Population

The population of any research is intended to denote the total amount of individuals from which a sample can be identified (Tashakkori and Teddlie, 1998) and from which data is required to answer research questions (Banerjee and Chaudhury, 2010).

4.4.1.1 Green business

In order to achieve the key objectives of this research, as discussed in chapter one, a critical piece of this research involved requesting insight to the eThekwini green economy from organisations and individuals that are at the heart of the eThekwini green economy. Those who have the actual required knowledge and insight seemed to have been concentrated to a small group of people. Basing this research on input from organisations and individuals that either operate in or can be considered experts on the eThekwini green economy will lead to a better depiction of the agents that are part of the economy, the manner in which they operate and their characteristics, amongst other nuances.

The identification of businesses that operate in the eThekwini green economy for this research has been greatly simplified by eThekwini Municipality (2013a). EThekwini Municipality (2013a) set out to determine, in addition to other objectives, the extent of the eThekwini 'green services and industries sector' which comprised of a database of business that operate in the eThekwini green economy. A total of three hundred and fifty nine businesses were identified by eThekwini Municipality (2013a). The aggregated composition of the total number is provided in Table 4.1.

Sector	Number of businesses
Energy	100
Waste management	78
Services	65
Natural resources	41
Retail and/or Wholesale	18
Property	16
Agriculture	12
Water	12
Manufacturing	12
Skills development	5
Total	359

Table 4.1: Breakdown of identified business in the eThekwini green economy

Source: eThekwini Municipality (2013a, pg. 8).

4.4.1.2 Green economy experts

In addition to three hundred and fifty nine businesses being identified as a part of the population for this research, a further grouping of subject matter experts had been identified.

The first group belongs to an organisation called the 'KwaZulu-Natal Sustainable Energy Forum' (KSEF). KSEF began life as a project of the eThekwini Municipality, with a core mandate of being an integral part towards the development of the sector by circulating relevant information and knowledge and developing a formal forum while implementing catalytic projects.

However, in 2013 KSEF was registered as a separate entity, as a Non-Profit Organisation (NPO). Currently there are five Directors on the KSEF Board. These five Directors formed the first component of the second part of the research population.

The second component of the qualitative research population came from the eThekwini Municipality, as an organisation. The individuals identified from the eThekwini Municipality, who are mandated to work on and stimulate the eThekwini green economy, are primarily based in the Economic Development and Investment Promotion Unit and the Energy Office. It is important to note that there are, likely, other eThekwini employees that work on elements of the eThekwini green economy, but as a secondary objective not related to core functions. These eThekwini Municipal

officials were not initially intended to be included in the research population. There were four eThekwini officials identified at the Economic Development and Investment Promotion Unit and one at the Energy Office.

4.4.2 Sampling

Due to the population identified for this research being relatively small, it was possible to adopt the entire population as the research sample.

A pilot survey was also included in this research to ensure that the questionnaire is clear and capable of eliciting the correct type of input for the research. A random, but stratified, sampling approach was utilised to identify a sample of 10% or thirty five respondents from the population of businesses that operate in the eThekwini green economy to complete the pilot survey. According to Robinson (2004, pg. 8), *"In a stratified sample, the researcher first selects the particular categories or groups of cases that he/she considers should be purposively included in the final sample. The sample is then divided up or 'stratified' according to these categories and a target number of participants is allocated to each one. Stratification categories can be geographical, demographic, socio-economic, physical or psychological – the only requirement is that there is a clear theoretical rationale for assuming that the resulting groups will differ in some meaningful way"*. This is largely supported by Singh and Masuku (2014). The stratification was undertaken according to the type of sector that the companies were a part of, such as energy or waste management.

A purposefully selected sample was drawn from the KSEF board and a total of two individuals were identified to form the sample. Both of the individuals selected have experience that spans multiple sectors, such as a public electricity organisation, a private energy focused organisation and academia. According to Tashakkori and Teddlie (1998) and Creswell (2014), purposeful sampling is a type of non-probability sampling, where the individuals are identified based on some key information, knowledge or role that these individuals can play in the research. According to Palinkas et al. (2015), utilising purposeful sampling in qualitative research is common.

Due to the small number of eThekwini Municipal officials that are directly involved in the eThekwini green economy, it was feasible and beneficial to include the entire population as the sample.

4.4.3 Amended population and sample

The initial population identified for the quantitative part of this research was three hundred and fifty nine companies, as identified by eThekwini Municipality (2013a). From those three hundred and fifty nine companies, thirty-five were identified through a random stratified sampling approach to participate in the pilot survey. The remaining three hundred and twenty four companies were to form the population and sample of the main survey.

The population for the interviews were split into two. The first part of the population was made up of the five directors of KSEF, two of whom were identified through a purposefully sample process to form the sample. In addition, five eThekwini Municipal officials were identified, as the number was small and access to these officials was easy, all were placed in the sample.

There was a dismal response rate from the initial three hundred and twenty four companies, which were identified to take part in the survey, the reasons of which are discussed in chapter 6. The population was broadened in order to increase the amount of data collected, as the responses received were not sufficient and to ensure that people with relevant knowledge and experience of the green economy are able to actively complete the survey. The following individuals were further added to the population: three individuals from a relevant national research institution; eight individuals from relevant international non-governmental organisations with a presence in South Africa; sixteen officials from eight other Metropolitan Municipalities in South Africa; forty three members from the Central KwaZulu-Natal Climate Change Compact; four officials from various South African government agencies that work with cities on climate change; four officials from the National Department of Energy and Department of Environmental Affairs; twenty one individuals from private companies or in their private capacity that are engaged in aspects of the green economy; twenty four officials from eThekwini Municipality who have a climate change or related mandate; three officials from a South African non-governmental organisation; four academics from an eThekwini based University; five academics from an University based in the Western Cape; two officials from Eskom; and one official from a coalition of large companies that focus on sustainable growth. These individuals were identified due to their work that was related to the green economy and climate change more broadly. Many of the identified individuals

hold either senior level management posts or technical posts that are related to thematic areas that contribute to mitigating climate change or adapting to climate change. It must be noted that a large portion of the above mentioned individuals were not based in the EMA, but would have some knowledge that can be utilised to answer the key research questions of this research.

The total number of individuals identified above totalled one hundred and thirty eight. As a result, this brought the final population to four hundred and sixty two.

It is important to note that for the initial interview population, one official that was identified from the eThekwini Energy Office resigned and could not be interviewed. However, the population for the interviews was also increased to include officials that have insight into the eThekwini green economy from specific sectors that have interventions within the green economy. It was envisaged that these officials would be better able to provide in-depth insight into their areas of expertise, such as electricity or revenue, which would then contribute to a more thorough understanding of the components of the eThekwini green economy and the manner in which they interact. The number of interviewees was increased by an additional nine people.

A third component to the population was also added in, to accommodate the addition of a data collection tool, focus groups. This data collection tool was added to gather data that emerged through the interaction of respondents during the focus group sessions and to get people with diverse backgrounds and experience to interact to determine if their opinions converge or not. The participants were purposefully selected, due to the unwillingness of organisations and companies to participate in the focus groups, to include: nine engineers that work on water and wastewater infrastructure; five participants of the 2017 Sustainable Living Exhibition; and eight individuals from an Energy Centre at an eThekwini based University of Technology. Table 4.2 provides an overview of the final numbers of the population and sample size.

Data collection method	Population	Sample
Survey	497 Individuals / Businesses	35 Individuals (Pilot survey)
		324 Individuals (Original survey)
		138 Individuals (Expanded survey)
Interviews	16 Individuals	16 Individuals
Focus groups	-	22 Individuals (In 3 groups)

Table 4.2: Final population and sample of the research

Source: Author.

4.5 Data collection tools

This section will describe the data collection tools that were utilised in the research. Data tools are essentially instruments of gathering information.

4.5.1 Pilot survey and main survey

According to Kelley et al. (2003), surveys utilise standard tools, typically questionnaires, to collect data from a large number of individuals. There is no standard definition of a survey (Khan et al., 2013; Ghazi et al., 2017).

Surveys were included in this research to collect data from a large audience which would then be triangulated with other data collection tools and data sources to arrive at a more robust outcome. Before undertaking the actual survey, a pilot survey was undertaken. This was undertaken in order to ensure that the questions were clear and to determine the amount of time that the survey takes to complete, the information was to be utilised in the request for participation in the main survey.

The pilot survey was designed on QuestionPro and on Microsoft Excel. Both the platforms had the exact same questions. The main rationale for having two platforms for responses is that an assumption was made that some people will not be comfortable clicking on a link, from a person that they have not met. However, all initial emails contained a formal introduction and overview of the research, an example of which is attached in Annexure one. The pilot survey was undertaken in October 2016.

Due to the nature of the information that was being requested, it was decided that responses to Question two, the components that make up the green economy, would carry through to automatically contribute to Questions three to seven. The questionnaire is attached in Annexure two.

The main survey utilised the same survey as the pilot survey, save for the reduction of components that respondents were being asked to identify from ten to five. In addition, the last two questions of the pilot survey were irrelevant for the main survey. The main survey was also designed on QuestionPro and on Microsoft Excel. Initial surveys were sent via QuestionPro and follow-up correspondence was undertaken via email and telephone. The data collection phase for the main survey began at the end of October 2016 and ended mid-September 2017.

It is important to note that the last two questions, in Annexure two, do not appear on the questionnaire of the main survey and the responses required for question two only require input of five components, not ten.

4.5.2 Interviews

The main thrust of interviews is to get an expert, in the field being researched, to participate in a process so that that person can contribute his or her accumulated knowledge and experience to the specific aspect being researched (Wahyuni, 2012; Gill et al., 2008). According to Gill et al. (2008) and Ryan et al. (2009), interviews are utilised as a data collection tool when not much is known about the research topic, or when detailed insight into the research topic is required. There are three types of interviews: structured (a pre-determined list of questions are utilised to guide the interview process without much deviation), semi-structured (also consists of a pre-determined list of questions, but has flexibility to explore any avenue that might arise during the interview) and unstructured (does not have any pre-determined questions or detailed preparation undertaken) (Gill et al., 2008; Ryan et al., 2009).

All requests for interviews with participants were initially conducted over email. A brief introduction and overview of the research was contained in the email, an example of which is contained in Annexure three. In addition, the questions that were to be utilised during the interview were attached to the email. The interview questions can be found in Annexure four. The interview question were developed in a manner that relates directly to the key research questions, starting with establishing whether the individual being interviewed is of the view that the eThekwini green economy is in existence or not. Thereafter, questions were included that would result in the identification of components within the eThekwini green economy and resulting characteristics of the components. Further probing questions were included that

sought to determine the manner in which components behave. Lastly, it was important to determine relevant indicators that would be useful to monitor the health of the eThekwini green economy.

Specifically, a semi-structured, face-to-face approach was planned and utilised for the interviews. All interviews were recorded with voice recorders, which were utilised for transcription and record purposes.

The details of when and where the interviews were conducted are presented in Table 4.3. All interviews were conducted face-to-face. In addition, each interviewee was given a unique identification code. Also indicated in Table 4.3 is the duration of each interview. The only notable challenge with the interviews was setting up the actual appointments with some of the interview respondents, this was largely due to their busy schedule which results from their positions. The organisation and position of each interview respondent are included in Table 5.1.

Interview Respondent	Date	Location	Duration
I1	26/09/2016	Margaret Mngadi Avenue, Durban	1h:09m:13s
I2	13/10/2016	Margaret Mngadi Avenue, Durban	1h:05m:23s
I3	14/10/2016	Margaret Mngadi Avenue, Durban	0h:42m:05s
I4	18/10/2016	Chartwell Drive, Umhlanga	1h:20m13s
I5	09/11/2016	Moses Mabhida Stadium	1h:11m:46s
I6	09/11/2016	Moses Mabhida Stadium	1h:18m:54s
I7	10/11/2016	Pavilion, Westville	0h:35m:00s
I8	19/12/2016	Jeff Taylor Crescent, Durban	1h:12m:27s
I9	21/12/2016	Jeff Taylor Crescent, Durban	0h:48m:10s
I10	06/01/2017	K E Masinga Road, Durban	0h:59m:43s
I11	18/01/2017	Durban Club Place, Durban	0h:40m:40s
I12	27/01/2017	Jeff Taylor Crescent, Durban	0h:44m:52s
I13	08/02/2017	K E Masinga Road, Durban	1h:17m:40s
I14	06/02/2017	K E Masinga Road, Durban	1h:02m:12s
I15	18/07/2017	Anton Lembede Street, Durban	0h:19m:57s
I16	20/09/2017	Jeff Taylor Crescent, Durban	0h:31m:01s

Table 4.3: Details of interviews conducted

Source: Author.

4.5.3 Focus groups

Focus groups are meetings where up to twelve people are guided in a discussion around a central topic by an interviewer to elicit more robust information that would not have been possible utilising individualist tools (Nagle and Williams, 2013). Focus groups generally involve semi-structured open ended questions, where all participants have an opportunity to provide input (Leung and Savithiri, 2009). Leung and Savithiri (2009) highlight that focus groups consist of between seven to ten participants while Gill et al. (2008) suggest six to eight participants.

According to Gill et al. (2008), focus groups are utilised for the emergence of co-created responses by the many participants of focus groups. The focus groups resulted in depth to the responses of questions, as often respondents were building on each other's responses and supporting or disagreeing with them, this gave a further level of insight into the green economy.

Most of the initial requests for people to participate in focus groups were over email, refer to Annexure five for an example of such an email. In addition, a two page pre-focus group reading note, which included the guiding questions were attached to the email and can be found in Annexure six. However, for the second focus group the information was presented in hardcopy format to participants.

All focus groups were recorded with voice recorders. In addition, transcribing focus groups verbatim is a lot more complex than the process for interviews, as a result video recording was also utilised, with the permission of the participants. The voice recording was kept for record purposes but the video recordings were deleted immediately after the transcription of focus groups were complete.

The details of where and when the interviews were conducted are presented in Table 4.4, also included is the duration of focus groups. Each focus group was allocated a unique identification code. Details on the unique identification code of individual focus group respondents are presented in chapter 5. The specific details, such as age, race, gender and occupation, of each participant in the three focus groups can be found in Table 5.2.

Focus	Date	Location	Duration
FG1	29/08/2017	Prior Road, Durban	1h:23m:47s
FG2	15/09/2017	Durban Exhibition Centre	1h:06m:36s
FG3	19/09/2017	Durban University of Technology	1h:09m:15s

Table 4.4: Details of focus groups conducted

Source: Author.

There were two apparent challenges with focus groups. The first challenge was that there seemed to be an unwillingness of 'big business' that are a part of associations to participate in focus groups convened by the very associations that 'big business' subscribes to. The second, which is purely logistical in nature, is due to the large number of participants in focus groups, coordinating focus groups tended to be tricky with a lot of back and forth to arrive at a suitable date and time for all participants.

4.5.4 Data collection and transcription process

This section describes the step-by-step process that was undertaken to collect data and the manner in which it was transcribed.

4.5.4.1 Pilot surveys

An initial email that contained introductory information, an overview of the research, the link to the QuestionPro survey, the Microsoft Excel format, embedded informed consent and request to complete the survey was sent to all participants. Reminder emails were sent two weeks later, to people that had not responded. Telephone calls were made a week after the reminder emails. Not many respondents answered their phones though. All responses were then looked over and analysed for suitability. One major change was made to the survey, in question two, which then carries through subsequent questions. Respondents were initially asked to list ten components of the green economy, this was reduced to five for the main survey. Minor formatting issues were also rectified.

4.5.4.2 Main surveys

An initial email that contained introductory information, an overview of the research, the link to the QuestionPro survey, embedded informed consent and request to complete the survey was sent to all participants. A reminder email, with the Microsoft Excel format attached, was sent two weeks later. Follow-up telephone calls were made about a week later. It should be noted that not many of the respondents

answered their telephones. After the inclusion of the incentive into the research methodology, a third email was sent to all the respondents again. All responses received via QuestionPro were transcribed onto individual Excel formats, so that all responses could be on one standardised format. The original data dump from the QuestionPro platform will be kept for record purposes. All responses were then transcribed onto one data sheet, in preparation for the analysis phase.

4.5.4.3 Interviews

An initial email that contained introductory information, an overview of the research, and the questions that were to be asked (as an attachment) was sent to respondents. Follow up and reminder emails were sent to respondents. In addition to follow up emails, telephone calls were also utilised to find a suitable time to arrange the interviews. Before the start of the interviews, all participants were asked to sign the consent letters and a brief overview of the research was presented. They were also sensitised to the fact that a recorder would be on to assist with transcribing the interviews. There was no objection from any of the participants. A voice recorder was utilised to record the interviews and some notes were made by the researcher during the interviews. After the interviews, in most instances within one day, the interviews were transcribed, verbatim, onto a word document in preparation for the analysis phase.

4.5.4.4 Focus groups

An initial introductory email and brief overview of the research was sent to potential organisations that could host focus groups with their stakeholders. Reminder emails were sent to the organisations. Telephone calls were made, in addition to reminder emails. Just before the focus groups were to be hosted, an email with the informed consent forms and a pre-focus group reading note was sent to the participants or person that assisted with coordination. Before the start of the focus groups the researcher arranged the room, so that people were sitting in a circle or around a table, to allow for good interaction and proper video recording. Before the start of the focus groups, all participants were asked to sign the consent letters and a brief overview of the research was presented. They were also highlighted to the fact that two recorders would be utilised to assist with transcribing the interviews. It was further mentioned that the audio recording will be kept for record purposes but the video will be

immediately deleted after the transcription process is completed. There was no objection from any of the participants. All focus group participants were given a unique identification code. The unique identification codes were utilised when transcribing the focus groups, so that relevant input could be linked to a specific participant. All focus groups were transcribed thereafter, usually within two days of the focus group taking place and prepared for the data analysis phase.

4.6 Data analysis

4.6.1 Quantitative research

Creswell (2014) advocates a six-step process to analyse quantitative date. These steps are discussed below:

The first step is to compile an overview of the sample and response rate into an easy to read Table format. The next step was to determine if there is any response bias, wave analysis can be utilised to measure any potential bias. Wave analysis is a method that tracks specific item's average response changes on a week-by-week basis and that the last wave of respondents can be utilised to indicate the probable response of non-respondents (Halbesleben and Whitman, 2013). This is followed by the third step, descriptive statistics such as measures of central tendency i.e. mean, medium, mode and standard deviation are to be utilised for the survey responses. Thereafter, internal consistency needs to be addressed. The fifth step involved the use of a statistical software package to process the collected data, SPSS was utilised for this research. However, due to the entire population of the research being small and therefore part of the study, the sample is also the population and there will not be a need for inferential statistics. According to Gibbs et al. (2015, pg. 1) *"While the use of inferential statistics is a nearly universal practice in the social sciences, there are instances where its application is unnecessary"*. Gibbs et al. (2015, pg. 1) further adds *"inferential statistics are necessary tools to analyse sample data. Inference to the unknown population parameter is possible …"*. The second point of Gibbs et al. (2015) is largely corroborated by Anvari et al. (2015).. It should be noted that the sample taken from the population at the KSEF falls under qualitative data analysis. The final step is the presentation of findings in Tables, which is accompanied by a narrative interpreting the results.

4.6.2 Qualitative research

According to Creswell (2014), qualitative data analysis can be conceptualised as a six-step process, which is depicted in Figure 4.1 and discussed below. It was observed that there are many steps for qualitative analysis, but they can broadly be categorised as observation, transcribing, undertaking coding and development of themes (Leech and Onwuegbuzie, 2008; Fossey et al., 2002).

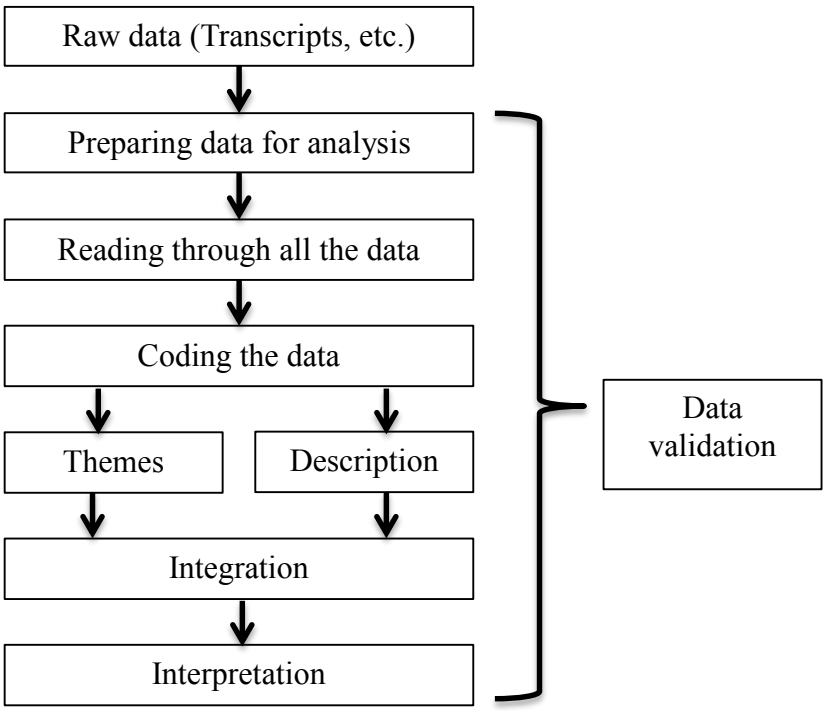

Figure 4.1: Qualitative data analysis process

Source: Adapted from Creswell (2014).

The first step in qualitative data analysis, according to Creswell (2014), begins with preparing qualitative data, which is purely an administrative step that essentially evolves arranging and formalising collected data into formats and categories that are of academic quality. Thereafter, the data should be thoroughly read. This step will give the researcher a good overview of the data and start to highlight aspects such as consolidated meaning, depth and credibility. The third step involves categorising data into homogenous components and then entails providing a name for each portion of data. It is important to note that no pre-determined codes will be utilised for this research, all codes will be developed as a result of the emergent portions of data. The next step is to then utilise codes as a basis for developing a description of various related aspects. The descriptions are in turn utilised to create themes. While Creswell

(2014) states that a small number of themes should be developed, this research will not contain the possible number of themes that will be identified. Creswell (2014) further states that the complexity of the themes do not have to be confined to merely identifying themes but can also progress to more advanced levels, which would include mapping themes. The fifth step involves developing a narrative that further develops the descriptions and themes. It is important to note that as this research is based on a mix method strategy and as a result a separate narrative will contain the quantitative narrative and a third will then discuss the dynamics between the qualitative and quantitative and will lead us to conclude where both sets of data are convergent, divergent or has elements of both. The process is concluded with a final interpretation of the entire data set, with the fundamental finding being highlighted. This narrative will also identify any gaps in the data collected, which will need to be filled to ensure that a comprehensive outcome is developed.

It should be noted that a qualitative expert was engaged to undertake the coding of the data, utilising the Nvivo 10 Software. The researcher undertook all other data analysis steps. Due to the nature of this research, in trying to bring about an understanding of the eThekwini green economy and how it operates, the most appropriate approach is Inductive Thematic Analysis. In addition, the data analysis process made use of word frequency counts, tag clouds, tree maps and matrix coding.

4.6.3 Quantitative and qualitative research comparison

It is important to keep in mind that this research was based on a concurrent triangulation strategy, one of the mixed methods procedures. As a result, it was critical that both sets of data and interpretation, for qualitative and quantitative data, to be discussed in a simultaneous manner. This discussion will be predominately in the form of a narrative, with Tables and Figures, from both data sets being employed to support the discussion. In essence, this discussion led to the conclusion on whether there is divergence, convergence, or a mixture of the qualitative and quantitative data.

One of the main outcomes from this was in the form of a map that will synthesis the findings to take us closer to meeting the key research objectives. The map will contain the types of agents and their interaction channels. This will be utilised as a basis for the development of the ACE framework. The maps are not presented in this research.

4.7 Data validation

This section discusses the manner in which the validation of data was ensured. According to Heale and Twycross (2015, pg. 66), *"Validity is defined as the extent to which a concept is accurately measured …"*. This is supported by Mohajan (2018, pg. 1) *"Validity concerns what an instrument measures, and how well it does so"*.

4.7.1 Quantitative research

According to Golafshani (2003), quantitative validity is to ensure that what is ultimately measured by the survey must match what was initially envisioned, which is supported by Thatcher (2010). As a result, an external statistician, assessed the construct validity for quantitative data of this research.

The researcher then also acted as the auditor of the outcomes from the process of SPSS coding. The auditor in this context means that the data coding undertaken by the statistician expert will be critiqued and double checked for accuracy.

4.7.2 Qualitative research

Creswell (2014) list various approaches that can be utilised for the validation of qualitative data.

One of the approaches for validating qualitative research is 'triangulation' of various data sources. Due to this research employing a concurrent triangulation strategy, the qualitative data was ultimately triangulated with quantitative data, but it should be noted that the triangulation only took place after both the qualitative and quantitative data had been analysed. Secondary data will also be utilised to triangulate the validity of such. It should be noted that the above technique for validating qualitative data took place much later in the study, i.e. after both qualitative and quantitative data was analysed.

Ensuring the soundness and trustworthiness of qualitative data can be derived by ensuring four criteria are met: credibility, transferability, dependability and confirmability, as developed by Guba (Greene, 2014; Shenton, 2004; Chowdhury, 2015).

Credibility is to qualitative research as to what internal validity is to quantitative research (Morse, 2015; Greene, 2014; Chowdhury, 2015). That essentially means that credibility confirms that the process has the ability to measure what it was intended to

measure. There is a plethora of tactics for establishing credibility, as initially developed by Guba (Greene, 2014; Shenton, 2004). The most relevant tactics for this research was the utilisation of: familiarisation with the culture of participating organisations, triangulation, comprehensive overview of the context of the research and the development of a repertoire and trust in the interview and focus group sessions that allowed participants to be honest and straightforward. Credibility was further established for this research through the use triangulation of interviews and focus groups, with secondary literature data sources. In addition, the researcher has been involved in related work for over ten years and this can be interpreted as being immersed in the context of the research.

Transferability corresponds to the quantitative concept of external validity (Chowdhury, 2015; Shenton, 2004). This concept would essentially ensure that the findings of the research would remain true for a broad application. However, qualitative research outcomes are by nature and definition only applicable to a specific context and as a result it is extremely tricky to generalise the findings. One of the ways in which this construct can be addressed is the use of a comprehensive description of the content in which the research has been conducted. Transferability for this research was difficult to achieve, however the methodology utilised can be replicated to arrive at findings that will be applicable to other contexts.

Dependability is the equivalent of reliability in quantitative research (Morse, 2015; Shenton, 2004). This construct also has some challenges for qualitative research, as the ever changing context will have an effect on reliability. One of the ways in which this can be overcome is to provide a precise description of the manner in which the research was undertaken. This research endeavoured to demonstrate dependability by describing, in this chapter, the specific steps that were undertaken during the research.

Confirmability is the incorporation of objectivity into the research (Morse, 2015; Chowdhury, 2015; Shenton, 2004). This is to essentially ensure that no researcher bias is entered into the research. To this end, triangulation was again utilised and audit trails where the research can be traced in a step-by-step fashion throughout the entire research process. Both triangulation and audit trails were utilised during this research. Triangulation was undertaken with interviews, focus groups and secondary data sources. An audit trail and record of all steps undertaken have also been electronically documented.

4.8 Data reliability

According to Golafshani (2003) and Heale and Twycross (2015), reliability entails ensuring that the data collection instruments are utilised consistently throughout the data collection process. This is supported by Roberts et al. (2006) *"Reliability described how far a particular test, procedure or tool, such as a questionnaire, will produce similar results in different circumstances, assuming nothing else has changed"*. The techniques developed for assessing reliability for qualitative and quantitative data are not the same and are discussed in the next sub-sections. However it should be noted that measuring reliability for quantitative data is easier than for qualitative data (Zohrabi, 2013).

4.8.1 Quantitative research

Internal consistency is ensuring that a tool is able to collect the same data from different respondents (Tashakkori and Teddlie, 1998; Roberts et al., 2006). As a result, the researcher ensured that the surveys were administered in a standard manner, as indicated in the above sections of this chapter. An independent external quantitative expert was engaged for the data coding verification in SPSS. The researcher then acted as the auditor of the outcomes from the process.

4.8.2 Qualitative research

Qualitative data reliability is concerned with the consistency of application of the research techniques employed in the research (Creswell, 2014). This is supported by Zohrabi (2013, pg. 259) *"... the purpose is not to attain the same results, rather to agree that based on the data collection processes the findings and results are consistent and dependable"*.

According to Zohrabi (2013), triangulation and establishing an audit trail are two aspects that can increase the dependability of qualitative data. The notion that keeping a precise record of the research process adding to the reliability of the research is confirmed by Roberts et al. (2006). Both triangulation and an audit trail were utilised for this research. Roberts et al. (2006) further adds that software packages, such as Nvivo, also contributes to the reliability aspect.

As a result, qualitative data reliability was ensured in this research by continually checking throughout the research, and at the end of the process, that the coding

remained consistent. Triangulation of data also played a critical part of the research process. In addition, Nvivo assisted in increasing the reliability of the data.

An independent external qualitative expert was engaged for data coding in Nvivo. The researcher was then better able to audit these codes, as the researcher conducted the interviews and focus groups and transcribed the sessions.

4.9 Bias and ethical considerations

Bias in this research was minimised during the interviews by recording the responses verbatim, where the interviewee consented, and by not manipulating the quantitative data via the surveys. This data was then fed directly into the processing of both sets of data.

The processing of data in Nvivo and SPSS by an independent expert might raise some questions, however this is deemed to be a specialised skill, i.e. the utilisation and management of those types of software. In addition, the outcome from that process is likely to have remained the same if processed by the researcher, or any other individual.

All participants in interviews and focus groups were requested to sign an informed consent letter, which are not attached to keep the identities of the respondents confidential but was archived with the University of KwaZulu-Natal and by the researcher.

Furthermore, gatekeeper letters were requested and issued from the eThekwini Municipality and KSEF. An ethical clearance letter was issued by the University of KwaZulu-Natal for this research, which is attached in Annexure seven.

Bias was limited as the coding and the researcher audited the outcome from the processing of the data. In addition, there was constant reading and referencing of data to ensure that there was no subjective influence from the researcher.

4.10 Conclusion

This chapter began with an overview of a few ACE models that have been developed utilising empirical information, i.e. the data was collected specifically for the development of those models. In addition, one of those models had to complement

primary collected data, with secondary data. These models were highlighted to indicate that there has been precedence for the collection of such data.

The options for possible fundamental underpinning of the research methodologies were discussed, with some of their characteristics being assessed for applicability to this research. It was concluded that the most relevant worldview is pragmatism. This would allow a mixed method strategy of inquiry to be utilised, which will incorporate both qualitative and quantitative data.

The initial population and survey that was set for this research was presented and incorporated people that work directly in the eThekwini green economy who belong to local government, local businesses or a supporting forum. Challenges with response rates to the survey was briefly mentioned but will be discussed further in chapter six. The reaction to the limited amount of data collected was to broaden the population of the research to include individuals that contribute to at least a part of the green economy.

Thereafter, the data collection tools were discussed, this research utilised: surveys, interviews and focus groups. The specific steps that were taken for the utilisation of each data collection tool was then presented. This was followed by the six-step process, as advocated by Creswell (2014) for the analysis of data. It is important to note that should there be any glaring gaps in the findings, secondary data will be utilised to supplement the primary data.

The data validation and reliability techniques were then discussed. This research rests heavily on triangulation and robustly documenting all relevant process of the research and contexts within which the research takes place.

The next chapter will present both quantitative and qualitative results and findings from the data collection phase.

CHAPTER FIVE: RESULTS

5.1 Introduction

The findings from data collection is presented in this chapter, the discussion and analysis of findings will be undertaken in the subsequent chapter. Due to the mixed methods strategy of inquiry being chosen for this research, there are both quantitative and qualitative data that were collected. The quantitative data was collected through a survey. Qualitative data was collected by means of interviews and focus groups.

The chapter will first present and discuss data from the qualitative component of the research, which will start with interviews and then proceed to focus groups. Thereafter, the quantitative component will be discussed.

Due to the number of themes and vast number of sub-themes, mind maps have been developed to provide a visual representation of the themes from each data collection method. Figure 5.1 represents themes that emanated from interviews, Figure 5.2 from focus groups and Figure 5.3 for data from surveys.

It should be noted that the findings from the three data collection methods are presented individually, as a result it will be noticed that there are some themes that have emerged from more than one data collection method. This is not an error, but rather will assist in the subsequent chapter where data is triangulated.

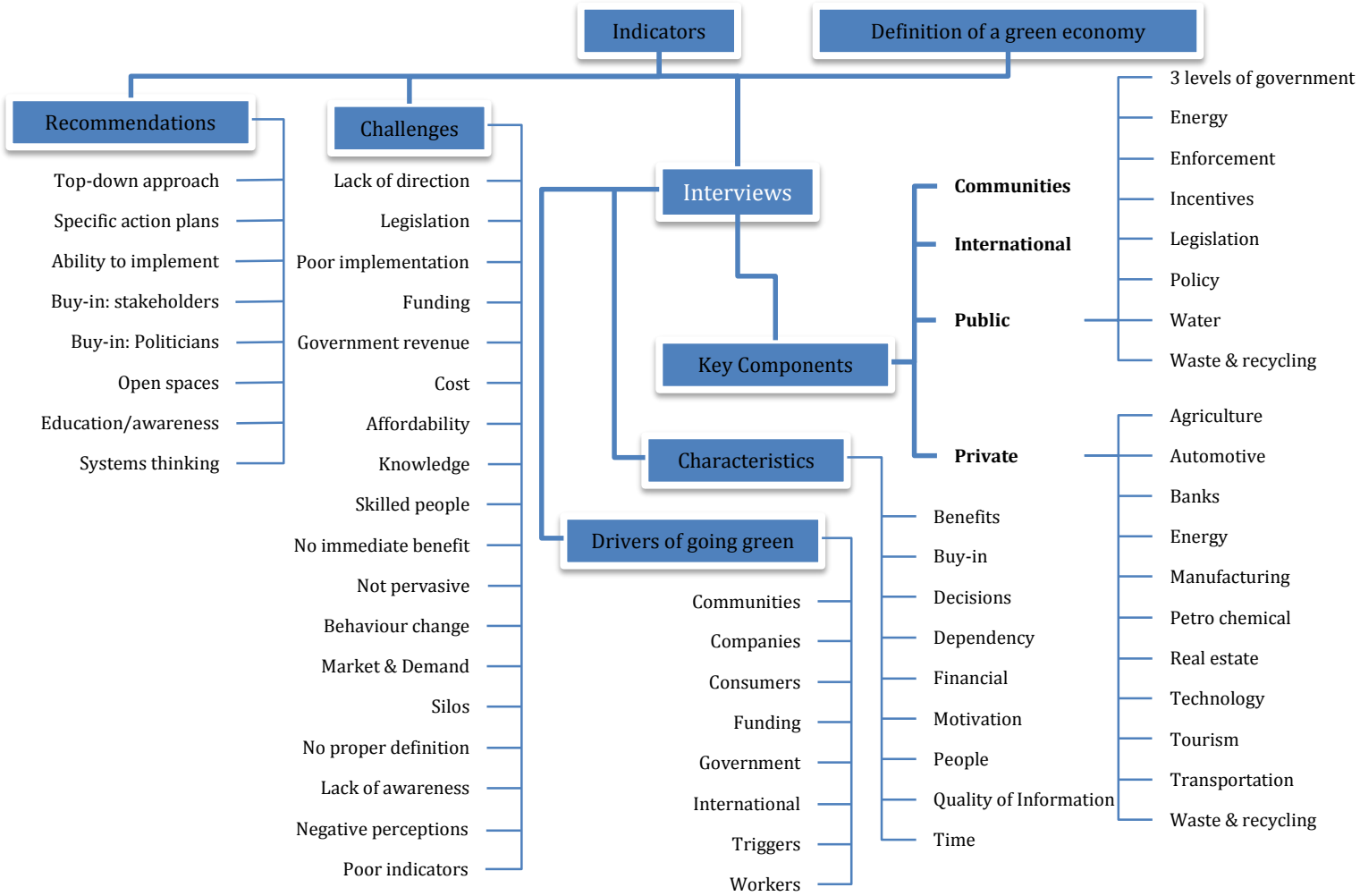

Figure 5.1: Mind map of themes: Interviews

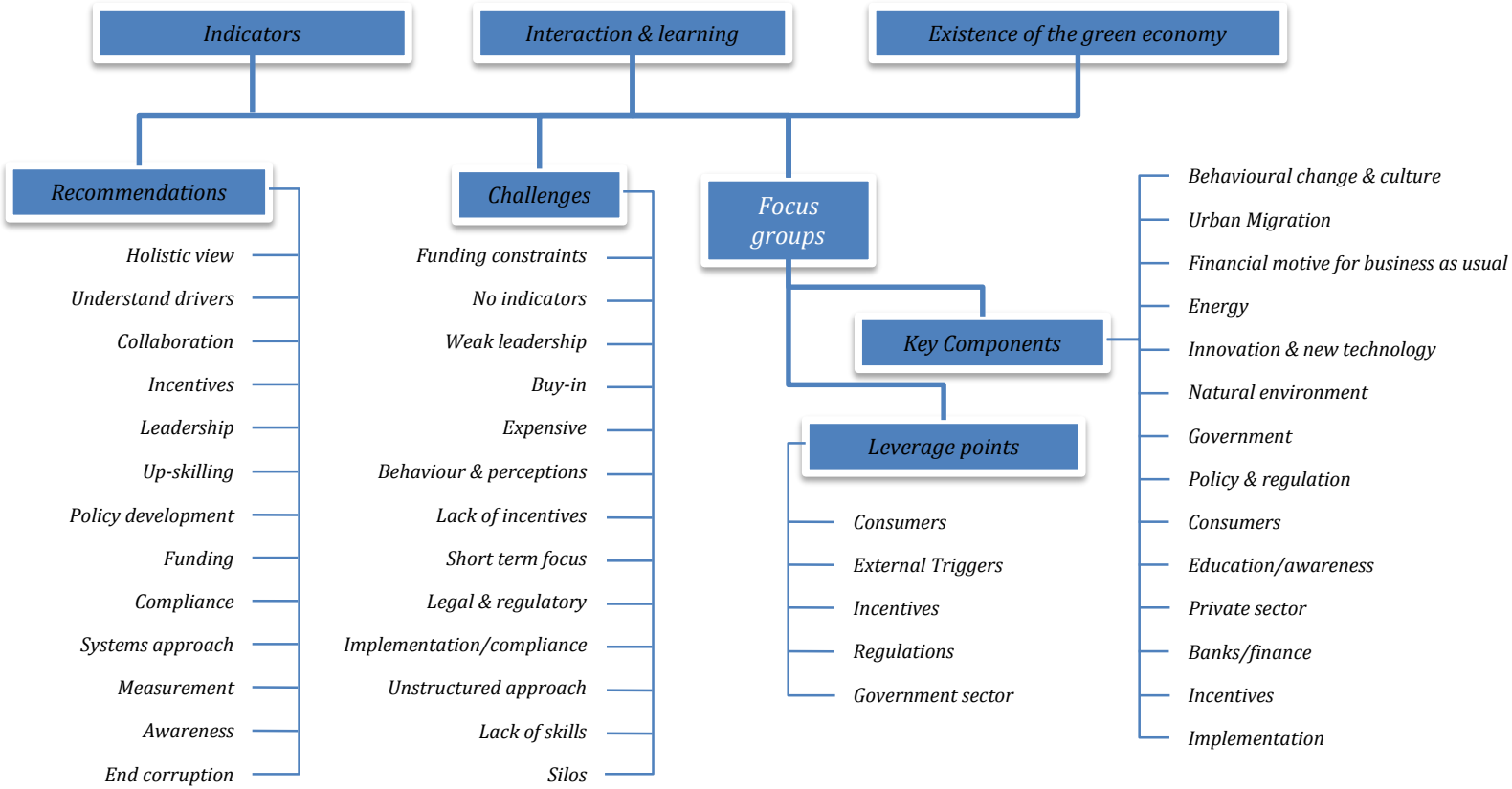

Figure 5.2: Mind map of themes: Focus groups

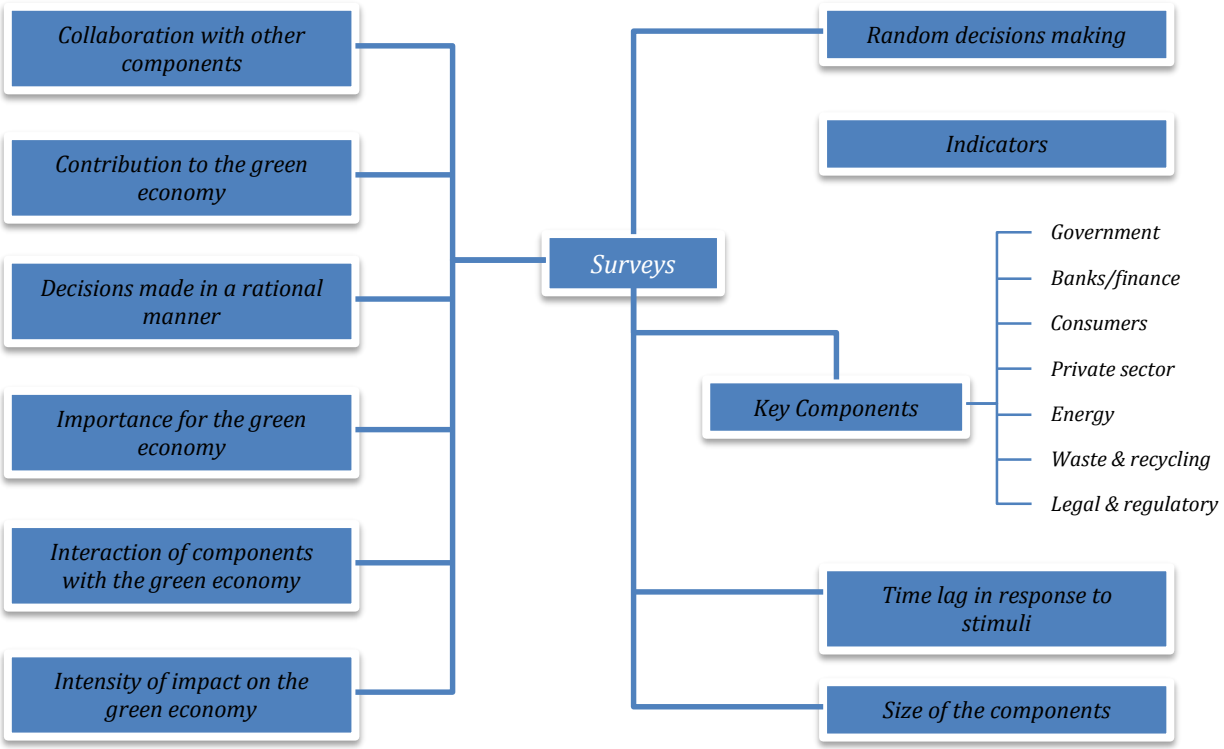

Figure 5.3: Mind map of survey data

5.2 Qualitative research: Interviews

All interviews for this research were conducted over a period of one year, with the first interview being conducted on the 26th of September 2016 and the final interview conducted on the 20th of September 2017. The extended time over which this qualitative data was collected was due primarily to the respondents. All of the respondents are gainfully employed in high-powered positions with busy schedules. Finding suitable timeslots in diaries of the respondents entailed a lot of dialogue and negotiation, often interviews had to be rescheduled.

As can be seen in Table 5.1, the sixteen interview respondents are not homogenous, which led to better research input and as a result data and research findings. Most of the respondents (ten) are in their forties, with one respondent being in their fifties, one in their sixties and four respondents in their thirties. However, only four respondents were female, with twelve males. This further highlights the gender inequality in the work place in, specifically, senior technical positions. In terms of race, there were four African participants, six Indian participants and six European participants. All of the respondents had varying job profiles, as indicated in Table 5.1 and all are at a senior level.

Interviewee	Age	Gender	Race	Employment
I1	Early 40's	Female	African	eThekwini Municipality – Economic Development Unit – Programme Manager
I2	Early 40's	Male	African	eThekwini Municipality – Economic Development Unit – Project Manager
I3	Late 50's	Male	Indian	eThekwini Municipality – Economic Development Unit – Head
I4	Early 40's	Female	European	KSEF – Director / Consultant
I5	Mid 40's	Male	European	eThekwini Municipality – Durban Investment Promotion – Head
I6	Mid 40's	Male	Indian	eThekwini Municipality – Economic Development Unit – Deputy Head
I7	Mid 40's	Male	European	KSEF – Director / Business Owner
I8	Early 30's	Male	Indian	eThekwini Municipality – Electricity Unit – Chief Engineer
I9	Late 40's	Male	Indian	eThekwini Municipality – Electricity Unit – Senior Manager
I10	Mid 40's	Male	European	eThekwini Municipality – Climate Protection Branch – Senior Manager
I11	Late 40's	Female	Indian	eThekwini Municipality – Imagine Durban – Project Coordinator
I12	Mid 30's	Male	African	eThekwini Municipality – Electricity Unit – Project Executive
I13	Early 40's	Male	European	eThekwini Municipality – Environmental Department – Senior Manager
I14	Late 30's	Female	African	eThekwini Municipality – Climate Protection Branch - Scientist
I15	Early 60's	Male	European	eThekwini Municipality – Revenue Unit - Head
I16	Mid 30's	Male	Indian	eThekwini Municipality – Electricity Unit – Tariff Engineer

Table 5.1: Demographics of interview participants

5.2.1 Tag cloud

Figure 5.4: Tag cloud collated interview data

Figure 5.4 displays the tag cloud that was generated from all interview responses. This tag cloud provides a good visual overview of the frequency of identified words and incorporates words that are at minimum three alphabets long.

The most prominent words that were captured by the tag cloud include ‘economy’ and ‘green’, which was to be expected, as the bulk of the discussion centred on the green economy. The next most visible word in the tag cloud is ‘think’ which was predominantly utilised in respondents answers to questions.

“I would think that the green economy starts off, or should start off firstly with the vision for the city” (Interview Respondent I16).

The next most noticeable word in the tag cloud is ‘people’, which is an aspect that was constantly raised throughout the interviews. This was largely in terms of education and awareness levels of people, but that in terms of the green economy it is driven by people, whether individual consumers or those people that make decisions on behalf of organisations.

5.2.2 Themes

It should be noted that themes and aspects that were raised explicitly during the interviews are discussed. A number of additional themes and aspects could have been inferred from the interviews, but due to the high possibility of researcher biasness and researcher subjectivity that would have been intertwined in the identification of the themes and aspects, the inferred themes have not been included.

5.2.2.1 Definition of a green economy

There was general consensus that a green economy does exist within the EMA and that the eThekwini Municipality, as an organisation, has been supportive of the green economy.

"The eThekwini green economy does exist, there is definitely a green economy out there" (Interview Respondent I14).

"So, I would say eThekwini is committed towards a green economy and the wheels are turning" (Interview Respondent I12).

However, the second position that was broadly agreed on by respondents was that the eThekwini green economy is currently in its early development stages. Many of the respondents painted a possible future of huge growth opportunities in the eThekwini green economy. This is, naturally, dependent on a number of pertinent factors coming together. The notion that the sector has a lot of potential was only countered by Interview Respondent I4, but it appeared that Interview Respondent I4 was referring to local government operations in the climate change and green economy space as opposed to the broader eThekwini green economy.

"I think, basically the green economy is active, but we are going to see a lot more growth going forward" (Interview Respondent I8).

"I think it is definitely one of the forerunners in the country, sort of based on the history and where it started and those sorts of things" (Interview Respondent I4).

Respondents highlighted that the green economy consists of products and services. The products within the green economy have to deliver environmental benefits. For example, consumption of less energy and also being manufactured in a sustainable manner.

"I focus exactly what a green economy is, to me it's an economic system that includes products, employment" (Interview Respondent I10).

"Well, I think for me firstly, my view of the green economy is that it has to be an economy that is sustainable and aims to address some of the sustainability issues that we face. That includes the socio-economic side of this" (Interview Respondent I13).

Respondents indicated that the green economy has the potential to also incorporate a socio-economic angle. This means that through the green economy, poverty can be addressed in one of two ways: either through the creation of jobs or provision of goods or services that make the lives of the less advantaged easier.

"There is another component, the social upliftment aspects. Like when we hosted COP17 and the solar water heater rollout. There was extreme energy poverty in certain sectors that needs to be addressed as well" (Interview Respondent I7).

"We have the immediate benefits that people will get from doing the work. If they can now leap out of poverty from doing this work, getting some skills and proceeding to other green opportunities" (Interview Respondent I10).

The eThekwini green economy has to result in a positive benefit for the physical environment.

"It's about the broader economy and a more sustainable economy. The one thing, when you think about this space, it includes environmental rehabilitation" (Interview Respondent I3).

"At the same time, are we ensuring that there is minimal environmental risk and damage to ecosystems and ecosystem services? That is essentially my view of what a green economy does" (Interview Respondent I13).

Most respondents were not able to comprehensively describe the eThekwini green economy, with most respondents focusing on parts that were relevant to their profession. There was only one response that was remotely close to encompassing all relevant aspects.

"Well, I think for me firstly, my view of the green economy is that it has to be an economy that is sustainable and aims to address some of the sustainability issues that

we face. That includes the socio-economic side of this. You know, are we addressing poverty. At the same time are we ensuring that there is minimal environmental risk and damage to ecosystems and ecosystem services? That is essentially my view of what a green economy does" (Interview Respondent I13).

When all the responses are aggregated, from interview participants, all the elements that are included in the traditional definition of a green economy emerges. However, the majority of respondents were not able to provide a concise and succinct definition of what the eThekwini green economy actually is. The responses included answering the question indirectly and through discussion of elements and aspects of the eThekwini green economy. This can be linked to the position of the majority of respondents, that the green economy is still in its infancy and that education and increased awareness on the topic is important. The previous statement should be valid for the ordinary resident within the EMA, but not for people that work within the green economy or broader sustainability space who by position should have a fairly robust understanding of the eThekwini green economy.

However, when the aggregated data of all the interviews is looked at holistically a clear picture emerges of the eThekwini green economy. This observation further validates one of the key tenets of a CAS, none of the components individually will be able to completely comprehend the entire system on their own.

5.2.2.2 Key components of the eThekwini green economy

The respondents highlighted components that can be broadly categorised into: communities, private sector, government sector, triggers and international sector. It was observed that a rather comprehensive picture was created for the private and government sectors. The government sector detail even went so far as to indicate that all three levels of government are important, however provincial level was the least mentioned. There was scarcely any mention of environmental components being key elements that are a part of the eThekwini green economy, rather the respondents seem to view the components as having an impact on environmental aspects. For example, one of the indicators that was highlighted as important to measure are GHG emissions reductions and resilience. The mention of the physical environment was its critical linkage to tourism. This indicates that the green economy objectives are being

pursued, not for want of protecting the environment, but for want of profit with a co-benefit being the positive impact on the environment.

5.2.2.2.1 Communities

Naturally communities were identified as components of the eThekwini green economy. Labour comes from communities and a large portion of consumption takes place in communities. An interesting sub-component of communities is activism, where environmental and social elements are closely intertwined. This is where communities converge on areas of common interest, when their wellbeing is impacted negatively from pollution and related matters. It is important to note that for this research, a difference will be made for communities and consumers. Consumers in this research will take a broad classification and can be individuals from communities or government or the private sector.

"There is even social activism around conscious production processes such that it limits the infringements on the environment. In different areas you have environmental activism within the communities themselves, which actually forces companies to be more conscious of how they process their product, how they dispose of things and so forth" (Interview Respondent I1).

"That community, the Quarry Road informal settlement have actually changed their understanding of waste so much that they put up signs, telling people not to come and dump their litter or waste and the rubbish from external sources" (Interview Respondent I10).

5.2.2.2.2 Private sector

According to the respondents, the private sector consists of various components which will be discussed below.

Agriculture: one of the impacts of climate change, a concern raised by interview participants, was on food security. However, it has been raised as a secondary focus, when compared to utilising agriculture as a sector that can absorb waste from other sectors, such as fertiliser. There was also focus on consuming healthier organic food primarily for personal health reasons. The focus on food gardens was highlighted as important, partly to offset the increasing cost of agricultural produce. It was pointed out that retailers are putting increasingly more pressure on agri-business to deliver

produce that is as natural as possible, this can be linked to pressure on retailers from health conscious consumers. It was also raised that the agriculture sector is not very big in the EMA. This would then imply that the bulk of the produce that the eThekwini population consumes is imported into the EMA. The inflow of produce, whether to wholesalers, retailers or directly to consumers, for consumption within the EMA results in a corresponding outflow of money. This outflow of money is not good for the eThekwini green economy. It appears that only the downstream components of the agriculture sector, i.e. wholesalers and retailers, would derived direct benefit from the eThekwini green economy.

"Sewage can be cleaned up and fed into the economy, in the sense that a lot of it is used for manure which promotes a particular industry, the agricultural industry" (Interview Respondent I1).

"Thanks to Walmart and Woolworths, they specify the crops that they want - mostly non-chemical fertilised crops. Chicken, lamb and mutton has to be free-range. This has changed the mentality of the agri-business to say that the green economy is the way to go. What happens to their crops? They have added value to their crops so they can charge more. The more the public becomes aware, they buy those products. It is no longer about the price, it is about fresh food. There is a consumer behaviour element" (Interview Respondent I2).

"Agriculture is a very small sector in eThekwini" (Interview Respondent I6).

Automotive: the automotive sector in eThekwini was highlighted as having two aspects relevant for the eThekwini green economy. The first is producing environmentally friendly vehicles, in the form of either fuel efficient or alternative vehicles, such as hybrids. In addition to producing sustainable vehicles, the greening of operations of vehicle manufacturers was highlighted as important. It was pointed out that undertaking these green initiatives were still being implemented when it does not make financial sense. This is due to the international linkages of the companies. There was an interesting point raised on ownership patterns of vehicles, to the point where there is a shift to leasing and hiring, as opposed to one person owning a vehicle.

"So, they lean more towards eco-cars, eco-boost, all their vehicles are eco-driven" (Interview Respondent I12).

"What we are seeing, if we take for example [local company name mentioned redacted] here, they are an international company and obviously they have their head office's funding to make their whole operation carbon neutral and they export goods, etcetera" (Interview Respondent I8).

Real estate: it was highlighted that privately owned buildings are not optimised for energy savings and offers huge potential. In addition, the facilities owned by the eThekwini Municipality also offer such opportunities. Residential eco-estates were highlighted as important. However, the retrofitting and building of such facilities are only possible if architects and designers incorporate such elements into their designs.

"I think the key clusters that are there is the commercial building sector, I think there is a huge opportunity there" (Interview Respondent I16).

"Property cluster, how you design your buildings for energy efficiency, plays a major role" (Interview Respondent I2).

Petro-chemical: the respondents highlighted the oil refineries in the EMA and the revenue that is derived from those activities by the Municipality. There has been a shift to lower sulphur products. In addition, a small sector has emerged that produces bio-degradable products but this seems to be isolated to a handful of businesses. Bio-fuels were also highlighted. However, it has emerged that this sector cannot easily mitigate its GHG emissions and has to rely on reviewed research. An important point raised is that this cluster is not going anywhere anytime soon. The companies have a lot of financial capital invested and their products are a critical part of operations that happen within the EMA.

"There is a small sector around more environmentally friendly chemicals, bio-degradable stuff" (Interview Respondent I6).

"I don't know what's being done there but innovation around reducing emissions and cleaning up what they produce. There is a lot of research that goes on with that as well" (Interview Respondent I13).

"The petro-chemical cluster. To me, we have one. We are on the coast, the tankers come down, they park at the Bluff and offload their oil. [Local company name mentioned redacted] process the fuel. I think it is not something that is going to go away anytime soon" (Interview Respondent I13).

Manufacturing: according to the respondents, eThekwini has a large manufacturing sector, which manufactures basic products all the way to complex technologies. It was raised that this sector has tried to become more sustainable and reduce cost in the process. Industrial symbiosis came across as having huge potential, this is where waste from a process is input into another process.

"There are manufacturing industries and again we have lots in Durban, where there is a lot of work being done and whether it is manufacturing soaps or other households products, there is definitely a drive to doing stuff in a more sustainable manner" (Interview Respondent I13).

"In terms of, also within the products but more, the practices there has become a more conscious attempt to look at raw materials. So, the whole drive around industrial symbiosis, looking at what is your waste and how best it can be used in another process. Those kind of things have become a lot more heightened and people are becoming a lot more conscious about it" (Interview Respondent I3).

Banks: were identified as key components of the eThekwini green economy, as most people will rely on financing for their larger projects. However, it was also highlighted that only recently have banks changed the way they do business, which allows the banks to accommodate unique financing requirements of the green economy. It was further highlighted that banks require accurate, reliable and consistent data to be able to make informed decisions on granting loans.

"Banks. Very reluctantly provide financial assistance. In the last three years the banks have come to the fold" (Interview Respondent I2).

"The banks are a part of the green economy. Most of the banks have changed and now have funds and special interest rates for the renewable energy side of things" (Interview Respondent I4).

Technological innovation: through technological advancement, resources will be utilised more efficiently. However, it would be best for the eThekwini green economy if the technology is developed within the EMA. It is critical to have the correct people that are able to drive the process, this links closely with educating and up-skilling people. Innovation on its own is not sufficient to be of benefit, it has to be commercialised.

"Research and development and the growth of that technology space, the energy technology space, there definitely needs to be an investment in terms of Durban developing technology within the borders of our Municipality" (Interview Respondent I7).

"Technology. You are kind of forced to innovate around a lot of things, as the city, as different companies, as people. You are able to be within the legislation, or of limited resources, or of the need to clean out processes and be more efficient and effective. There is a lot of innovation that is coming about, but the change in technology forces us to use our resources better" (Interview Respondent I1).

Tourism: it is a large part of the eThekwini economy and it greatly relies on our physical environment being kept in a pristine condition. There was a good point raised, that while the actual tourist facilities in eThekwini can be green, a larger percentage of tourists come from some distance away. These tourists rely on fossil fuel based transportation to get to eThekwini. As a result, when the complete cycle is taken into account tourism becomes a carbon intensive sector, even eco-tourism.

"Tourism is a big thing. People come for the beaches and if the dunes are in good condition and the beaches are in good condition, and clean, then that's obviously a big draw card for the Municipality" (Interview Respondent I13).

"You got the Durban Green Corridor and whilst we are having a very conscious focus around cleaning rivers and the areas around rivers, by doing that we are also impacting and creating a new product in the form of tourism. We are creating trails and a whole range of things, mountain biking and bird watching, with an environmental rehabilitation slant. It's part of the green economy, its interventions are to minimise carbon and getting rid of alien vegetation and so forth" (Interview Respondent I3).

Transportation: reflective of the GHG emissions profile of the EMA, respondents highlighted transportation as a key component of the eThekwini green economy. The information can be synthesised into two broad sub-components. The first is public transportation, which is inclusive of the Integrated Rapid Transportation Network that the Municipality is currently rolling out. It was essentially concluded that public transportation is not very efficient in the EMA. The second broad sub-component is private transportation. This includes elements of non-motorised transportation, such as bicycles as a means of commuting and recreational cycling. There was also mention of transitioning to cleaner fuels, i.e. blending of fossil fuels with bio-fuels. Electric vehicles were also raised and presented a huge opportunity as it is currently not very common.

"A big role in infrastructure provision, like your Integrated Rapid Transportation Network" (Interview Respondent I6).

"Conversion of current petrol, into a more blended fuel will be massive for transport" (Interview Respondent I2).

Energy: this sector, according to respondents, is made up of renewable energy and energy efficiency. The Renewable Energy Independent Power Producers Programme was raised as an important component of the green economy but not directly for the eThekwini green economy as no projects have been implemented in the EMA. The adoption of energy efficient technologies for lighting, water heating and air-conditioning systems were highlighted as critical for reducing electricity consumption. Water efficiency was also raised. An important point raised is that whether someone is investing in a large expensive renewable energy system to power their home, or purchasing a tiny photovoltaic system to charge their cellular phone, it still needs to be construed as supporting the eThekwini green economy.

"You would have the renewable energy and energy efficiency cluster" (Interview Respondent I4).

"Everyone has access, it depends what they want to use it for and what their needs are" (Interview Respondent I4).

"If I had to think about it, it is largely the type of renewables that we are using. The type of renewables that make up this big green economy and the underpinning of all of this will be the general citizens" (Interview Respondent I9).

Waste and recycling: the waste sector is one of the components raised by respondents that appear both within government operations and in the private sector. At times they both try to play the same role. In most instances, however, a lot of the value added services to waste is delivered by the private sector. For instance, industrial symbiosis was raised several times, this is where the waste or left over output from one process is utilised as input to another process. There was mention of various private organisations that play a recycling role and manufacture sustainable building products from waste. There was also mention of the job opportunities that are created through the recycling sector, especially with regards to informal entry-level type jobs. Minimising waste that goes to landfills is important because of limited landfill space and will also result in recycling and re-using products.

"A further example of industrial symbiosis: in that space, when you look at property, they give out rubble and then you get that rubble recycled into making building material. Nothing goes to waste" (Interview Respondent I2).

"Waste minimisation, like I said, we try to send as less waste to the landfill site as possible" (Interview Respondent I11).

"The recycling, the re-use, the re-purposing, waste benefaction component" (Interview Respondent I5).

It would be prudent to summarise the private sector components that interview respondents highlighted. The components were discussed in no order of importance. Agriculture was highlighted as being an important part of the eThekwini green economy, not just from a job creation perspective but also from producing organic produce that would contribute to the evolution of lifestyles and healthy living. The automotive sector was also highlighted, predominately relating to the manufacture of vehicles in a sustainable manner and manufacturing environmentally friendly vehicles. Real estate came across as offering a huge opportunity for retrofitting buildings and facilities, so that they become energy efficient and possibly generate their own energy. The petro-chemical industry in the EMA was highlighted and its

transition to environmentally friendly processes and products. While there might be some overlap with the manufacturing sector and the automotive sectors, these seem to be discussed separately by respondents. The manufacturing sector was identified as a key sector within the broader eThekwini economy. Banks and access to viable financing was mentioned multiple times by interviewees, this is due to the normally high capital investment that is required to install green technologies and a large portion of companies are not willing or able to part with their cash. The promotion of technological advancement within the eThekwini green economy, specifically research and development being undertaken, was identified as being important. This is due to most of the skills and technology being imported into the EMA. Tourism plays a central role in the economy and can easily transition to a greener sector. However, the life-cycle of eco-tourism and perhaps all sectors, should be taken into account as people often travel great distances to holiday in the EMA, the transportation of which results in high GHG emissions. Energy was separated into two aspects, renewable energy and energy efficiency. The last component highlighted was the waste and recycling sector, which can incorporate people with no skills, all the way to highly skilled engineers who would be involved with the recycling processes.

5.2.2.2.3 Government sector

The key components of the eThekwini green economy raised by the respondents for the government sector are discussed below. It is important to note that in a subsequent section of this chapter, leverage points of the eThekwini green economy will be discussed and some of those leverage points can also be considered as components of the government sector.

Three levels of government: the respondents were very clear that government is a key aspect of the eThekwini green economy, mainly for the legislation and incentive components. The government related components of the eThekwini green economy are discussed below, but it is important to note that government was not highlighted as a homogenous group. The three levels of government were mentioned: national, provincial and local. There seemed to be consensus that the flow of decision-making and strategic direction is from national to local. While all three spheres were mentioned, the main levels are national and local, as provincial was not raised as frequently by respondents.

"There's a role to play at each level, government is also in that interaction – providing the regulation and providing incentives for stimulating private sector to make certain changes" (Interview Respondent I6).

"We are part of three tiers of government, so obviously what happens in higher levels, national policy and things like that, would direct what we do here" (Interview Respondent I10).

Legislation: according to the respondents, there has been a lot of activity in the legislative space. Certain initiatives and work can only start on the back of enabling legislation. However, at the same time, certain pieces of legislation can also be a huge obstacle. A lot of the legislation being developed, aligns to the NDC that was put forward by the South Africa government in the run up to COP21, where the Paris Agreement was agreed upon. National legislation has to be supported by local bylaws where applicable. In essence, government plays the role of regulator and that role is best served through legislation. All local laws need to take its cue from national government. An important point raised is that government often says one thing, but does something else. When the legislation does not match the objectives, the objectives will not be achieved.

"I suppose a key component is government. So, government as a regulator, for putting in enabling legislation, that helps the different components and the local, provincial not so much" (Interview Respondent I6).

"Naturally, there's compliance with national law. EThekwini has to be subservient to what national law directives are in place. National law should be subservient to global law. An example of that is the ratification of the COP21 agreement" (Interview Respondent I7).

Policy: it did seem like some of the respondents were using the terms 'legislation' and 'policy' interchangeably, but they are two very different types of documents. Policy is most relevant to government officials and acts as a guide to direct the manner in which strategies and legislation will be implemented. It has emerged that without policies, government officials are reluctant to implement or undertake anything. This will then lead to a situation where the private sector will largely continue implementing a specific intervention, which would lead to an unregulated sector.

"In terms of policy in place, I don't think we have policy for the green economy. A good example, we are also promoting moving from coal to renewable energy, but we do not have a policy or strategy on how to transition" (Interview Respondent I14).

"The second 'P' is around policy, so it could be the policy insofar as how the city procures products, a policy on buildings and introduction of energy efficient design and components, so everything around policy. The policy could be around how the city views future development, policy around the way we purchase vehicles and energy efficiency, so that's the second 'P'" (Interview Respondent I3).

Enforcement: while legislation, bylaws and regulations have been mentioned, the respondents gave due consideration to the manner in which those aspects are enforced. It was highlighted that enforcement is lacking and non-compliance by people and organisations is due to this lack of enforcement of legislation and regulations by the authorities.

"So, there is a role for government to do the 'policing' aspect" (Interview Respondent I6).

"Enforcement, you have to bring in a level of enforcement if you set a level of criteria. Only electric vehicles will be accepted into the inner city, there must be enforcement to ensure that is what is happening" (Interview Respondent I15).

Incentives: can be thought of in either constructive or compliance terms. Compliance incentives can border on a destructive path at times. Constructive incentives refer to spurring behaviour of people or organisations. This can be in terms of providing financial incentives or direct rebates, when procuring and installing certain types of green technologies. Carbon tax can be seen both as a positive and negative incentive. Government will have more funds to allocate to green projects and for further incentives. The tax will act as an additional cost to organisations, forcing companies to either pay the tax or invest heavily to reduce their GHG emissions. Nevertheless, incentives were frequently mentioned.

"Incentives, it is unfortunately human society, they do not do things unless they have to, or get something out of it" (Interview Respondent I4).

"Right now people mainly want financial incentives, they are not interested in the 'noddy badge' and being green. It doesn't mean anything to them" (Interview Respondent I4).

Energy: the participants raised two primary components within the energy sector, which includes energy efficiency and renewable energy. The first aspect is the projects that the Municipality is actually implementing, a lot of it is on Municipal owned facilities. From a theoretical perspective, these projects should decrease operating cost to the Municipality and act as proof of concept. This would also stimulate local businesses that manufacture, supply and install those technologies. The second is a more strategic and catalytic function that the Municipality should play in driving and bringing about change in the larger community. The second aspect would be a natural follow from the first aspect.

"The energy efficiency and renewable energy sector" (Interview Respondent I10).

"The Municipality itself has already embraced some green economy principles" (Interview Respondent I13).

"I also see a cluster emerging, sometimes driven by government …" (Interview Respondent I3).

Waste and recycling: a very similar picture emerged as for the energy component in the government sector. The Municipality owns the majority of the bulk waste infrastructure in the EMA. As a result, eThekwini Municipality's Durban Solid Waste Unit will have to play a big role in adapting the infrastructure to a more sustainable format.

"You have within the City, initiatives that look at how waste will contribute to the economy and take away the burden on the landfills but create a whole new industry, which uses waste as a resource" (Interview Respondent I1).

"The recycling, re-use, re-purposing and waste benefaction component. The key characteristic of that component is one man's trash is another man's treasure, but I think a key characteristic is that it is potentially a low cost input, a low cost element theoretically" (Interview Respondent I5).

Water: from an infrastructure point of view, there is efficiency that needs to be achieved, consumption of less water and more recycling of water. It was also raised that water can be a good resource to generate renewable energy from.

"Obviously, let us take them again. If you look at infrastructure, those are the guys! Water, engineering, electricity and waste. They all play key roles in environmental impacts" (Interview Respondent I15).

"I know that at some point, with the recent water issues, we need to have JoJo tanks in our houses. It is an element that would push a particular industry, where people are looking at alternative ways of saving water or using water sustainably, it is a particular industry that could be refined" (Interview Respondent I1).

In summary, the government sector has come across as being critical for the development and stimulation of the eThekwini green economy. There were components raised by the interviewees that have a place in both the private and government sectors. These sectors would have key nuances for the same components. According to interviewees, a key role that government, at all levels, should play is to ensure that there is a conducive legislative and regulatory environment. A further step on from legislation and regulations is to ensure that appropriate policy is developed for the eThekwini Municipality's officials. This is to ensure that government officials have a very clear and authorised manner in which they can stimulate the green economy. However, this would likely not be one policy, but a collection of policies due to the large number of different Municipal Units and functions that are relevant for the eThekwini green economy. It was noted that there is currently some legislation and regulation, but enforcement leaves a lot to be desired. Various interviewees advocated for the provision of incentives, predominately financial. This is needed to offset the higher costs that green goods and services carry. Energy, which was also raised for the private sector, comprises two elements, renewable and energy efficiency. Waste and recycling, also mentioned as part of the private sector, is predominately a function of government. The bulk of such infrastructure, especially for waste collection and landfills, is owned by government. Water provision, apart from being a scarce resource, also carries an inherent energy cost for every litre consumed. Government largely owns the bulk water infrastructure.

5.2.2.2.4 International sector

The international sector comprises of broader agreements and positions that take place on international platforms, such as the Paris Agreement. It has a huge bearing on what happens in South Africa. This is due to the involvement of the South African national government in those deliberations and submission of national plans of actions. That national position eventually filters down to local government and has a knock-on effect on legislation and policy. This ultimately drives change in the broader community and business sectors. It was reiterated that companies with a direct international link, such as large multi-nationals, have already begun their green journey. This journey is even undertaken when the actual interventions are not feasible. It was highlighted that this can be seen as a rather pro-active approach by these companies, who are driven by moral or brand positioning considerations rather than immediate financial gain. The expertise that is held internationally was raised by participants and that for certain projects, which takes place in South Africa, fully locally-owned companies do not play a significant part. This highlights the importance for accelerated training and development of local people and transfer of skills.

"So, we have the international climate change agreement, we have South Africa's national environmental contributions which are a part of it" (Interview Respondent I10).

"It is easier for international companies to change their model of operations or pick up on the principles of sustainability and green their activities" (Interview Respondent I1).

"The ability to raise capital, intellectual capacity and research and development are unquestionably enhanced at the international level. Led by the international entity, the local private sector might at best be equal partners but most often junior partners" (Interview Respondent I5).

5.2.2.3 Characteristics

This section discusses the characteristics that were highlighted by interviewees of key components of the eThekwini green. It should be noted that in the discussions on components and leverage points of the eThekwini green economy a number of characteristics will also be alluded to. All of the characteristics will be synthesised

during the discussion, which will be contained in chapter six. Characteristics should be read and conceptualised as elements of components.

5.2.2.3.1 Financial

A viable source of funding is critical for projects within the green economy. Various sources of funding were highlighted, which included government, private funds, investment vehicles, special renewable electricity feed-in tariffs and banks. The second financial aspect that was raised is that investment will only be undertaken if the specific project is bankable. However, this statement needs to be accompanied with a disclaimer because, at times, both private and government organisations do undertake certain initiatives that are not bankable but have other primary objectives, such as Corporate Social Investment initiatives.

"I think you need a financial source, whether it is budgeting side, political leaders voting on budgets from Municipal budgets or private sector doing Corporate Social Investment" (Interview Respondent I10).

"Investment and finance instruments, your off-takers, your ReFit, and Feed-in tariffs" (Interview Respondent I12).

"We have seen large corporates making investments into the green sector for reasons other than financial" (Interview Respondent I16).

5.2.2.3.2 Benefits

The benefits derived from the green economy and value that emphasis is placed on, is different for each component. The private sector is largely driven by profit. If there is an opportunity for green initiatives to deliver better profits, the initiatives will be pursued. When the private sector undertakes green initiatives for Corporate Social Investment and branding purpose, the intended outcome of those activities are noble. However, in most cases those specific initiatives would have been identified to deliver value to the company indirectly or over a period of time. The government sector is concerned about the populace and will undertake projects that will ensure that the best average decision is taken, i.e. a triangulation of sustainability and socio-economic considerations. A small percentage of organisations, individuals or households actually undertake these green initiatives due to their conscience. Affordability of technologies plays a big role, particularly since the price of green technologies is at a

premium over traditional equivalents and as a result the majority of the population are not able to procure certain levels of green technologies and services.

"So there is still profitability at the end of the day, while they are not getting money they are still able to function as a company or business and keep the ball rolling. The incentive is to keep the business running as opposed to getting money back or an incentive" (Interview Respondent I4).

"We have seen globally, big companies that have embraced green economy principles and improved profits because they are reducing their baseline costs on a whole number of areas and in that show better profits" (Interview Respondent I13).

5.2.2.3.3 Dependency

The vast majority of the respondents hold the view that all components are dependent on each other. However, the details of dependency have not been fully established. The respondents highlighted that certain components would be directly dependent on some components and indirectly dependent on other components. The important finding here is that no component in the eThekwini green economy can sustainably operate in isolation. Some of the dependency is a natural dependency, where regulatory aspects would feed into practices of local government and businesses. In other instances, very specific processes can actually feed into each other. While there is this high level of dependency within the eThekwini green economy, there are also strong links to the international context. This has an effect on national government and then to the local level. However, in certain instances eThekwini Municipality has gotten involved in international level activities and currently maintains those linkages. This means that while eThekwini Municipality would eventually be affected by national stances that come from international initiatives, eThekwini Municipality would have already started to undertake a lot of what is required due to the direct international linkage.

"They definitely do. Some of them are synergistic and some are antagonistic" (Interview Respondent I10).

"They interact closely with your retail sector, the retail sector then interacts with the manufacturing and other sectors. So, there are different roles for each of these" (Interview Respondent I6).

5.2.2.3.4 People

It was iterated, many times, that sufficient skills are needed for the eThekwini green economy to be stimulated. There was a concern, however, that within certain areas like renewable energy, availability of tertiary educational courses are scarce. In lieu of those specific courses, the next closest available qualification has to be relied upon and additional training provided. The base qualification and qualified individuals that would be necessary, such as engineers, are also in short supply. People, being end-users, will have an impact on the supply chain going green. In addition, people when negatively impacted, turn to activism to ensure that their rights are protected. The last element is that education and awareness levels amongst people need to be enhanced.

"So, I think funding and human capital are two of the characteristics that comes out of these components" (Interview Respondent I16).

"… so it's about people, it's about conscientising people. It's about energy efficiency, it's about everything related to how people can become better citizens of the world. So that's the people aspect, it's about outreach programmes and all those kinds of things" (Interview Respondent I3).

5.2.2.3.5 Decisions

The general consensus from the respondents' input is that decisions are based both on a strategic (proactive and non-random) approach and reactive (random) approach. The type of approach will depend on what the decision is and on what necessitates the decision. It seems like the default approach, is that a plan is created and followed. However, when a trigger materialises, then decisions are made in a reactive manner. If a trigger is an act of god then it will be reactive decisions. If the international agreement triggers are taken into account, then it will be a strategic and proactive approach to decisions. While in some instances decisions are taken strategically, they often fail to plan for a longer-term. The input provided by respondents seems to lean towards being appropriate for government, large organisations and small organisations only and not necessarily for the residential sector.

"I think it's a hybrid answer. Some of them are made strategically and some made randomly" (Interview Respondent I5).

"If there are no triggers then you fall into a planning approach, otherwise decisions are made randomly" (Interview Respondent I1).

"We don't have this ability to look at the thing that is still on the ground and see the potential when something is still in the pipeline" (Interview Respondent I14).

5.2.2.3.6 Quality of information

The availability of information when making decisions was raised as an important issue, frequently decisions are based on partial information. Having sub-standard information when making any type of decision, particularly proactive decisions, can have negative consequences directly on the initiative and also pose knock-on and indirect negative consequences to broader stakeholders.

"I think the quality of the information feeding into those decisions is not always the best. So, while people are trying to be strategic they may not be fully understanding of all of the practical requirements of the people on the end of the value chain" (Interview Respondent I5).

"There is the risk of a silo approach, especially between the government and private sector and other institutions. So, there is the potential to miss information, that's working purely independently, a better word is working on assumptions" (Interview Respondent I12).

5.2.2.3.7 Time

The underlying finding is that in the majority of instances there will be a substantial time lag. This includes government, the private sector and research institutions. The private sector will operate quicker than government. However, it was observed that within specific sectors the time lag can be a lot shorter. Importantly, the time lag seems to be a function of three main aspects, which are: size of organisation, financial value involved and impacts. It should be noted that there is no guarantee that there will be a time lag. If the right conditions are not present the action or intervention might not materialise at all. 'Quick' seems to be anything under three years and includes policy formulation. It should be noted that 'long' on the other hand was considered to be between four to ten years.

"There is a time lag. By shear nature of dependencies" (Interview Respondent I10).

"Unfortunately, I am with the government, with the private sector the general response is quick but with the government it is very slow" (Interview Respondent I2).

"I would say inside a cluster it can probably happen a lot quicker but between clusters and between components it would be longer" (Interview Respondent I4).

"So, I think those are the three areas we need to look at, having stimuli to affect the financial needs of a person, the quality of life of a person and just to be able to speak to a person directly. So, if you are talking about something, or if the stimuli is able to talk to me directly, then the time lag can be quite short. Anything other than those three, I think the time lag is then long and may sometimes never happen" (Interview Respondent I16).

"That time lag can be up to ten years if it is not an economically feasible thing for someone. It may never even take off, if the price or technology is too high or the repayment period is too great" (Interview Respondent I9).

"Some of these things can be done quick, others will take time. If you look at policy, to design a policy now around this whole thing, I think it can take us anything from two to three years" (Interview Respondent I15).

5.2.2.3.8 Buy-in

There still seems to be unwillingness on the part of critical stakeholders to promote elements of the entire eThekwini green economy. The situation is still 'business as usual' for the majority of the stakeholders in the eThekwini green economy.

"My concern when you say describe the green economy, I don't think that it has been fully embraced, there is a long way to go" (Interview Respondent I13).

"Then there is the Durban Business Chamber. To tell you the truth, I don't think everybody is on-board. People are not paying attention to social responsibilities" (Interview Respondent I14).

"The green economy sector is vibrant intellectually, it hasn't trickled down to the man on the street" (Interview Respondent I2).

5.2.2.3.9 Motivation

It has emerged that a lot of the activities are being undertaken by organisations, not because it is the right thing to do in terms of sustainability, but because of an anticipated financial payoff. The same seems to apply to individual consumers. However, there are people that are undertaking sustainability interventions for ethical reasons, a small percentage though.

"They do have high level plans in place to meet certain green targets, whether it is driven by the financial reasoning, whether it is driven by the need to be green – I actually don't know" (Interview Respondent I16).

"While it seems like the person is investing in the green economy I actually think that this person is investing in the business model and has the spin-off of saying it is now green" (Interview Respondent I16).

"Right now people mainly want financial incentives, they are not interested in the 'noddy badge' and being green, it doesn't mean anything to them" (Interview Respondent I4).

"Environmental side, people are doing it for different reasons, obviously people are doing it for green imaging" (Interview Respondent I8).

5.2.2.3.10 Summary of characteristics

The key characteristics highlighted by interviewees are as follows: the bankability of projects and initiatives will impact the outcome of projects, in addition to source of funding. Green economy related initiatives are undertaken by various stakeholders but is motivated by specific benefits that they will derive, these include: reduction of costs, increased profitability, Corporate Social Initiative considerations and environmental consciousness. All components do not operate in isolation and do definitely interact with other components of the eThekwini green economy. Regarding people, not as consumers undertaking initiatives but as labour, the availability of required skills levels are critical to the functioning of various stakeholders. Decisions made by stakeholders seem to be made either in a proactive or reactive manner, triggers can initiate both types of decisions with planned considerations predominately directing proactive decisions. Triggers can be conceptualised as essentially anything that would have a catalytic impact, positive or

negative, on the green economy, such as a severe storm or international agreement. Quality of information is seen as crucial for effective and efficient operations within the eThekwini green economy, mainly so that informed decisions can be made. Interestingly, the time taken for components to respond to stimuli varies drastically and seems to be a function of three aspects. Due to a plethora of stakeholders, buy-in of stakeholders is vital for the success of the eThekwini green economy, as each component has to play their unique role. Lastly, it was noted that each component operates according to different motives, for example business predominately exists for generating profit.

5.2.2.4 Drivers of going green

The drivers that have emerged from the interviews are essentially some of the components of the eThekwini green economy that have the ability to spur on the growth of the eThekwini green economy, in a catalytic manner. The drivers have been also been referred to as 'leverage points' in this research.

5.2.2.4.1 Communities

Ultimately, we all belong to communities, as in residents of a specific locality. This driver highlights the potent force of environmental and social activism that can and does emerge from communities. Specific examples have been mentioned by respondents where extreme situations have driven communities to organise themselves for a common cause.

"The fact that you have activism around the health issues and how toxic waste, I mean in eThekwini you have the South Durban Basin where the amount of toxins that have been put into the air have mobilised the communities and consumers to not be just passive consumers to issues that affect their health and wellbeing" (Interview Respondent I1).

"The community is no longer throwing waste down, but they are collecting" (Interview Respondent I10).

5.2.2.4.2 Consumers

Consumer buyer behaviour and individual preference is also a factor for the eThekwini green economy. It acts as the pull in the value chain, to which manufacturers need to respond. Consumers do refer to individuals, but by definition

can also refer to organisations, business and government. This demand is a function of various factors, of an individual, such as education, awareness, health and income. An important aspect for driving the green economy seems to be affordability. As a result, higher discretionary incomes lead to better uptake of green technologies, which are generally more expensive. However, once people have a large enough discretionary income, then the increased price of more sustainable goods does not become a factor. As a result, per-capita GDP is critical for the stimulation of the eThekwini green economy. The demand of companies also have a few functions, these are discussed in a subsequent section.

"Consumers, for consumers to exercise choices is a big thing. That kind of thing drives demand in a particular direction. They have a big role to play" (Interview Respondent I6).

"Obviously government acts as a consumer as well; the private sector is also a consumer. As households and individuals, we are consumers" (Interview Respondent I6).

"… does do stuff in the energy space because of the consciousness that has developed" (Interview Respondent I7).

"The more the public becomes aware, they buy those products, it is no longer about the price, it is about fresh food" (Interview Respondent I2).

5.2.2.4.3 Workers

Workers are a key factor of production for the eThekwini green economy. However, the main driver is having the correct level of skills required for the green economy. It was noted that a lot of the required skills and qualifications are not currently available. As a result, there will be a huge demand for these skills going forward.

"There is no point in us becoming the photovoltaic centre of excellence for the country, because that is not going to be our skills set over here. We need to really focus on things that we have high volumes of" (Interview Respondent I7).

"They have been experimenting with quite good successes, again it is using local labour and generating jobs to maintain infrastructure or associated spaces which help to protect that infrastructure" (Interview Respondent I13).

5.2.2.4.4 Funding

Naturally, funding was highlighted as being a critical part of the green economy. This includes funding for large-scale projects from banks and investment for commercial ventures by the private sector. The ability of consumers to actually buy the goods and services also emerges from the interviews; as a result a populace that is wealthier is better able to procure green goods and services. It is important to note that this section is termed 'funding', but is intended to be inclusive of various types of funding, such as loans from banks, cash from project owners, ability of residents to afford procuring, investment from foreign and local businesses and various types of grants.

"If I am approached to test this, I will be given funding – then I will do it. Then, the question is – if the funding is gone will I continue?" (Interview Respondent I14).

"Banks provide funding for these green economy projects. These projects must be feasible. So, in that green economy space we also have some companies that have fully funded themselves in this sector …" (Interview Respondent I2).

"Financing will obviously play a role. Your bigger companies have their own finances, but for other people you need some sort of financing" (Interview Respondent I8).

5.2.2.4.5 Companies

Companies need to act as the backbone of the green economy. While they proceed with the adoption of green goods, services and processes to enhance their profitability and make their operations more efficient, they are also critical for actually providing the bulk of green services and goods.

"That's possibly been driven by a couple of different things, the interaction being led by businesses is one of them" (Interview Respondent I5).

"Business should also be driving this. We have seen globally big companies that have embraced green economy principles and realise improved profits because they are reducing their baseline costs on a whole number of areas" (Interview Respondent I13).

5.2.2.4.6 International sector

International linkages are generally seen to be a critical driver of the eThekwini green economy particularly with regards to international agreements that involve national governments. Companies that have an international linkage also seem to transition easier to green economy principles. In addition, a lot of the intellectual property is owned by international stakeholders.

"A lot of clusters that have an international relation, or an international branch, or some type of international influence, be it shareholders or some type of interaction with an international counterpart, you general find that they have a very structured approach, even though the form of a policy document in terms of dealing with green issues and how green must now tie into the economy" (Interview Respondent I16).

"The ability to raise capital, intellectual capacity and research and development are unquestionably enhanced at the international level. Led by the international entity, the local private sector might at best be equal partners but most often junior partners. The flow is from international to local, from a technology and research and development perspective, in the main – we might have one or two exceptions" (Interview Respondent I5).

5.2.2.4.7 Government

It was observed during the interviews that the respondents only view national and local government as being important for the eThekwini green economy. National government is mainly responsible for some regulations, strategic direction and legislation, while local government is tasked with the actual implementation, delivery of those services, policies and also some regulation. EThekwini Municipality has a lot of power due to being a well-resourced Metropolitan Municipality and ability to enact bylaws. Local government nevertheless has to work within the confines of what is set by national government.

"These are some of the things that needs to be unpacked. I think that government has a huge part to play" (Interview Respondent I9).

"EThekwini is conscious, and you can only do that through legislation – the need to regulate these things" (Interview Respondent I1).

"I suppose a key component is government. So, government as a regulator, for putting in enabling legislation, that helps the different components and the local, provincial not so much" (Interview Respondent I6).

5.2.2.4.8 Triggers

This component can actually overlap with various other types of components. For example, while incentives can be identified as a stand-alone component, it also can act as a stimuli or trigger for other components' action. Many of the triggers can be financial. Legislation can also act as a trigger. The manner in which a trigger is differentiated from normal components is important. Triggers would be a once-off, ad-hoc situation or initiative that is either planned (short-term incentive) or unplanned (load shedding or sever storm) that happens within the eThekwini green economy, or larger government structure or environment. In addition, international level initiatives that flow top-down also acts as a trigger. Lastly, acts of god or environmental disasters that can be linked to climate change or have the same negative consequences would definitely be classified as a trigger that would stimulate the eThekwini green economy, either directly or indirectly. There also seems to be an element of varying lengths of time of triggers; some triggers will result in almost instantaneous impacts, for example a climate change induced storm will result in immediate negative outcomes, while other triggers will often unfold much slower, such as certain types of legislation.

"Like I was just saying, load shedding was a stimuli. People started paying attention. Drought was a stimuli for people to start paying attention" (Interview Respondent I14).

"Your energy shortages, load shedding, as well as your water issues are kind of playing a positive role as well" (Interview Respondent I6).

5.2.2.4.9 Summary of green drivers

In a way, all components due to the interconnectedness play a driving or critical role in the eThekwini green economy. However, there have been specific components highlighted that act as leverage points with the eThekwini green economy that have the ability to either exponentially stimulate the green economy or severely inhibit its growth. It should be noted that the components are highlighted, not in general, but for very specific roles that the components plays. When communities start organising

themselves against or for a cause it acts as a potent force, especially if human rights are being infringed upon. Consumers are not limited to individuals but also include organisations and is probably better termed as end-users, which have the ability to demand and pull an economy towards green goods and services. Ultimately, if there is no demand, the market will have no incentive to produce. The availability of an able workforce to meaningfully contribute to the green economy, especially with regards to the technical aspects is critical. Access to viable funding is another leverage point, without which even the best idea is likely to fail. There were various funding sources highlighted but are aggregated under the term funding. While end-users create demand, companies are ultimately responsible for producing the services or goods that will satisfy that demand. In certain instances, companies will also be consumers of green services and goods. Government has been highlighted as another critical piece of the puzzle, for government's role is to create an enabling environment within which the eThekwini green economy can be stimulated. Triggers are an interesting component that emerged from the interviewees. Essentially, they are macro events that occur which have the ability to spur on the green agenda and as a result the green economy. The term 'triggers' is an all-encompassing term that includes man-made, natural, short-term and long-term stimuli.

5.2.2.5 Indicators of the health of the green economy

The indicators mentioned by the respondents do not focus only on financial elements but include a broader range of aspects that have significance for the eThekwini green economy. There were both quantitative and qualitative indicators that respondents have mentioned. The measurement of some of the qualitative aspects will pose certain challenges. Aspects linked directly to both climate change mitigation and adaptation were mentioned, in addition to international level objectives. Monitoring human development investment and broader adoption rates rounded off all the indicators that were highlighted.

The single best manner in which to monitor the aggregated health of the entire green economy is to measure the green economy's contribution to GDP, or Gross Value Added (GVA). The emergence of this indicator was to be expected. Financial value of the green economy would provide a generic holistic picture of the size of the eThekwini green economy. This would then allow us to determine the potential for growth.

"Economic indicators, we can say just very broadly – percentage contribution to GDP, that will tell you whether it is growing or not" (Interview Respondent I6).

"We would say that you want a situation from an economic perspective where you have growth" (Interview Respondent I1).

Some respondents highlighted the importance of tracking the number of new green companies. This would be one of the indicators that will contribute to the interpretation of aggregated eThekwini green economy indicators, such as GDP. This was also slightly expanded to specifically mention manufacturing companies. There would be a need to measure and monitor the manufacturing companies in the EMA.

"An indication would be a solid base with regards to manufacturing companies in the green space being sustainable" (Interview Respondent I1).

The actual financial value that would be invested into the green economy was another critical element mentioned. From respondents inputs that has given rise to previous themes, the invested amount will need to be disaggregated into the government and private sector investments. In addition, sector specific investment should also be defined. It does emerge that there is a need to further stipulate if the investments are for actual installation of technologies and implementation of such programmes, or if the investment is more strategic in nature, such as for manufacturing facilities, which would have far more benefits for the eThekwini green economy.

"A good indication of where we are is to look at the investments, if possible, through some type of means – for indicators that are related to investments in the green sector" (Interview Respondent I16).

"You can also look at the financial institutions, how much money they put in for renewable projects, how much they have loaned for renewable projects" (Interview Respondent I4).

Various examples for existing projects were highlighted. It was suggested that all green projects be monitored. These include all new and existing projects. Respondents also mentioned that the monitoring of projects should include number, type and benefits delivered.

"So, I think one of the easy ways that you could look at it as well, is the number of projects" (Interview Respondent I8).

"It could be number of projects implemented. Upgrades to certain areas, uShaka Marine is now putting a photovoltaic system on their roof – that's an improvement" (Interview Respondent I4).

A rather qualitative aspect, which the respondents mentioned that should be monitored is the degree of integration of sectors. Multiple examples were cited of initiatives being undertaken in one sector that have positive impacts in another sector. It also emerged that interdependence exists between numerous components. However, while there is a level of independence, resilience of other components to the loss of one component is important. It seems like a systems approach was being subtly and subconsciously advocated for.

"How will we know for starters, when we are still working in silos, on what is working out there, when we cannot collate the information, when we are not connected to the business sector. That is one gap for us to assess, in terms of what is happening out there. Maybe the indicator there is the connectivity" (Interview Respondent I14).

"While it is better that they all work with each other and integrate with each other, I think that is a good indicator as well – how components integrate with each other, if you do move one component, you don't lose the green economy because you have other components that are able to stand up and continue" (Interview Respondent I10).

The notion that a carbon credit is a valuable tool for monitoring the health of the green economy did emerge. This is in line with the previous findings, that legislation is key to growing the green economy and the carbon tax would form a key part of legislation. It also aligns to the dire need of incentives to drive the green economy. While this is an excellent method, it is mainly appropriate for larger organisations and projects but would not necessarily capture all activity in the market.

"One part that does play into that, is the carbon programme – both the international carbon credits and the South African carbon tax, when we were trading the carbon credits for eThekwini, there was definitely a revenue stream that came into the

community and the skills development that came into the community" (Interview Respondent I7).

"I think you can also look at other projects, in terms of carbon credits that we have certified, all carbon credits have to be certified before they can be sold" (Interview Respondent I8).

Net value that is created from the green economy needs to be tracked, according to respondents. This does not only include first value, for example, recycling, but also the benefits that accompany it like cleaner streets, which will be better for tourism. It will be advantageous to develop an indicator that can directly calculate this.

"The value that they are getting out of it" (Interview Respondent I10).

"Economic indicators, we can say just very broadly – percentage contribution to GDP, that will tell you whether it is growing or not. It is more than that. I think employment would be another indicator, number of people employed in the green industry. I would say the amount, so you can break it down per sector, let's say on the energy side, the amount of energy consumed locally that is generated from a renewable source. We might not be generating all of it here, but the amount of energy that we consume that is generated using renewable methods. So, you can say the value or the volume of waste that is diverted from landfills" (Interview Respondent I6).

"Whether it is able to tell us if we are healthy or not, I don't know, but I think it is able to tell us that there is a greater investment, both from a financial, as well as a human capital perspective" (Interview Respondent I16).

While the SDGs were mentioned by only one respondent, there is a lot of sense and value in adopting some of the indicators of the SDGs, not all would be completely appropriate for local government contexts though. This will also allow for integration of reporting local level information into national and international platforms. There will however, be a need to develop tailored, supporting indicators to take into account our local nuances and allow better collection of disaggregated data.

"For me, we have got particular road maps that we need to be making progress on, so we have got things like the SDGs that have been hammered out. Internationally, I

think that a lot of very good thinking has been put into that" (Interview Respondent I13).

Current progress towards achieving GHG emissions reduction targets was highlighted multiple times. It is important that these targets be disaggregated to regions, sectors and eventually individual facilities. This is already being tracked by the eThekwini Municipality, at an aggregated level. If the GHG emissions inventory process is going to have any meaningful impact as a management tool, it needs to further incorporate disaggregated data and be published more widely.

"Obviously, the one is emissions" (Interview Respondent I15).

"So, you might also want to break it down into different critical zones" (Interview Respondent I6).

"For me, it is about full resource optimisation management. I am very encouraged to see that there are a lot of water activities happening in the city. There are a lot of people without, but there's a lot of infrastructure development taking place. I think if one can measure energy consumption and you can measure emissions related to that and your carbon footprint, a nice way to do that is to have an online tool or some structures with measurement criteria" (Interview Respondent I7).

Resilience to impacts are important, which can be achieved if many sectors are developed and are collaborating and in support of each other.

"... if you have green economy projects, with water, solid waste, biodiversity management, mitigation, renewable energies, if you can stimulate green economy in all those sectors, to me you will have a much more resilient green economy to shocks that might happen" (Interview Respondent I10).

"Then, I suppose that is not an indication directly of the green economy, its more indirect. I'm thinking about critical areas, where you have problems, where you need to bring about change. There could be all kinds of measures" (Interview Respondent I6).

There were two primary aspects with regards to human capital. The first was the actual number of people that are employed in the eThekwini green economy. It would be prudent to calculate what the actual potential would be for the green economy and

utilise that figure as a benchmark to juxtapose the actual number of people employed. The second aspect involves the amount of finances that are utilised to develop the actual human capital in the sector. This would make sense, as most of the sector requires high skills sets. There are existing mechanisms that can be piggybacked-off to calculate these figures.

"I think employment would be another indicator, number of people employed in the green economy" (Interview Respondent I6).

"We have thousands of people, our unemployment level is so high – so people are there. We need to bring those people in, they are looking for jobs, give them the necessary skills and let them work" (Interview Respondent I9).

Awareness levels of citizens are important. This is a critical indicator, which will also have a bearing on the strategies and policies that government will take, in addition to businesses' approach.

"As well as the awareness, people – how aware are they now as compared to when we started engaging in renewable energy, maybe five or six years ago" (Interview Respondent I12).

"I think what we need to do, part of the goal is for us to become a little more conscious of the broader green economy, we need to map it out a little more intelligently, we need to then do some baseline studies and then manage it" (Interview Respondent I3).

The adoption rates of the various levels of technologies and more broadly, into the green economy have also emerged.

"Number of up takers, number of people that are tapping into the green industry, as in customers" (Interview Respondent I9).

"I am sure you can have something around the number of people, number of households that are doing rainwater harvesting, on-site energy …" (Interview Respondent I6).

Respondents raised a number of indicators that could serve as a viable means to monitor the health of the eThekwini green economy. In terms of financial elements,

the green economy contribution to the broader eThekwini economy GDP was seen as a good way to determine the health of the green economy at an aggregated level. To supplement that figure, the actual financial contribution should also be monitored. The total value created by the eThekwini green economy should then be monitored and measured. This would possibly include elements such as financial savings that result from investment in green technologies. Monitoring the amount of carbon credits traded and carbon tax paid are other good indicators, albeit for larger organisations. Moving away from purely financial indicators, it was also mentioned that the number of companies and new companies that participate in the eThekwini green economy should be constantly monitored. This is in addition to specific large scale or catalytic projects. A qualitative element that was highlighted as being important is the degree of integration amongst sub-sectors of the eThekwini green economy. The SDGs, while not frequently mentioned during the interviews, can provide a good platform from which to develop indicators for the eThekwini green economy. Naturally, interviewees stressed the importance of measuring GHGs and progress towards meeting GHG emissions reduction targets. On the flip side of emissions monitoring, it also emerged that monitoring resilience of the economy is equally important. The total number of people employed in the eThekwini green economy is seen as an important element. From an end-user and individual perspective, the current awareness levels of residents of green economy principles are seen as important, in addition to adoption rates of relevant technologies.

5.2.2.6 Challenges

This section presents the challenges that were highlighted during the interview sessions.

5.2.2.6.1 Lack of direction

The eThekwini green economy seems to be plagued by a lack of communication and interaction amongst its various stakeholders. The resulting lack of purpose and direction is further exacerbated by lack of enabling legislation and policies. This then results in demand that cannot be satisfied by business because of the potential legality of interventions. It has been observed that there is somewhat of a misalignment between the direction that government wants to pursue and market demand.

"... there just seems to be confusion on how this needs to unfold ..." (Interview Respondent I16).

"In the renewable sector, the customers are pushing on our door, we are then pushing on the regulator and then the regulator is dragging their feet and trying to come up with something to feed back to us, to feed back to the customer" (Interview Respondent I8).

5.2.2.6.2 Legislation

There seems to be a notion that the governance of the green economy needs a lot of work, this is in terms of using legislation and policy to actually create a conducive environment for the development of the eThekwini green economy. However, there was also a contradictory minority view, that there is too much regulation. It was observed, that when legislation or policy was being referred to, specifically with regard to the energy sector, the current legislation and policy seems to be not enabling or non-existent.

"I believe there is still a long way to go in regulating the environment in a way such that each and every company that comes through follows a pattern that leads us to a much more greener economy" (Interview Respondent I1).

"On the renewable side, you have nothing on the small-scale side that is cast in stone at the moment, whether new regulations has come up and it has covered the issues adequately, things like that" (Interview Respondent I8).

5.2.2.6.3 Poor implementation

This is specifically related to local government operations. There is difficulty being experienced with translating strategy into implementation and enforcement. A key reason for this is the lack of enabling policy.

"In terms of the level of implementation, I think we are a little bit behind in that space. I know we have been threatening to change the building regulations, but I do not think that has happened" (Interview Respondent I3).

"A good example, we are also promoting moving from coal to renewable energy, but we do not have a policy or strategy on how to transition" (Interview Respondent I14).

5.2.2.6.4 Accessing funding

A huge problem for small business is access to finance. They often have to forego green principles in order to survive. This is compounded because financial investment into the bulk of sustainable goods and services only starts to pay itself back after a prolonged period of time.

"The guy might say "great, we have the money, let's do it, because we can see the benefit and we know that within five years we will be reaping the benefit". If the money is not available, they might say sorry go ahead but cut out all of that stuff, our budget is this tops, just build the structure and we will figure it out from there. So, funding is a big one" (Interview Respondent I13).

"Some of these guys, they couldn't answer the question; they said "you can only have up to R 150,000". So I said, "you are telling me, as a business with a banking account with you I cannot have access to funding?" …" (Interview Respondent I4).

5.2.2.6.5 Government revenue

A big challenge for government, in particular local government, is that with the promotion of sustainability there is an anticipated decrease in revenue from sale of electricity. This would have a negative impact on financial resources that will be available for the maintenance of the electrical grid by the eThekwini Municipality.

"We also have a conundrum in terms of the financial components of the green economy. If the city invests in promoting the green economy, it reduces the revenue stream, within the city as an organisation" (Interview Respondent I7).

"You must remember if government loses control of electricity generation, they have lost a huge revenue stream coming in – they've lost control and opened it up to the market" (Interview Respondent I9).

5.2.2.6.6 Cost

Closely linked to accessing funding is the cost of interventions. The participants are generally of the opinion that larger organisations are less impacted by cost than smaller organisations. As a result, larger organisations will inherently find it easier to adopt green economy goods, services and principles.

"My sense is that those are very big companies that have got money to invest upfront. I don't know if the small companies have got the drive to invest money upfront to do that" (Interview Respondent I13).

"The technology is expensive, but the more it is used across the board it will become cheaper and cheaper, economies of scale will direct the market price" (Interview Respondent I2).

5.2.2.6.7 Affordability

Individuals that have funding in excess of their requirements often have more choice than individuals that have just enough money to get by. Similarly, the situation is present in the business sector, i.e. business that do not have high levels of disposable income will not be as able to participate in the green economy as business that have a higher income earning potential.

"The poorer communities want the cheapest products, whereas your wealthier households can afford to choose. Green products are often more expensive" (Interview Respondent I6).

"Unfortunately, it kills us all because it becomes unaffordable. I don't know, if you look at the solar geyser, it does very well. My problem is the price. I haven't found it cheaper, there is no way I will buy a solar geyser over an electrical geyser at the moment" (Interview Respondent I14).

5.2.2.6.8 Lack of knowledge

Stakeholders that are involved in the green economy seem to have knowledge around specific sectors. Most of the stakeholders lack understanding and knowledge of the broader green economy and climate change issues.

"I think it was, in developing the Durban Climate Change Strategy we found a similar sort of thing where there was quite a lot of stakeholders that had some climate change knowledge about a specific sector but there was very few stakeholders that had a broad range of climate change knowledge. That was quite difficult in kind of planning the strategy" (Interview Respondent I10).

"... we have people who obviously have a bit of knowledge but the smaller guys they don't" (Interview Respondent I8).

5.2.2.6.9 Skilled people

The availability of suitably qualified technical people to actually implement projects or maintain projects remain a challenge. Even when expertise is developed in the green economy, it seems to remain clustered and owned by a few without empowerment of other stakeholders.

"I can speak on the technical front, we do not have enough technical people to run with these projects, to deploy, to analyse, to do research – it has always been a problem" (Interview Respondent I12).

"Small islands of expertise that are being developed but not always being developed into an economically feasible space" (Interview Respondent I7).

5.2.2.6.10 No immediate benefit

A fundamental challenge with the green economy is that immediate benefits to the consumer are not apparent. This long period for the realisation of benefits will act as an inhibitor for the uptake of sustainable behaviour and goods. It should, however, be noted that there are some quick benefits, within a limited number of aspects.

"My experience tells me that thirdly, there is no immediate benefit, remember green economy is about long term relationships between our existing environment and our desire to profit out of that" (Interview Respondent I2).

"Some of them in the sense that they take two or three years to pay itself back for the energy taken to build the system" (Interview Respondent I8).

5.2.2.6.11 Not pervasive

It was generally observed by the respondents that there are existing pockets that subscribed to the green economy but it is not pervasive and widely adopted.

"I think people are trying to embrace the green economy, like I said, I think we have these pockets" (Interview Respondent I13).

"If they are doing anything in climate change, it might just be a small part of the sector, as opposed to it being pervasive throughout the sector" (Interview Respondent I10).

5.2.2.6.12 Behaviour change

Widespread behaviour change by eThekwini stakeholders towards green economy principles is not going to happen organically. In most instances, a strong stimuli, or multiple stimuli are needed to bring about behaviour change. The stimuli includes incentives and situations that inconvenience individuals, such as electricity load shedding and the current drought situation.

"We need a stimuli. We need something for us to react and change our ways" (Interview Respondent I14).

"You see some changes in the agriculture sector, with the meat too – with water shortages, the sector is under a lot of pressure" (Interview Respondent I6).

5.2.2.6.13 Market and demand

According to the respondents, current demand for green economy goods and services is coming from larger companies and organisations that have an international exposure. Newer companies are focused on establishing themselves, rather than on outlaying additional funds for green technologies. This was taken further by some respondents who stated, newer firms have to think primarily about survival. From a demand perspective, a number of respondents mentioned that Durban residents largely cannot afford green technologies. However, that has not dissuaded residents' participation in the green economy, by procuring products and services that are within their financial reach.

"I do see things changing but you know that level of understanding, acceptance, adoption and implementation is not sufficiently penetrating below JSE listed corporates" (Interview Respondent I5).

"The older companies I would say are becoming more greener while the newer companies might not be as much, especially smaller industries where the first priority is to get their product out as fast as possible, the focus is on survival" (Interview Respondent I1).

"In terms of, particularly, with the smaller guys the issue is more on the bottom line. You will find a lot of those firms are just battling to survive" (Interview Respondent I6).

"One of our problems we have in Durban is inequality, that for the majority of Durbanites these sort of products would be unaffordable" (Interview Respondent I10).

"The end-user can be split into three different components in the residential space. We have the high earner, who can afford and does do stuff in the energy space because of the consciousness that has developed. We have the middle income earner that really doesn't have the affordability to implement the high end energy efficiency components and are forced to pay the bill. They are also seeing reduced disposable income coming out of that space. We have the energy poverty extreme …" (Interview Respondent I7).

This small demand in turn has implications for setting up manufacturing facilities in the EMA and the entire country. There would be no sizeable and viable market to sell the goods to.

"We have spoken to some of the guys from the bigger companies, inverter companies etc. and they were saying that the demand is not so big in South Africa for them to open up plants here" (Interview Respondent I8).

5.2.2.6.14 Silos

There was general consensus amongst respondents that the various stakeholders do not actively interact and do operate in a silo fashion. This is both within the eThekwini Municipality, as an organisation and between eThekwini Municipality and the private sector. This is perhaps compounded by distrust of government.

"There is the risk of a silo population, especially with government to private sector and institutions. So, there is the potential to miss information, that's working purely independently, a better word is working on assumptions" (Interview Respondent I12).

"Government drives it, there is always scepticism between private sector and government" (Interview Respondent I2).

5.2.2.6.15 No proper definition

It emerged that the respondents could not adequately describe, nor agree upon a definition of the eThekwini green economy. Due to people being unable to define it, they are often not aware that they are participating in the green economy because they

become so focused on their specific areas of expertise. If stakeholders are not even aware that they participate in the green economy, then there is no way that they can have any meaningful basis to stimulate it.

"It might not be as vibrantly defined as in other parts of the country" (Interview Respondent I1).

"In terms of the green economy, people are doing it and they are not even aware that they are doing it …" (Interview Respondent I14).

5.2.2.6.16 Lack of awareness

The inability of stakeholders to agree on a definition of the eThekwini green economy and acknowledge that they participate in it, is largely due to their awareness levels.

"The key characteristics of the public sector, whether you might call it conservatism or scepticism around the green economy displays levels of ignorance of the green economy" (Interview Respondent I5).

"In terms of the green economy, people are doing it and they are not even aware that they are doing it …" (Interview Respondent I14).

5.2.2.6.17 Negative perceptions

As with all other things, negativity does not bode well for the sector, particularly since consumers are ever ready to articulate bad experiences. At this stage of the development of the eThekwini green economy, negative publicity by word of mouth can be a deathblow.

"With that as well, word of mouth is important and recommendations. If someone sees a successful project then they will tell all their friends and then the converse is true. Then they will say energy efficiency is a waste of time and a scam. If people have a bad experience they will tell ten people. If it is a good experience they will tell two. Unfortunately the same applies to the green economy" (Interview Respondent I4).

"… the perception is that green cannot be seen. It is this theoretical thing that tends to come out and we can't always see it" (Interview Respondent I16).

5.2.2.6.18 Poor indicators and monitoring

Many respondents alluded to the concern that the monitoring of the eThekwini green economy is not adequate. As a result, properly monitoring the benefits that are derived from the eThekwini green economy is not being undertaken. In addition, if targets are set in the green economy, it will not be possible to determine if those targets are being met, without active monitoring.

"It is hard to try and quantify at this stage, often we look at short term cost and benefit and very narrowly define range of benefits" (Interview Respondent I10).

"We have no information to do this assessment, whether it is growing or not. If we are not supporting anybody to start these businesses, how are we going to know if it has failed or not" (Interview Respondent I14).

5.2.2.6.19 Summary of challenges

Interviewees were eager to highlight challenges that inhibit the development of the eThekwini green economy. A fundamental problem with the eThekwini green economy is there seems to be no widely agreed on or adopted definition of what a green economy is. As a result, there seems to be a general lack of direction from government. This results in a situation where legislation and regulations are not developed in a manner that is conducive for stimulating the green economy. Generally, the cost of green services or goods come at a premium over traditional goods and this premium inhibits its uptake. The lack of availability of accessible funding then creates a huge challenge for implementation. Linked to the position that there is no proper definition of the eThekwini green economy is the current lack of awareness amongst stakeholders. Many interviewees highlighted that the lack of knowledge and skills required for the provision of services and manufacture of goods is a huge problem within the EMA. Time taken to get things done, could in instances, be excessive and will only be pursued if the benefits are sizeable. The motivation with which the green economy is pursued, by components, does not seem to be underscored by altruism but rather, ultimately, financial profits. Buy-in by various stakeholders remain a challenge, which can be linked to lack of awareness and education on matters of the green economy. Changing behaviour to more sustainable practices remains a challenge, particularly when the cost is higher and benefits are not immediate. This is further linked to a stagnated demand in the market for green

services and goods. The silo mentality seems to permeate throughout the economy. Often there are no synergies achieved between government and business in general. There was also concern that the eThekwini green economy is not being adequately measured and monitored.

5.2.2.7 Recommendations

This section presents the recommendations that interviewees provided in response to some of the challenges raised and general points that should be considered for stimulating the eThekwini green economy.

5.2.2.7.1 Top-down approach

According to respondents, the eThekwini green economy needs to be driven by a top-down approach. In other words, legislation needs to be supported by policies and strategies which are then expanded in plans and followed by implementation. This implies that national level initiatives play a big role. Without the correct legislation, no amount of bottom-up pushing is going to effectively stimulate the eThekwini green economy. It is important to note, this does not detract from the decentralised nature of the eThekwini green economy, but rather leans towards the importance of having a unifying legislative and policy framework.

"National policy and things like that, would direct what we do here. So, it is important for us to communicate with our city leaders and draw on the legislation and policies at national level that align with what we are saying and provides us with a mandate" (Interview Respondent I10).

"So, I think that we are going to need a top-down approach to meet those objectives. I think the target is 34% reduction by 2020, of global emissions. The only way to really achieve that is going to be through legislation, not through voluntary action. So, there's most certainly a legislation component. That has to be a drill down approach, to meet national objectives and objectives signed off or ratified by our government" (Interview Respondent I7).

5.2.2.7.2 Specific action plans

Specific action plans that translate all of the high level strategies and plans into a realistically implementable set of actions is critical. Once there is direction, investment can be sought and allocated.

"It is nice to say that this is what we want to do. How do we want these people to do it? We need to have a clear implementation plan that details each aspect of what the community of eThekwini needs to do" (Interview Respondent I16).

"So, the plan determines whether we need to do any research, the plan determines whether we have sufficient resources and are we going to up-skill or do we need to engage in partnerships like we engaged with Bremen. The plan talks to these aspects" (Interview Respondent I12).

5.2.2.7.3 Effective implementation

The ability to effectively implement projects needs to be further developed. Robust planning should, however, precede that. It is important to highlight that this is primarily focused on local government, eThekwini Municipality. To a lesser extent, there was also mention of the private sector.

"Everyone is sitting in a gap at the moment, they need to get to the implementation side" (Interview Respondent I4).

"So, one clear-cut policy or strategy that is tangible to the city. So, not some airy, fairy stuff that we see other countries doing, something that is tangible to the city at a strategy or policy level. That is the first thing that I would ask for. Then I would ask the genie to use the second wish to clearly map out how we translate the policy into implementation plans for the city" (Interview Respondent I16).

"If you look at the industry, as I said we are an entrepreneurial nation, lots of good ideas come out there. If you get into a room and you brainstorm, people are throwing ideas, but we need to actually pursue those ideas in an environment like a University research facility" (Interview Respondent I9).

5.2.2.7.4 Buy-in of stakeholders

Acquiring the buy-in of stakeholders is important, but this can best be achieved through educating stakeholders, raising awareness levels of sustainability and the ways in which it can be practiced. However, not all behaviour will be changed merely through education and awareness raising; incentives will play a big part in changing behaviour or stimulating the uptake of certain goods or services. Stakeholders refer to both individuals and organisations.

"For starters we need to be aware. Awareness of the potential, are we aware of the potential?" (Interview Respondent I14).

"Education and awareness will be critical to make people aware that the law has changed" (Interview Respondent I4).

"Educating consumers, for consumers to exercise choices is a big thing. That kind of thing drives demand in a particular direction" (Interview Respondent I6).

"Behaviour change is our biggest competition" (Interview Respondent I14).

5.2.2.7.5 Buy-in from politicians

Buy-in from eThekwini Municipal political leadership is critical for the growth of the eThekwini green economy. It was further highlighted that the best way to garner buy-in from leadership is to appropriately raise education and awareness levels.

"Once we see the potential as a Municipality, obviously we will get political buy in. Then we will support and work with the private sector who are already running with these things. We need to learn and work together to support each other, to say that we are going to create the green economy within eThekwini and they must account …" (Interview Respondent I14).

"So, you have this enabling environment in terms of policy, and this also relates to mitigation as well, having a political leadership that is sympathetic to climate change or at least acknowledges climate change as an important issue" (Interview Respondent I10).

5.2.2.7.6 Preservation of open spaces

EThekwini Municipality remains a very green city, with lots of natural open spaces. It is critical that these spaces are preserved, not just for sustainability considerations but also for the important role that these open natural spaces play in supporting tourism and eco-tourism in the EMA.

"People are a lot happier because they are in an environment where there is greenery and nice open spaces. I think there are a whole lot of benefits, health benefits that come with something like that" (Interview Respondent I13).

"The plans for the green spaces are an important part of it. Your green economy must be part of the planning processes. The city must be strongly committed to planning and the value it places on those green spaces" (Interview Respondent I10).

5.2.2.7.7 Education and awareness

Education and awareness raising are prominent components throughout all interviews. It stands to reason that the advocacy and acceleration of such interventions have been highlighted as an important recommendation.

"It is actually interesting when you think of it as a web and everything is linked. So that education and awareness would be the overall, which would affect everyone and everything, all components. It's almost the understanding of why you are changing certain policies, or bringing in certain projects" (Interview Respondent I4).

"So, the solution lies probably in better educating people about using the environment for improving their living conditions and reducing their vulnerability" (Interview Respondent I10).

5.2.2.7.8 Systems thinking approach

A pertinent recommendation was that a systems thinking approach needs to be utilised for the promotion of the green economy. This aligns with the intention of this research. The practical application of this 'concept' is to identify synergistic relationships that can be capitalised on and conversely, gaps that need to be closed.

"Components, you start to look at systems and complexity. Without detailed models, it is quite tricky to understand the nature of that complexity because you are not only dealing with actual components interacting, you are dealing with the social systems within the Municipality as well" (Interview Respondent I13).

"So, you have to look at it holistically, you cannot say no further emissions from vehicles but you don't provide an alternative" (Interview Respondent I15).

5.2.2.7.9 Summary of recommendations

The recommendations highlighted by interviewees largely mirrored challenges raised. There seems to be a need for national government to be very clear on what can be undertaken and to eliminate policy uncertainty. Detailed realistic action plans are needed to translate high level strategies into reality, but must also be accompanied by

the relevant expertise to implement these plans. The buy-in of stakeholders remains one of the critical elements, which is closely linked to enhancing awareness levels of green principles. At a more substantive level, the pursuit of education to ensure that the requisite skills are available remains central. An interesting point raised was that an integrated approach needs to be taken by government, as opposed to the currently perceived piece-meal approach.

5.3 Qualitative research: Focus groups

The three focus groups conducted for this research were undertaken during August and September 2017. The focus groups were a combination of employed professionals and students from a local University, as is indicated in Table 5.2. It should be noted that while the category of employment is largely indicated by the participants' official titles, their actual work overlaps with the green economy.

5.3.1 Tag cloud

Figure 5.5: Tag cloud for focus groups

Focus group 1				
	Age	**Gender**	**Race**	**Employment**
FG1A	Mid 30's	Male	African	Engineer in training
FG1B	Late 20's	Male	Indian	Mechanical engineer
FG1C	Late 30's	Female	Indian	Senior technician - chemical
FG1D	Early 40's	Male	Indian	Mechanical engineer
FG1E	Early 30's	Female	Indian	Civil engineer
FG1F	Late 40's	Male	Indian	Chief civil engineer
FG1G	Mid 30's	Male	Coloured	Professional civil engineer
FG1H	Early 60's	Male	Indian	Senior manager water planning
FG1I	Early 40's	Male	Indian	Senior manager (Water and sanitation)
Focus group 2				
	Age	**Gender**	**Race**	**Employment**
FG2A	Late 40's	Male	European	Installer of solar water heaters (company owner)
FG2B	Early 30's	Male	Coloured	Environmentalist
FG2C	Mid 30's	Male	European	Installer of water solutions
FG2D	Late 30's	Male	Indian	Regional director large electrical retailer
FG2E	Early 40's	Male	European	Agricultural expert
Focus group 3				
	Age	**Gender**	**Race**	**Employment**
FG3A	Early 20's	Male	Indian	Engineering student in training
FG3B	Mid 20's	Male	African	Engineer
FG3C	Mid 40's	Male	Indian	Head of an energy centre
FG3D	Early 20's	Female	African	Engineering student in training
FG3E	Early 20's	Male	Indian	Engineering student in training
FG3F	Mid 40's	Female	Indian	Administrator of an energy centre
FG3G	Mid 40's	Male	Indian	Lecturer: energy centre
FG3H	Mid 40's	Male	European	Lecturer: energy centre

Table 5.2: Overview of focus group participants

As was observed in the tag cloud for interviews, the focus group tag cloud illustrates that the word ‘people’ seems to be central to the discussion on the eThekwini green economy. This can be seen in Figure 5.5. The words ‘green’ and ‘economy’ again appear prominently in the tag cloud, as to be expected due to the research topic and key research questions.

5.3.2 Themes

It should be noted that while the interviews generated information and components that could be classified as being either under the government or private sectors, that differentiation was less clear with the focus groups.

5.3.2.1 Existence of the eThekwini green economy

Across all focus groups, there was general consensus amongst participants that there is an eThekwini green economy. However, it is still not very visible and is in its early stages of development. In addition, when compared to other cities, the eThekwini green economy does not seem to be as well developed. However, there are a number of initiatives that have been initiated within the eThekwini green economy, but those are not easily visible.

"I am going to agree with everyone, because if you look at Durban – the city as a whole, if you look at it, there are not many places where you see that they are living green, or anything of that sort" (Focus group Respondent FG3E).

"The green economy does exist. There is a broad principle that we work on, although not documented. The principles that we are using at the moment is energy saving, reduction of costs in terms of our production, balancing the energy saving to carbon" (Focus group Respondent FG1H).

According to the respondents, one of the current primary aspects of the green economy is the DCCS, which was developed by the eThekwini Municipality. The DCCS sets high-level objectives and responses which serves to guide behaviour and resources. It also provides some targets on key areas, such as energy generation. A point emphasised during the focus group sessions, is that the green economy is about more than just energy or electricity, it should incorporate aspects such as transportation, water and wastewater.

"The Energy Office does have a strategy in terms of energy and although we don't refer to the strategy but we try and align ourselves to that strategy" (Focus group Respondent FG1H).

"... it is not just energy saving it is about how you can minimise the impact on the environment" (Focus group Respondent FG1E).

5.3.2.2 Components of the eThekwini green economy

5.3.2.2.1 Behavioural change and culture

This component of the eThekwini green economy seems to have been one of two components that respondents reiterated during the focus groups, the other being

incentives. There is general consensus amongst respondents about the importance of individual current behaviours. This will determine the manner in which we adopt a positive attitude towards 'sustainability' or the green economy. If we do not change behaviour patterns it will be 'business as usual', which is not good for the green economy. It was further raised that becoming environmentally responsible should be inculcated in children from a young age.

"I think for me, apart from tangible things, is actually the culture. The culture needs to change. When our culture changes, we replace whatever technology we need to. To ensure a better green economy culture needs to change" (Focus group Respondent FG1D).

"For me, I think what we need as a Municipality is a change of mind-set because you look at what is happening around the world" (Focus group Respondent FG1A).

5.3.2.2.2 Urban migration

Some respondents raised a very interesting point, life in the city is being perceived as being better than in rural areas. This results in an increased rate of urbanisation, as a result the opportunities available in rural areas are being overlooked.

"A lot of rural people grow food but it is an aspect that can be enhanced. A lot of people make their way to the city for money and I think that we are not really focusing on the rural green economy. We need to actually tell people that within your rural area you can start-up businesses with what you have around you and do it sustainably to create an internal economy. This sort of tackles two things, the sustainability and the exodus of people into the cities from rural areas" (Focus group Respondent FG2E).

5.3.2.2.3 Financial motive for business as usual

According to some respondents, there are segments of the population that have a financial motive to continue with business as usual, which is most often not environmentally friendly. These segments of the economy then actively work against transformation.

"There's a lot of people that are making a lot of money out of not keeping things sustainable" (Focus group Respondent FG2E).

"For me it is about changing the 'business as usual' approach. In order for us to do that, we also need buy-in from the top level, you know like getting buy-in from national and coming down to provincial, then local buy-in. Basically, for any project to be successful in the Municipality, we need the various branches to buy-in to the concept and what I noticed many times, just coming back to our Unit as a whole, sometimes you have engineers that are going off on a different tangent and not really open to innovative technologies and changing the way we do things" (Focus group Respondent FG1E).

5.3.2.2.4 Energy

Respondents emphasised, a few times, that the green economy is more than just energy. Energy did, however, come through as one of the larger and more common components of the eThekwini green economy. There are two primary aspects of energy that was raised: renewable energy and energy efficiency. In terms of renewable energy, solar and wind have been mentioned predominately. It was pointed out that there is huge potential for renewable energy within the eThekwini green economy.

"So, I know what we are saying, and guys it is not only about energy. The green economy is very broad" (Focus group Respondent FG3C).

"It is very hot in Africa. You can generate more energy here" (Focus group Respondent FG2B).

5.3.2.2.5 Innovation and new technology

A number of respondents have indicated that innovation is critical for the development of new technologies. These new technologies will then allow a better and more efficient transition to the green economy.

"It will probably be innovation because that is the only way the economy is going to grow. We have our traditional systems that we are trying to improve on and the only way the green economy will get better is if we innovate and introduce new technologies" (Focus group Respondent FG1B).

"What is the definition of a green economy in eThekwini? I think it is a mixture of modern technologies and traditional technologies" (Focus group Respondent FG3H).

5.3.2.2.6 Natural environment

The impact on the environment from current activity was raised multiple times by respondents. The aspects raised under this theme included consideration of disposal of harmful green technologies, such as some efficient lighting that contains mercury, to protecting the environment for the next generation.

"It's a combination of all of those things. Financial, energy, the water, whether you can measure things like degradation to the environment, all those sort of things – if they can be measured and weighted and quantified in some way it may be different for different projects and for different things. So that is the economic side of it. The green side is anything that will affect and is affected by the natural environment and its resources" (Focus group Respondent FG1F).

"... the impact to our environment and all the greenhouse gases, that is very important" (Focus group Respondent FG2D).

5.3.2.2.7 Government

The green economy should be led by government so as to act as an example for other stakeholders. Government must support development, rather than being bureaucratically focused. References to government by respondents always tended to gravitate back to aspects such as regulations and incentives. A concern raised, was that government is bad at implementation.

"It will be fantastic if eThekwini drives this in terms of the green economy" (Focus group Respondent FG3C).

"I think something like that, unless you have got some really big corporate inputs from it, then it obviously lies with the government. If what they really want is a green economy then that should come from the government's side" (Focus group Respondent FG2E).

5.3.2.2.8 Policy and regulation

There was consensus amongst respondents that legislation, regulation and policy is important for the green economy. Not surprising, policy seems to be more important to local government officials who participated in the focus groups. This is due to the nature of a policy document, which spells out the manner in which something must conducted. Regulations on its own will not be of any use. Enforcement of the

regulations is critical. A respondent raised an example, where he was confronted with a customer who refused to implement a technology, even though it is in the building regulations. This further raises the need for efficient enforcement mechanisms and regulations that are designed properly.

"Like 'FG1C' said, there needs to be a policy, if there is a policy in place it needs to filter down. If that happens then we have other Departments, let's say Operations then they adopt a new management style or a new technology and we then have Procurement procuring new technologies and everything" (Focus group Respondent FG1A).

"I say to him, "it is a government regulation you have to do it" and he says "no, I don't have to do it, I am not going to do it" …" (Focus group Respondent FG2A).

5.3.2.2.9 Consumers

Service levels to consumers are important, both private and government sector participants raised this. Some of the respondents that are from private sector indicated that there is a lot of interest in the green economy but there still seems to be a disjuncture. One of the critical aspects linked to consumers is education and awareness – this would set the basis for behavioural change to take place and adoption of technologies to begin.

"If you look at a simple case of the solar panels, they first came onto the market and they were very expensive. Once people saw the benefit they saw that you can make use of this, obviously we had situations that affected it. With time the technology improved and the cost of the solar panel came down" (Focus group Respondent FG1B).

"As an example, if we are providing a level of service to the consumer, let's say in terms of water, us providing the water to that person using less energy, less money, less everything – then I think it will be an improvement in terms of the green economy" (Focus group Respondent FG1A).

5.3.2.2.10 Education and awareness

Across all respondents, it was agreed that education and awareness is critical. Awareness has been referred to as being cognisant that something exists. Education refers to a slightly more in-depth understanding of the green economy and specific

technologies. Starting education initiatives, for aspects of the green economy and living sustainably, must be targeted at youth and children.

"... we should be able to educate the local people to become more sustainable" (Focus group Respondent FG3C).

"Another aspect, which I did mentioned before, would be to educate people more thoroughly, especially from the youth now" (Focus group Respondent FG2E).

5.3.2.2.11 Private sector

Many focus group respondents have highlighted the private sector and businesses prominently in their responses. There seems to be conflicting perspectives, with regards to the amount of initiatives that private sector is undertaking. It was further raised that the private sector has the ability to do a lot more than it is currently doing, but is constrained by government legislation and regulation. In addition, the current perceptions of government being corrupt, act as a deterrent for private sector engagement with government.

"I mean private sector is willing to do, or to support, but they are not willing to support any corrupt structure and unfortunately the perception is that all state driven entities are corrupt and that is a big problem. So, that puts a hold on even the most willing private company to invest" (Focus group Respondent FG3H).

"The private sector is going ahead with doing as much as it can do. That is because they have seen the savings that they can get from it" (Focus group Respondent FG1G).

5.3.2.2.12 Banks/finance

According to respondents, banks and the provision of finance is a critical part of the green economy. In certain instances, there are even foreign banks financing local projects. Due to the high capital intensity of most of the green economy, banks and finance will play an important role especially in the provision of capital loans for small and medium companies.

"The financial aspect. I think that is one of the important aspects" (Focus group Respondent FG3C).

"If you look at a return on investment, if you had to ask, there are banks in America that are investing in South Africa, on photovoltaic systems" (Focus group Respondent FG2A).

5.3.2.2.13 Incentives

Incentives were raised by multiple respondents, but not as much by public sector respondents. In addition, it appears that South Africans are most responsive to financial incentives. The need for incentives is due to the higher prices of certain technologies where offering incentives will lower the total cost to the consumer and thereby increase uptake. In addition, behaviour change is difficult to achieve but can be stimulated by the provision of incentives. Respondents highlighted that the source of incentives should be the government, but when probed on how these additional funds should be raised by government, many respondents cited corruption has a drain on resources.

"I think South Africans will not do things voluntarily. There has to be some monetary incentive that they like attached to it" (Focus group Respondent FG3G).

"Other countries have incentives to do this and is driven by government. It is driven by government" (Focus group Respondent FG3C).

5.3.2.2.14 Implementation

Both government and private sector respondents conceded that implementation is lacking. The higher level plans and policies are being put in place or are already in place, but that is not translating into actual tangible outcomes.

"I think that the ideas are there, but the implementation is lacking. It is not that it is not happening, but it is happening at a slow rate" (Focus group Respondent FG3C).

"For example, they do concept layouts, some of the developments, yes, they talk about green economy but when it comes to implementing, that just falls away" (Focus group Respondent FG1H).

5.3.2.2.15 Summary of components

The components highlighted by participants of the focus groups include behavioural change towards sustainable practices. Some participants alluded to urbanisation and the opportunity cost to people that migrate to urban centres. Maintaining the current

'business as usual' model, with unsustainable practices, financially benefits a small portion of the population who have invested in certain industries and as a result are anti-green. Energy was mentioned multiple times, but participants highlighted that the green economy is not only about energy. The promotion of technological innovation was highlighted as being important for the advancement of the eThekwini green economy. Participants also highlighted the natural environment link to the green economy, specifically with regards to impacts of disposing waste and protection for value adding activities. The notion that the green economy should be driven by the government was reiterated by participations, especially with regards to setting regulations, policy and the provision of incentives. The government was criticised for bad implementation. Both government officials and private sector stakeholders raised the point that consumers are central to the eThekwini green economy. Closely linked to consumers are their awareness levels and education about sustainable living. There didn't seem to be much focus on the actual skills that are needed to drive the green economy. The private sector is largely seen as the engine of the green economy, but due to mismanagement of government, the private sector is holding back on unleashing their full support. Financing of projects and initiatives by local and international banks came across strongly. Interestingly, implementation seems to be a problem in both the private and public sectors.

5.3.2.3 Interaction and learning

The breadth of information that focus group respondents presented to the relevant questions were substantially less robust than for interviews. This seems to have arisen due to members of focus groups latching onto initial points raised, discussing those points in some depth and discussing peripheral issues. However, the major points that emerged in terms of the manner in which components interact and learn are contained in this section.

It was widely accepted by focus groups respondents that all components within the eThekwini green economy are linked together. It was also noted by a number of respondents that the lack of interaction amongst components is one of the challenges facing the eThekwini green economy, due to different core objectives that various key components of the green economy have. When each component has different objectives, and where there is no synergy, then the system will likely be pulled in many directions.

"You know how a spider builds its web, once you land there it vibrates on everything and eventually everything interacts" (Focus group Respondent FG2B).

"… there are various components in terms of the green economy, each has its own purpose but there is a disconnect. There is a disconnect in terms of actual information flow and the actual values that these components add to the green economy" (Focus group Respondent FG1D).

In terms of learning within the eThekwini green economy, most respondents are of the view that there is minimal learning taking place. Even when opportunities present themselves for learning, those opportunities are not capitalised on. This is linked to not getting the correct people to undertake required tasks. However, when eThekwini green economy components are faced with calamity, there is a tendency to follow a steep learning curve, in a short space of time.

"I don't think there is much learning going on to be honest. I think people's current state is to carry on regardless" (Focus group Respondent FG3H).

"I think we are very reactive, we sort of wait for that worst case scenario to happen and then the light bulb moment …" (Focus group Respondent FG3A).

5.3.2.4 Leverage points of the eThekwini green economy

5.3.2.4.1 Consumers

Without people or organisations consuming products and services, there is not going to be any demand. As a result, consumers are a critical part of the green economy. Specific examples were provided which illustrated concerns. As an example, when photovoltaic panels were introduced, consumers did not understand the benefits, but once the benefits became apparent the uptake noticeably improved. Another example provided was around utilising different coloured refuse bags provided by the eThekwini Municipality, for separating different types of rubbish.

"Once people saw the benefit they saw that you can make use of this …" (Focus group Respondent FG1B).

"The youth really need to start thinking about it and not just about things which they will consume, but also getting involved in the green economy …" (Focus group Respondent FG2E).

"My wife is full of – put the plastic in this, put the glass there, put the paper there, put the things here. We have got to have six bags" (Focus group Respondent FG2A).

5.3.2.4.2 External triggers

Large events that can negatively jeopardise quality and way of life can have a positive impact on the eThekwini green economy. This is due to solutions for certain challenges, such as electricity and water shedding, having its roots in the green economy. However, if the external threat did not materialise, demand for green goods and uptake of green principles would not have been as high. In such a situation, the green economy unintentionally benefits.

"When you look back at it, when we had the crisis – we had a big drive towards energy efficiency and saving electricity to contribute to the green economy. Even Eskom was providing large demand-side management incentives" (Focus group Respondent FG1B).

"There has been improvements in certain areas. I am sure they learnt a lot from load shedding" (Focus group Respondent FG3C).

5.3.2.4.3 Incentives

Rebates and incentives have been identified as a critical component that will stimulate the uptake of greener technologies, which tend to be more expensive. Incentives greatly assists with reducing cost to the user of goods.

"I think some sort of incentive will make a big difference. It did make a big difference in terms of the solar water heating …" (Focus group Respondent FG2A).

"Incentives are a good way of kick starting it. I think South Africans will not do things voluntarily, there has to be some monetary incentive attached to it" (Focus group Respondent FG3G).

5.3.2.4.4 Regulations

The eThekwini green economy needs to be driven by government and by an enabling regulatory environment. This will give the private sector certainty on what can be undertaken.

"It would be better if they had a greater hold, or if there are more regulations. When I say that, it in particular means that I have witnessed projects now, I mean new

developments, but the guys are still on old technology. Why? It is cheaper" (Focus group Respondent FG2D).

5.3.2.4.5 Private sector

The actual engine of the green economy is the private sector. As a result, regulations, incentives and consumers need to align to form a conducive environment for the development of the green economy. In addition, a large portion of the expertise that is required for interventions within the green economy actually reside in the private sector. However, it seems like the full potential of the private sector is still to be realised.

"... you would get a lot more support from private industry" (Focus group Respondent FG3H).

"The second thing that is not happening in spite of the excellence in the private industry within eThekwini, is that there isn't any knowledge sharing ..." (Focus group Respondent FG1H).

5.3.2.4.6 Summary of leverage points for the eThekwini green economy

According to the focus group participants, consumers are a leverage point of the eThekwini green economy. Triggers that serve to act as a stimuli for action also change behaviour and attitudes. Another component that has a critical role to stimulate the green economy is incentives. Proper regulation by government was mentioned multiple times. There seems to be a lot of scepticism and cynicism of government. Lastly, the private sector is seen as the driving force of the green economy, but is hugely reliant on enabling regulations.

5.3.2.5 Challenges facing the eThekwini green economy

5.3.2.5.1 Funding constraints

A huge challenge, raised by a number of respondents, is that while desktop calculations make financial sense, the actual availability of funding will determine whether those projects materialise. More expensive green projects and their resulting benefits are often bypassed for less expensive projects with older technology. In addition, if actual cash is not held by a resident or organisation, the cost of that capital from a financial institution often makes the total capital required larger and increases payback periods.

"The biggest challenge is budget. You know. That is what impedes our implementation" (Focus group Respondent FG1H).

"You have Joe Soap who rather put the fluorescent tubes and get away with the project and then stays away from LED technology because it is too expensive" (Focus group Respondent FG2D).

5.3.2.5.2 Measurement of indicators

All of the respondents emphasised that the green economy is made up a number of different aspects, however there is a current lack of monitoring of the eThekwini green economy. It is challenging to quantify and monitor the progress of the green economy, partly because no one has defined it and because it is tricky to objectively measure all indicators.

"The green economy is very broad, it is a whole lot of different components …" (Focus group Respondent FG3C).

"We are not quantifying it in terms of what we want to add. These are the fundamental things that I see lacking in the entire thing" (Focus group Respondent FG1D).

"At the moment, we don't have a benchmark in terms of the green economy. So, I think as a Municipality we need to set a benchmark and then see how we improve on that" (Focus group Respondent FG1A).

5.3.2.5.3 Weak government leadership

The inherent nature of government and bureaucracy results in very slow processes within government. Another challenge with government is corruption and as a result, resources get misused. The problems within government result in the private sector being reluctant to partner with government. The private sector has been holding back on the full potential of what they could be contributing.

"… things turn slowly in the Municipality" (Focus group Respondent FG1F).

"The perception is that all state driven entities are corrupt and that is a big problem" (Focus group Respondent FG3H).

5.3.2.5.4 Buy-in and commitment

Within the eThekwini Municipality, there is still a lack of buy-in from various role players. This ranges from support departments such as Supply Chain Management Unit to the various technical Units. More broadly, even engineers that understand technologies are reluctant to consume recycled water.

"We are trying to create one for our Unit itself, but it is going to take a lot of buy-in and commitment from the Heads for the management system" (Focus group Respondent FG1C).

"... not just the general public. I tried a small survey, I took bottles of recycled water to Ballito and I gave it to my friends, who are engineers. One of them is even doing his PhD at UKZN. They understand engineering and they understand the processes that the water would have gone through to make it portable. It is properly controlled, but it still has that eek factor, like I'm not going to be drinking that water. Out of five people, qualified people, people that I consider having a good understanding of the system, only one drank the water" (Focus group Respondent FG1G).

5.3.2.5.5 Expensive

Many of the respondents have raised a serious challenge that inhibits the growth of the green economy: the products and services within the green economy are more expensive. This means that only people with high disposable incomes will be able to actively participate in a meaningful way in the eThekwini green economy. This higher cost of green products and services are further compounded by situations where people don't have cash and take out loans, which attract interest costs and further push the costs of green interventions up.

"The second part is, in most instances especially for the end user, the green economy can be very expensive. You try to make your house green, rather than going the conventional route, sometimes it ends up being a bit more expensive than the traditional route" (Focus group Respondent FG1G).

"Actually, in terms of the finance, we know that to implement some of this, it is capital intensive. So, that is a challenge ..." (Focus group Respondent FG3C).

5.3.2.5.6 Behavioural change and perceptions

There is an age old saying: you can't teach an old dog new tricks. The same seems to apply to the eThekwini green economy. People will inherently be resistant to change, especially when no sizeable benefit or need is present. It seems like, according to respondents, that another contributing factor is ignorance of the green economy and benefits. This lack of education is inclusive of all information relative to the green economy or specific technologies that range from general awareness, to how it operates and the payback periods. A comprehensive comparison of alternatives are not being actively promoted. Comparison seems to be effective in convincing people that green economy principles is a viable alternative.

"... people are very reluctant to take on new things that can change their life – keeping with the devil that they know" (Focus group Respondent FG2E).

"People are so used to sticking to what they know. Twenty, thirty years into what they are doing. They are so used to that, they don't want to change. So, the baseline is to start educating people, especially the youth ..." (Focus group Respondent FG3E).

5.3.2.5.7 Lack of incentives

Due to the lack of incentives, people are not as willing to procure green services or goods. This includes both positive and negative incentives. It is being viewed that government wants everyone to proceed down this path and must therefore come to the party with, mainly, financial incentives to offset the higher prices.

"The one guy came to our stand and said he has seen us doing a lot of solar stuff but I am not interested because there is no government subsidy" (Focus group Respondent FG2C).

"We are actually going backwards. I am sorry to say this but if you look at other countries, other countries have incentives to do this and it is driven by government. It is driven by government. We do not have much incentive ..." (Focus group Respondent FG3C).

5.3.2.5.8 Short-term focus

When consumers are shopping for products and services, there is a bigger focus on short-term as opposed to long-term benefits. This results in consumers comparing upfront costs only and not full life cycle costs which generally result in fewer green

items being selected. This short-term focus can also be linked to the current disposable income of consumers, where available funds actually don't allow for more expensive options being chosen.

"If you present it in that way, that your payback period is a much shorter period – then you can actually sell the product" (Focus group Respondent FG3C).

"They don't look at payback, they don't look at lifecycle costing …" (Focus group Respondent FG1C).

5.3.2.5.9 Lack of legal and regulatory frameworks

While there are strategies available, there needs to be corresponding implementation plans and policies that will determine how initiatives are implemented. In addition, the more expensive aspects of the green economy will not materialise until legislation and laws are very clear. This will result in the reduction of perceived risks.

"When it comes to installation, a lot of people don't have much education on payback periods. A lot of people just think it is a high cost. The one thing that I have noticed, people don't really have much education on payback periods" (Focus group Respondent FG3E).

"It would be better if they had a greater hold, or if there are more regulations" (Focus group Respondent FG2D).

5.3.2.5.10 Implementation and compliance

Implementation by local government is severely lacking. This mainly links back to the lack of policy, but is compounded by a lack of relevant skills in government. Ownership of the projects and general lack of management are additional hindrances. On the private sector side, the lack of implementation is as a result of poor enforcement by government. This then allows the private sector to get away with non-compliance of some regulations and bylaws.

"I mean you've got hundreds of fancy and good plans, some fantastic documentation but nothing is done" (Focus group Respondent FG3H).

"Nothing happens after that, flat. So, I think to second what 'FG2A' is saying, government needs to enforce those regulations" (Focus group Respondent FG2D).

5.3.2.5.11 Unstructured approach

A concern raised by some respondents is that certain aspects of the green economy seem to be implemented in a random fashion. This is because implementation of aspects, at times, is in response to macro-events or political considerations.

"There is nothing systematic in place from what we can see currently. Like we said, the developers are doing their own thing" (Focus group Respondent FG1F).

5.3.2.5.12 Lack of skills, education and awareness

Awareness and education of the green economy is lacking, right from the top echelons to the average man. According to respondents, this lack of education is not limited to the average man or politician only, but also to skilled sectors such as engineers that have not updated their knowledge. In addition, a lot of companies exist but also lack skills. This is compounded by the scarcity of people that have the foundational qualifications and skills on which the advanced green initiatives are developed.

"As 'FG1H' rightly says, the people that drive this from the top are not educated" (Focus group Respondent FG1D).

"For me, an important aspect is the capability of the design engineer" (Focus group Respondent FG1H).

"The energy services companies are there, but if you take an emerging company, they do not have the skills, but they have the right idea" (Focus group Respondent FG3C).

5.3.2.5.13 Silos

The lack of communication, integration and collaboration within eThekwini Municipal Units and within the broader EMA results in potential duplication and conflicting actions and situations. This results in expertise not being shared and a general suspicion of others. Specifically, there is a severe lack of collaboration and synergy with the private sector.

"We need to move forward, so that everyone is looking, as a team, at one goal. Now it is still a bit disjointed, simply because there is no policy requirement" (Focus group Respondent FG1I).

"The second thing that is not happening in spite of the excellence in the private industry within eThekwini, is that there isn't any knowledge sharing …" (Focus group Respondent FG1H).

5.3.2.5.14 Summary of challenges

The key challenges raised during the focus group sessions include: funding constraints by stakeholders who want to implement initiatives. Linked to funding constraints is the notion that participating in the green economy is generally more expensive and as a result only the wealthy can meaningfully participate. According to participants, the green economy is currently not being monitored or measured, in part due to there not being a clear definition of what the eThekwini green economy is. There seems to be weak government leadership in stimulating the green economy and the lack of policy from government acts as a huge inhibitor of the green economy. Also related to government, enforcement is severely lacking and this offers an opportunity for stakeholders who persist with outdated technology to circumvent certain regulations. Poor implementation of initiatives has also drawn a lot of criticism. In addition, government is not offering the right incentives or in some instances, not offering incentives at all. Buy-in and commitment by stakeholders remains a challenge. The respondents seemed to indicate that behavioural change initiatives need to target younger audiences. There is often a focus on the short term, where people do not take the full life cycle cost into account. The green economy seems to be approached in an unstructured manner, due to stakeholders working in silos.

5.3.2.6 Recommendations for the eThekwini green economy

This section presents recommendations from focus groups.

5.3.2.6.1 Holistic view

Respondents indicated that while there are initiatives being undertaken within specific aspects of the eThekwini green economy, there is a real need for a holistic approach to the entire economy, which includes the green economy. This would then allow for better synergies and gaps to be identified. In addition, it was observed that there are multiple perspectives on what the green economy is and what it entails. This needs to be clearly defined and effectively communicated with all stakeholders.

"These are the fundamental things that I see lacking in the entire thing. So, if we look at the eThekwini Municipality, we need to look at it holistically from city fleet to see how we can reduce the carbon footprint, the emissions from that to the component level like lights" (Focus group Respondent FG1D).

"In terms of green economy, I would say first – let the people know in terms of the term itself. What do you mean by saying green economy" (Focus group Respondent FG3B).

5.3.2.6.2 Identify and understand drivers

Generating an in-depth understanding of key drivers of the eThekwini green economy was identified as a necessary action to be undertaken. This is particularly with regards to the key leverage points within the eThekwini green economy.

"Understanding our customer will go a long way in driving this and ensuring that what is implemented or what is proposed is acceptable and is accepted on a broader scale" (Focus group Respondent FG1G).

"So, there are a number of scenarios we need to create to get a better understanding of what the impact and relationship is between carbon reduction versus investment in the green economy" (Focus group Respondent FG1H).

5.3.2.6.3 Collaboration

If the green economy is going to be maximised, then collaboration needs to be facilitated amongst key stakeholders. While this will ensure synergies, more importantly it will minimise conflicts. In addition, there also needs to be better feedback loops and consolidated reporting platforms. A key gap identified along the theme of collaboration is between end-users and producers.

"You know how a spider builds its web that once you land there it vibrates on everything and eventually everything interacts. It's crazy like that, everything needs the other to survive" (Focus group Respondent FG2B).

"There is a lot of interest from some people on the ground – they are very open to the idea of getting involved in the green economy but there is a gap between the, you know, the producer and the actual end user" (Focus group Respondent FG2E).

5.3.2.6.4 Incentives

Many respondents have ardently advocated for the introduction of incentives. The respondents have highlighted the fact that the introduction of incentives is critical for stimulating the uptake of new technologies, especially ones that are substantially more expensive than existing options. The most common type of incentive mentioned was a form of rebate and feed-back tariff for excess energy generation into the electricity grid.

"To make Durban green I think the government has to be involved as well, maybe to meet the people half way, so that they can afford those technologies" (Focus group Respondent FG3D).

5.3.2.6.5 Leadership by the eThekwini Municipality

It was emphasised by a few respondents that the eThekwini Municipality really needs to start taking a more active and visible leadership role in the eThekwini green economy. This would then result in a consolidated vision and way forward for the eThekwini green economy and in the process overcome the multitude of parallel definitions.

"I think if the eThekwini Municipality can get more involved, then people are willing to go with that. I just think that they need to promote it more and get more involved there" (Focus group Respondent FG3A).

"I would actually wish that eThekwini Municipality gets more involved in research that is driving the green environment, be able to fund it and collaborate with research institutions. More importantly, I think that the green environment needs to drive the economy and the biggest factor now in our economy is our unemployment rate. So, we need to be able to actually reduce the unemployment rate using the green economy and the environment" (Focus group Respondent FG3G).

5.3.2.6.6 Up-skilling

Due to the shortage of skills in the green economy, it is imperative for up-skilling to be given a lot of attention. Specifically, it was highlighted that engineers, architects and senior decision makers should be recipients of these exercises. Focus also needs to be given to small and medium business owners.

"There are some architects and designers, and so forth, that we have come across but we have to empower more of the guys with knowledge and say "listen that is the way it should be done" …" (Focus group Respondent FG2D).

"How well capacitated are the officials at the top. There must be more done and I am not sure by whom and how. For me, the biggest issue is capacitating the relevant officials that are responsible for a number of these projects. Unless you get that formula right, there will be a big gap in the system" (Focus group Respondent FG1H).

5.3.2.6.7 Policy development

There needs to be enabling policy developed within the eThekwini Municipality that will support existing strategies. This policy will then better enable managers, engineers, architects and planners to incorporate such green guidelines into plans and projects.

"As 'FG1I' rightfully said, there should be a policy driven towards attaining the green economy. It is not being filtered down" (Focus group Respondent FG1D).

"It is about building all this into a policy, in strategy, to guide the Municipality as well as guide other private developers. So, that's how I see it" (Focus group Respondent FG1E).

5.3.2.6.8 Funding

Access to funding is important, especially affordable financing. Some respondents also indicated more government funding will be welcome. The input from respondents highlight the need for easier processes to be put in place to access funding, especially for high value initiatives, through existing financial institutions.

"… because every time, right now, this guy has a million great ideas, so do you and so does he, but the thing is, there is no capital to invest in that" (Focus group Respondent FG2B).

"You guys had your roadshow for the Energy Efficiency Demand Side Management Programme. There are some fantastic plans and initiatives, especially with financing, offering the financing, incorporating emerging companies" (Focus group Respondent FG3C).

5.3.2.6.9 Compliance

Compliance needs to be enhanced. If regulations and bylaws are introduced that involved an additional burden, there will be people that will try to avoid complying. As a result, government needs to effectively ensure that there is active monitoring and policing of regulations.

"If they are going to make a regulation, they have to make sure that people comply" (Focus group Respondent FG2A).

"So, if that regulation can also be enforced then it will assist our economy and the Municipality" (Focus group Respondent FG2D).

5.3.2.6.10 Systems approach

From the respondents' observation of initiatives in the green economy, there seems to be a real need to take a systematic approach. Better alignment of initiatives will allow more efficiency in the system. There cannot just be talk and generation of ideas, these need to translate into tangible actions.

"Let's not use the word controlled, because people don't like to be controlled. It needs to be ordered systematically" (Focus group Respondent FG1F).

"They are all interlinked. I think you need proper frameworks to do things. You have got to make a decision, this is what we want in terms of the green economy, this is how we are going to do it" (Focus group Respondent FG3H).

5.3.2.6.11 Measurement of the green economy

Some respondents have highlighted the importance of measuring the eThekwini green economy. This is to allow the development and growth of the green economy to be tracked. An important sub-component would be to first set a baseline of parameters that are to be measured and then targets to be achieved. Parameters and aspects that can be measured include: financial (payback periods, investment, savings), carbon footprint, environmental impacts, recycling, water saving, fossil fuel consumption, individual projects and social impacts (provision of services, healthier lifestyles).

"I think the measurement part is very important" (Focus group Respondent FG3H).

"After that, what we would like to see is if there was a negative or is there a positive impact on the environment and has the city met its target and goals" (Focus group Respondent FG1H).

5.3.2.6.12 Awareness, education and changing mind-sets

The vast majority of respondents raised the need for large-scale awareness and education initiatives. The awareness initiatives would merely serve to make people aware of the green concepts. The next step would be to build on that awareness and introduce some relevant education, such as what are the different technologies, how can one use them and on relative and related topics. This should be introduced to all people. However, it seems like the impact will be the greatest if youth are the focus of this initiative.

"Just to add quickly to what 'FG1G' was saying. It is very interesting that he has talked about the culture change, even the educated people. The interesting case is Singapore. They introduced re-used water, they actually call it New Water. They put a lot of emphasis on education behind re-use and that is focusing on the younger generation in the schools …" (Focus group Respondent FG1I).

"You need to go out there and target the youth …" (Focus group Respondent FG3F).

5.3.2.6.13 End corruption

Respondents from the private sector indicated that the private sector is able and willing to collaborate a lot more with government. However, a huge barrier that needs to be overcome is the current level of corruption. The money that is currently being spent needs to be utilised for the right initiatives and in a transparent manner. It is important to note that while not everyone and everything in government is corrupt, the amount of corruption that gets reported in the media leaves people with a general sense that this is the norm in government. Therefore, they are reluctant to part with their resources, even for noble causes that are not tainted by nefarious intentions.

"… that private sector are willing. However, they are not willing to engage a system that is not transparent" (Focus group Respondent FG3M).

"If I had a big company and I was willing to give R 10 million, I would like to see everything. Like you say it has got to be transparent, but I would like to see the result" (Focus group Respondent FG3H).

5.3.2.6.14 Summary of recommendations

A systemic and holistic approach to the green economy is needed, that would better align efforts to stimulate the eThekwini green economy. There is a need to understand what drives the green economy and how it operates. According to focus group participants, collaboration will positively contribute to overcoming conflict. The provision of incentives by government is highly recommended. Leadership by the eThekwini Municipality for the green economy is imperative. Furthermore, ensuring an enabling environment through policies is one of the basic elements of a successful green economy. It is widely accepted that there is a general skills shortage and it is no different in the green economy. Initiatives that will plug the skills gap is seen as non-negotiable. Participants highlighted that access to viable sources of funding is a key priority. Compliance of regulations and policies need to be thought about when plans and strategies are being developed, so that whatever needs to be complied with can be effectively enforced. Focus also needs to be directed to raising awareness and education initiatives. This would also assist with changing mind-sets to develop a more environmentally friendly consciousness amongst citizens. Corruption within government is seen as a drain on resources and as a result, a lot of potential collaboration and positive input that the private sector can make is withheld. Finally, the measurement and monitoring of the green economy is seen as vital for actively steering the green economy.

5.3.2.7 Indicators of the health of the eThekwini green economy

The indicators highlighted by the focus group participants were not as succinct as those mentioned by interview participants. However, the more prominent indicators that arose from focus groups are presented below.

It was raised by Focus group Respondent FG1B that it is important to have a dashboard type indicator framework to easily display progress towards achievement of green economy goals and objectives. This dashboard would imply that there should be key indicator categories, which will encompass specific indicators.

An indicator that came through most frequently was the monitoring of awareness and marketing for green principles, goods and services.

"Businesses and the Municipality, and stuff like that, if they don't show people how to live in a green way – they won't know" (Focus group Respondent FG3C).

"They fill in check lists when a certain activity is done. Now what we have done is incorporated, or trying to incorporate energy awareness to some degree" (Focus group Respondent FG1C).

Awareness and marketing would then have an impact on mind-sets within the EMA towards the green economy. This would be an indicator of the success of various interventions to show if mind-sets are positively changed.

Recycling of water seemed to be another pertinent aspect that needs to be monitored, in addition to reduction of water consumption. Monitoring the carbon footprint and reductions through green related interventions are mentioned as being important for the health of the eThekwini green economy. It was also highlighted that carbon emissions should not be looked at in isolation, but juxtaposed against other indicators.

"Then on the same line, we would like to see what was the carbon reduction, the balance between initiatives and the gains to carbon reduction" (Focus group Respondent FG1H).

"Maybe we can even look at things like GDP and a percentage of carbon foot printing" (Focus group Respondent FG1B).

Implementation of policies relating to buildings was highlighted, particularly with regards to energy efficiency standards. This was supported by a broad focus on energy efficiency.

"How do we monitor it? I think eThekwini needs to, in terms of, policies – especially when it comes to buildings" (Focus group Respondent FG3G).

"Like 'FG3G' said, look at your buildings. I mean that is very important, look at glazed, double glazing, triple glazed windows, whatever the case might be" (Focus group Respondent FG3H).

Energy mix, in terms of type of technologies that are used to generate energy, is seen as important to measure.

"Energy, solar, methane to electricity, all of that as the energy component, and it has the various factors where we can measure it" (Focus group Respondent FG1D).

"To me, I would like to see factors like the amount of energy consumed versus the amount of green energy consumed" (Focus group Respondent FG1B).

Monitoring the number and success of projects and initiatives was highlighted as a possible indicator of the health of the eThekwini green economy.

"It must be out there so people can see it. It is like you are showcasing that the project is a success and you can actually see that implementation is working and it is adding to a more sustainable and healthy green economy in eThekwini Municipality" (Focus group Respondent FG3C).

5.4 Quantitative research: Surveys

5.4.1 Response rate

The response rate to the main survey is depicted in Figure 5.6. As can be seen, only 12% of the sample returned the survey via QuestionPro or Excel document. A further 8% did respond, but as a courtesy indicated that they will not be participating in the research.

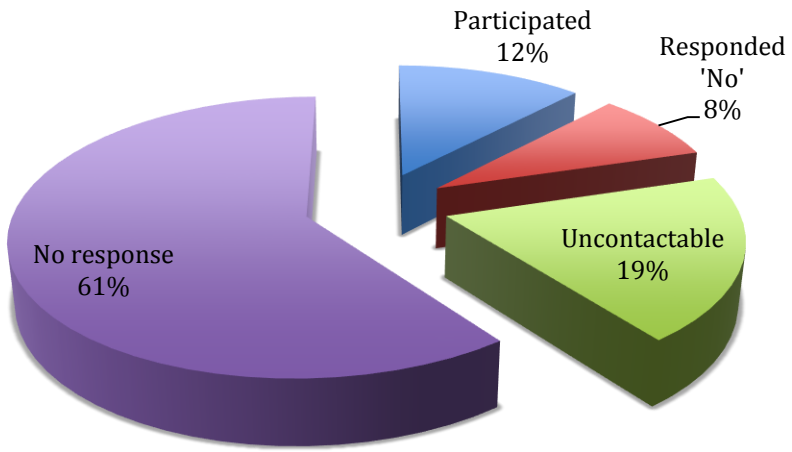

Figure 5.6: Survey response rate

A large portion of the sample, 19%, was not contactable, i.e. emails bounced and telephone numbers were not in operation. The vast majority of the sample, 61%, did not respond to emails or telephone calls and as a result did not participate in the survey, despite numerous attempts to contact them.

5.4.2 Components

Figure 5.7 indicates the breakdown of components that survey respondents have indicated make up the eThekwini green economy. All three levels of government are mentioned the most at 9%, with the bulk of references to national and local government, with virtually no reference to provincial government. Banks then followed at 8%, the components in this sector broadly related to the provision of capital for initiatives in the green economy and includes financial institutions broadly. Also mentioned at 8% is consumers, as well as the private sector at 8%. The private sector was highlighted by respondents as small businesses, larger businesses and industry. Consumers are not separated into different sub-types and can be interpreted as end-users for the purpose of this research.

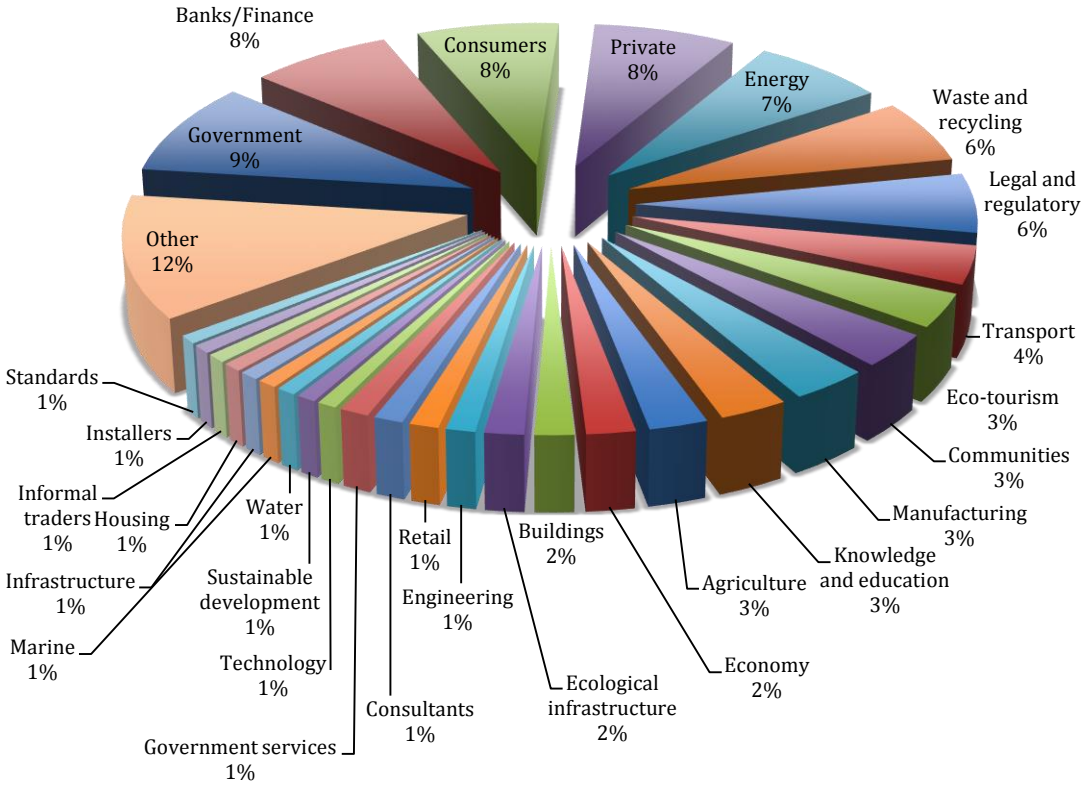

Figure 5.7: Components of the eThekwini green economy identified through the survey

The energy sector, inclusive of both renewable energy and energy efficiency was highlighted at 7%. Solid waste, inclusive of related recycling activities, is the fourth

most frequently mentioned component at 6%. Also at 6% is the legal and regulatory component. This component includes national laws, local bylaws and government policies.

Some of the components highlighted at less than 6% frequency will be briefly discussed in this section but will not be carried through the quantitative presentation in this chapter. All the components that had higher than 6% frequency will be discussed.

According to 4% of information provided, on components, transportation is an important sector of the eThekwini green economy. Eco-tourism that is inclusive of hotels and restaurants was highlighted by 3% of responses. Survey respondents raised communities, which comprise of residents, people and citizens of eThekwini Municipality, at a 3% frequency. Manufacturers and producers of goods, within the EMA, were cited at 3% frequency. Knowledge and education could be linked to awareness, but was kept separate due to these components playing a more robust role in developing the foundations of the eThekwini green economy. Agriculture only had 3% frequency rate. The economy was highlighted at 2%. This included the broader economy, free trade and general commercial activities. According to 2% of responses, new and existing buildings are seen as being an important component of the eThekwini green economy. The last category of components with 2% frequency is ecological infrastructure, which relates to eThekwini Municipality's natural environment and biodiversity.

5.4.3 Collaboration with other components

Respondents of the survey were requested to rate the components that they had highlighted in a scale of one to five, according to the degree that respondents perceive the component collaborating and interacting with other components within the eThekwini green economy. A weighted average of responses were taken and the collaboration level of the top seven, most frequent, components are contained in Figure 5.8. Banks were highlighted as being the most connected at 3.86, followed by energy and legal and regulatory at 3.75. Respondents rated consumers as being the least collaborative within the green economy. However, the private sector does not collaborate, relatively, with other components of the eThekwini green economy, as indicate by the weighted average of 3.18.

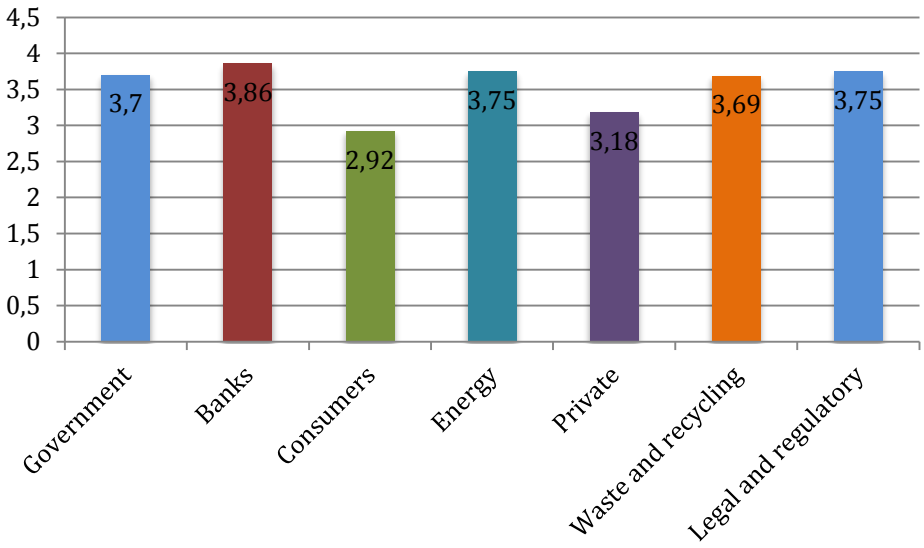

Figure 5.8: Mean collaboration of components with other components

Component	Medium	Mode	Range
Government	4	5	5
Banks	4	4	5
Consumers	2	0	5
Energy	4	3 and 5	5
Private	3	2	5
Waste and recycling	4	4	5
Legal and regulatory	3	5	5

Table 5.3: Medium, mode and range of collaboration with other components

As can be seen in Table 5.3, government and legal and regulatory components were most often scored at five, which would indicate that the majority of responses do see these components as having the most amount of interaction with other components. The most frequent score indicated for consumers was zero.

5.4.4 Contribution to the green economy

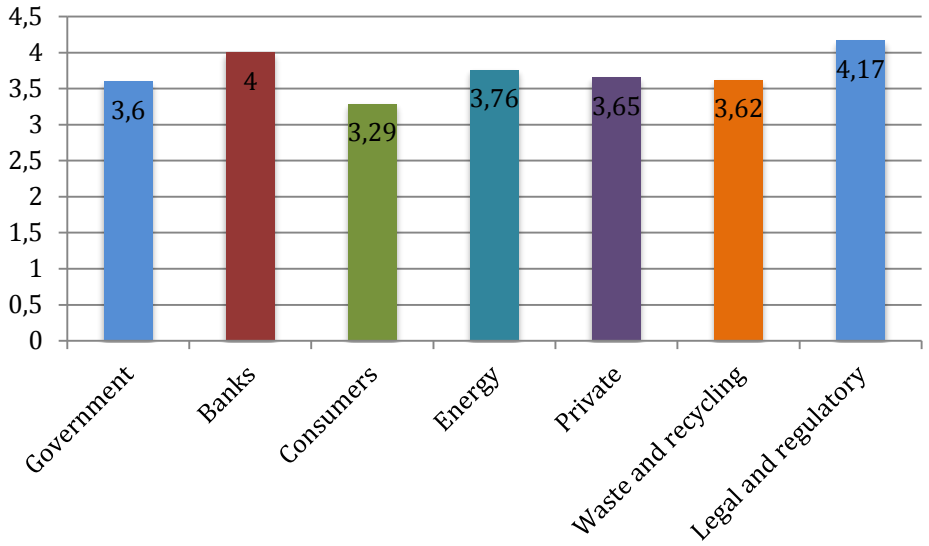

Figure 5.9: Mean contribution of components to the green economy

According to Figure 5.9, the legal and regulatory component can make the largest contribution to the development of the eThekwini green economy, followed by banks or access to affordable funding. Consumers are again ranked as having the least ability to contribute to the development of the eThekwini green economy. However, it must be noted that ultimately, demand is derived from consumers and without this demand there will be no market for green goods and services.

Component	Medium	Mode	Range
Government	3	3 and 4	5
Banks	4	4	5
Consumers	3	3	5
Energy	4	4 and 5	3
Private	4	4	5
Waste and recycling	3	5	5
Legal and regulatory	4	5	5

Table 5.4: Medium, mode and range of contribution of components to the green economy

The range of scores indicated for components all equate to five, except for the energy component which equated to three. This indicates a higher level of agreement

amongst respondents on the contribution of the energy sector to the eThekwini green economy, as indicated in Table 5.4.

5.4.5 Decisions made in a rational manner

According to respondents, the legal and regulatory component and banks approach decisions within the eThekwini green economy in the most proactive and strategic manner, at 4 and 3.6 respectively, as depicted in Figure 5.10. Consumers are yet again rated the lowest, at 2.63, in terms of being rational in decision making.

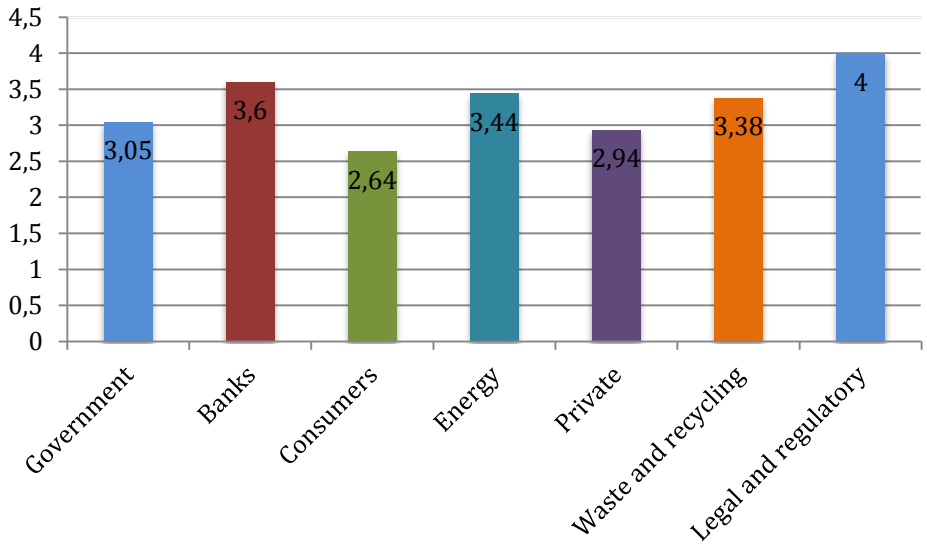

Figure 5.10: Mean decisions of components made in a rational manner

Component	Medium	Mode	Range
Government	3	3 and 4	4
Banks	3	3	5
Consumers	2	2	5
Energy	3	3	5
Private	3	3	4
Waste and recycling	3	4	5
Legal and regulatory	4	3, 4 and 5	5

Table 5.5: Medium, mode and range of decisions of components made in a rational manner

As indicated in Table 5.5, consumers seem to be consistently viewed as making the least rational decisions, with a medium score of two and mode score of two as well. On the other end of the spectrum is the legal and regulatory component, which seldom makes irrational decisions.

5.4.6 Importance for the green economy

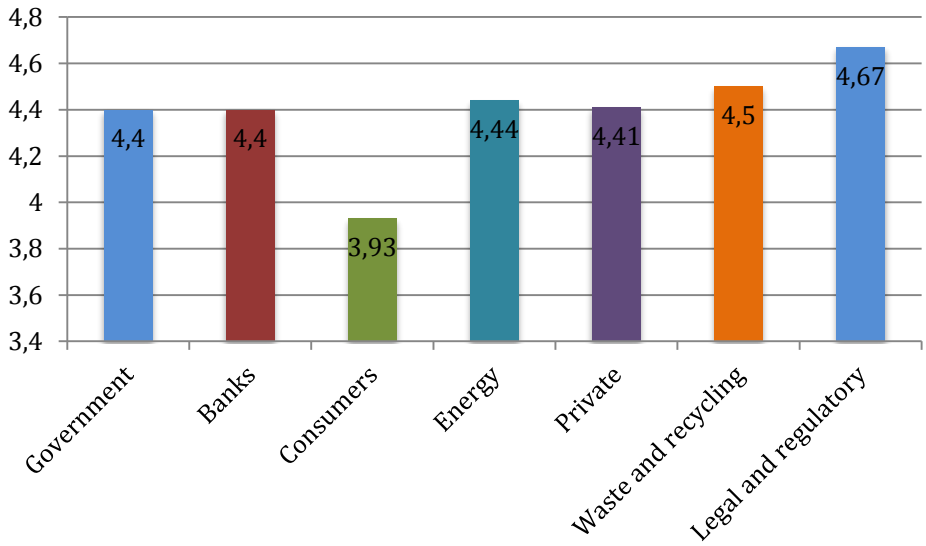

Figure 5.11: Mean importance of components for the green economy

The top seven components, according to respondents, all occupy a relatively high importance for the existence and growth of the eThekwini green economy, as indicated in Figure 5.11. Consumers seem to be viewed as the least important for the green economy, with legal and regulatory being the most import, at 3.93 and 4.67 respectively.

As viewed in Table 5.6, all components are seen as being important for the functioning of the eThekwini green economy.

Component	Medium	Mode	Range
Government	5	5	5
Banks	4	5	5
Consumers	4	5	5
Energy	4	4	5
Private	5	5	5
Waste and recycling	5	5	5
Legal and regulatory	5	5	5

Table 5.6: Medium, mode and range of importance of components for the green economy

5.4.7 Size of the components

Respondents were asked to rate the size of each component, relative to other components, as can be seen in Figure 5.12. The private sector was rated as being the largest component for the eThekwini green economy at 4.12, followed by the banking sector at 3.93. The waste and recycling sector is the smallest sector, but it should be noted that later on in this research the waste and recycling sector, and other sectors, are classified as a sub-component of the private sector. Government is ranked as being the second smallest at 3.5.

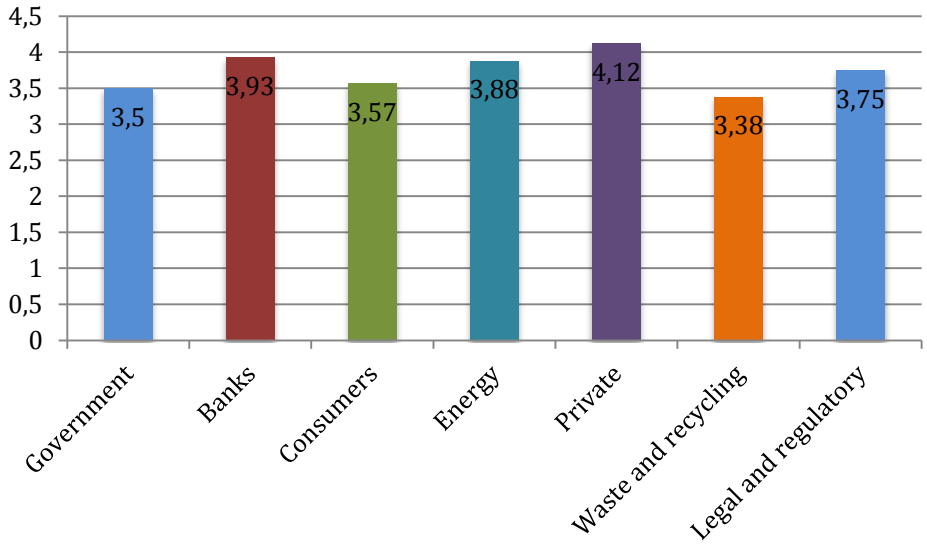

Figure 5.12: Mean size of components within the green economy

Component	Medium	Mode	Range
Government	3	5	5
Banks	4	4	5
Consumers	3	3 and 5	5
Energy	4	5	5
Private	4	4	5
Waste and recycling	3	3	5
Legal and regulatory	4	4 and 5	5

Table 5.7: Medium, mode and range of size of components within the green economy

All of the components, as displayed in Table 5.7, have been viewed as being medium to large components of the eThekwini green economy.

5.4.8 Interaction of components with the green economy

Respondents were asked to rank components according to the manner in which they interact with the economy on a scale of zero to two, with zero being no interaction, one relating to indirect interaction and two being direct interaction. As can be seen in Figure 5.13, the energy sector has the most direct level of interaction with the eThekwini green economy, followed closely by the private sector. Having the least direct interaction is government at 1.42 and the banking sector at 1.54.

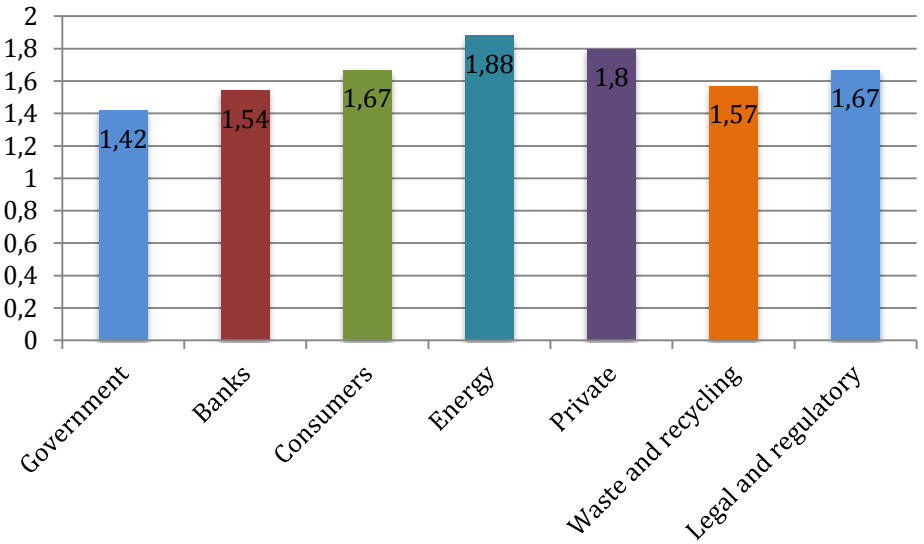

Figure 5.13: Mean interaction of components with the green economy

5.4.9 Time lag in response to stimuli

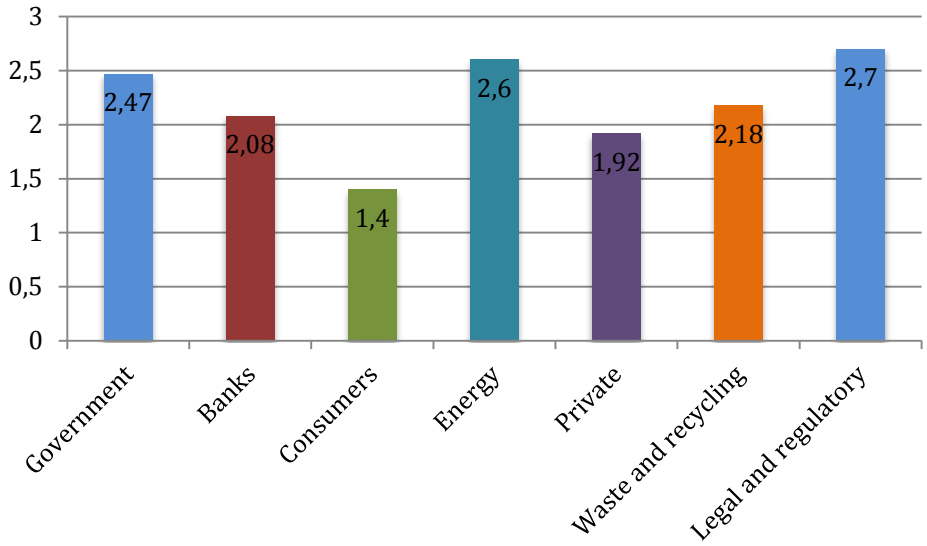

Figure 5.14: Mean time lag of components response to stimuli

A question was posed in the survey that required respondents to indicate how long components take to react to stimuli, with zero being no impact, one being immediate impact, two being short-term impact and three being long-term impact. Components that are inherently bureaucratic and need a long lead time for planning are ranked as having the slowest response time: legal and regulatory at 2.7, energy at 2.6 and government at 2.46. Consumers are less restrained and have the ability to respond almost immediately at 1.4, as can be seen in Figure 5.14.

5.4.10 Intensity of decisions on the economy

Respondents were asked to rate components on the impact that the components have on the eThekwini green economy, with zero indicating no impact, one indicating not intense, two indicating somewhat intense and three indicating intense. As can be seen in Figure 5.15, all listed components have an impact on the eThekwini green economy led by energy at 2.85, banks at 2.83 and the private sector at 2.73.

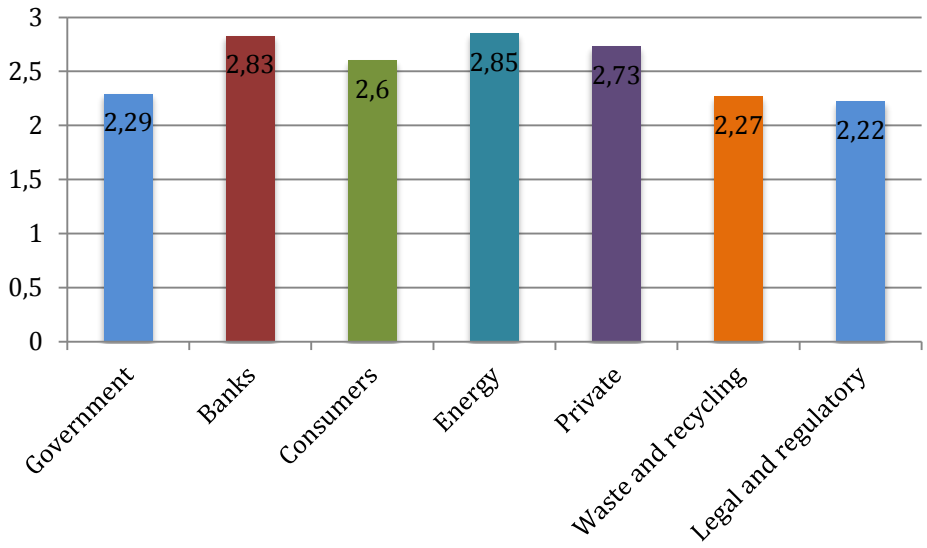

Figure 5.15: Mean intensity of components decisions on the green economy

5.4.11 Random decision making

This section presents the findings on whether respondents are of the view that components make decisions in a random manner. There were two questions in the survey that sought to determine this. One appears in question three and the other as question seven. The respondents indicated similar behaviour of components in both questions three and seven, except for consumers and the waste and recycling sector, which showed an increase in question seven.

5.4.11.1 Government

Figure 5.16 displays the respondents input on whether government, at all three levels, makes decisions at random. The majority of respondents, 63%, perceive government as not being random, while 23% are of the notion that government's decisions are random. Fourteen percent of respondents did not provide information to the question.

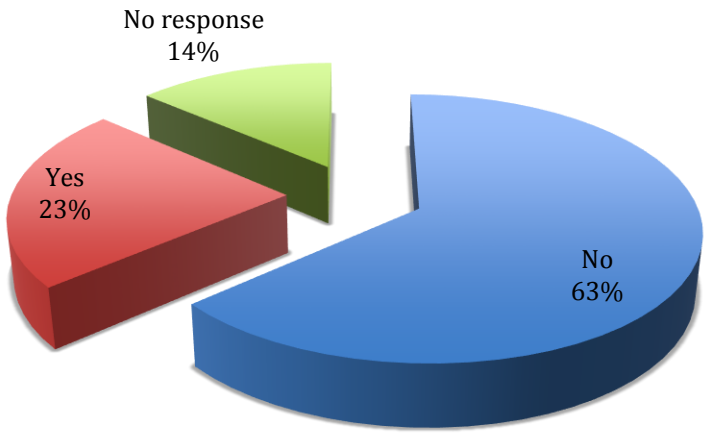

Figure 5.16: Randomness of government decisions

5.4.11.2 Banks and finance

Banks and access to finance, was also rated by respondents and is depicted in Figure 5.17. A larger number of respondents view banks and the finance sector as not making decisions with any randomness. This is at 78%. Seventeen percent of the respondents view banks and the finance sector as making decisions that can be classified as random. No response to the question accounted for 5%.

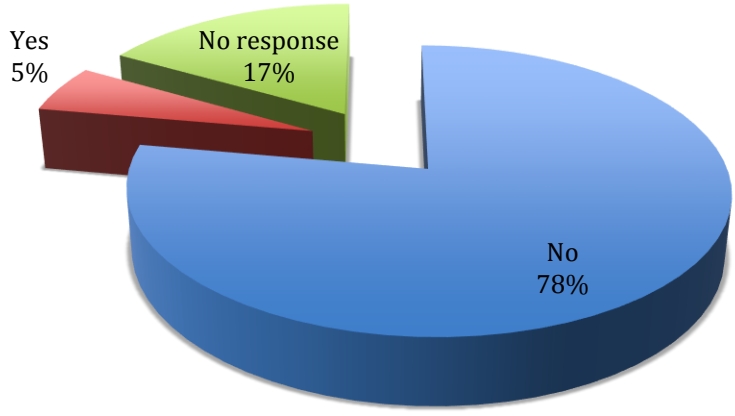

Figure 5.17: Randomness of banks and finance decisions

5.4.11.3 Consumers

Respondents are tied in viewing consumers as making random decisions and not making random decisions, both accounting for 39%. Respondents that did not provide information to the question account for 22%. This is displayed in Figure 5.18.

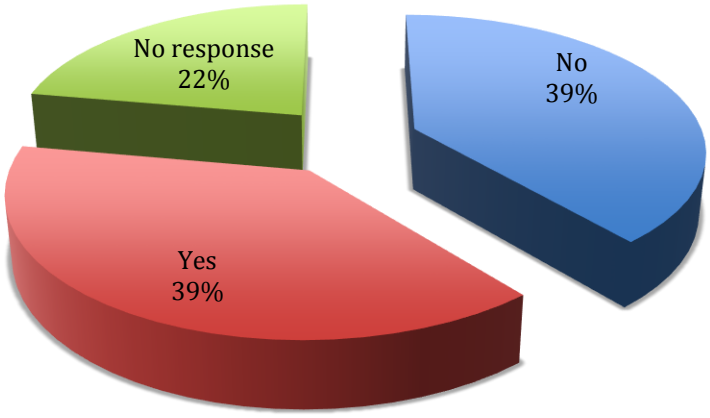

Figure 5.18: Randomness of consumers' decisions

5.4.11.4 Energy

Nineteen percent indicated that the energy sector does have some randomness to the decisions that are taken. Most, 69% of respondents view decisions as not having any randomness to it. There was 12% non-response to this question. This can be seen in Figure 5.19.

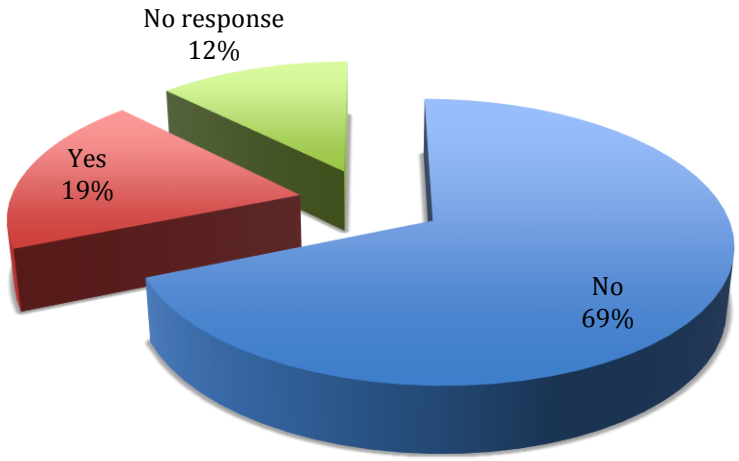

Figure 5.19: Randomness of energy sector decisions

5.4.11.5 Waste and recycling

The opinions of respondents for the waste and recycling sector are less polarised than for the energy sector. Forty seven percent of respondents have indicated that the waste and recycling sector does not make decisions at random, as depicted in Figure 5.20. In contrast 40% of respondents have the opposite view, that there is randomness in decision making. There was a non-response rate of 13%.

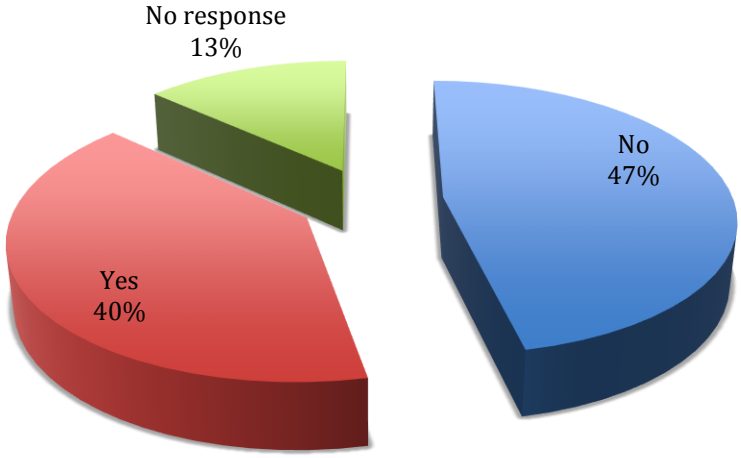

Figure 5.20: Randomness of waste and recycling sector decisions

5.4.11.6 Legal and regulatory

The bulk of the respondents view the legal and regulatory sector as being very strategic and lacking in randomness when making decisions. This is indicated by 79%. A minority of respondents, 14%, sees the sector as imbuing some randomness when making decisions. Seven percent of respondents have not provided any response to the question. Refer to Figure 5.21.

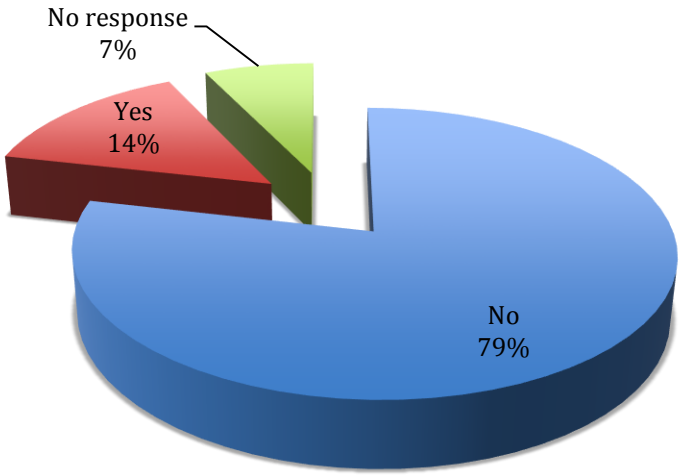

Figure 5.21: Randomness of legal and regulatory sector decisions

5.4.11.7 Private sector

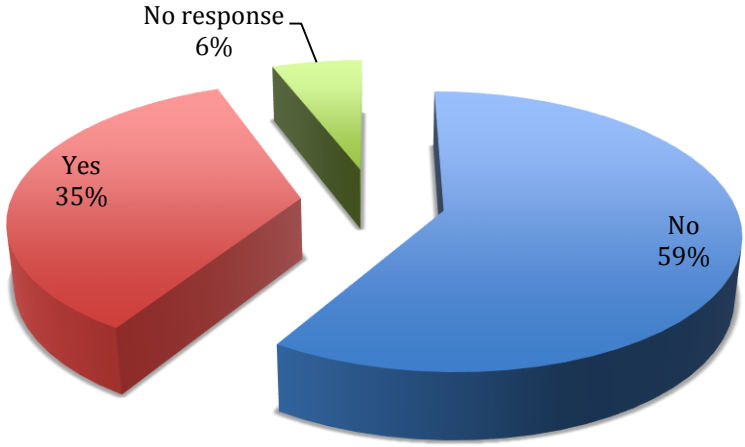

Figure 5.22: Randomness of private sector decisions

Decisions in the private sector of the eThekwini green economy are made without taking a random approach, according to 59% of responses. Thirty five percent of responses, on the contrary, see randomness for private sector decisions, with 6% of respondents not providing a response, as indicated in Figure 5.22.

5.4.12 Indicators

Respondents provided a range of indicators that could be utilised to monitor the health of the eThekwini green economy. Indicators cover both quantitative and qualitative elements, with a heavy slant towards quantitative indicators.

Indicators highlighted by respondents were categorised into their relevant thematic areas, but it should be noted that certain quantitative indicators such as energy, waste and emissions should be monitored on a per capita basis, in addition to aggregated figures. A snapshot of indicators identified by respondents is displayed in Figure 5.23.

Energy indicators, at 13%, were highlighted the most by respondents. A variety of energy indicators were suggested that cover both renewable energy and energy efficiency, in addition to the energy mix and consumption measures. Deriving energy intensity figures, against the economy and population were also highlighted. Marketing and awareness was the second most mentioned type of indicator at 8%. This indicator relates, generally, to the broad level of awareness amongst the eThekwini population on matters that pertain to the eThekwini green economy. The third most mentioned category is green growth. Green growth indicators encompass total value that is generated in the green economy, investment that results from such activities and the number of new organisations that are engaged. Also highlighted at 7% are waste reduction and recycling indicators, which includes diversion of waste from landfills, amount of waste recycled and waste intensity figures against the economy and population. GHG emissions make up 6% of all indicators mentioned by respondents and include accounting of total emissions and reduction of emissions, towards reduction targets.

Green employment, which accounts for 5%, purely aims to monitor the amount of jobs created within the eThekwini green economy. This can be disaggregated into the various sectors that make up the green economy. Green spaces, at 5%, primarily related to monitoring the amount of physical space that is protected and forms part of the natural asset base of the eThekwini Municipality. Monitoring of physical, mental

and broadly social wellbeing make up 4% of total indicators. Respondents mentioned the conservation of water, water efficiency and health, at 4%, as an area that would have far reaching consequence for daily activities. Also at 4%, is the tracking of green projects. The indicators that are less than 4% will not be discussed further in this section, but some indicators will be brought back into the discussion in chapter six.

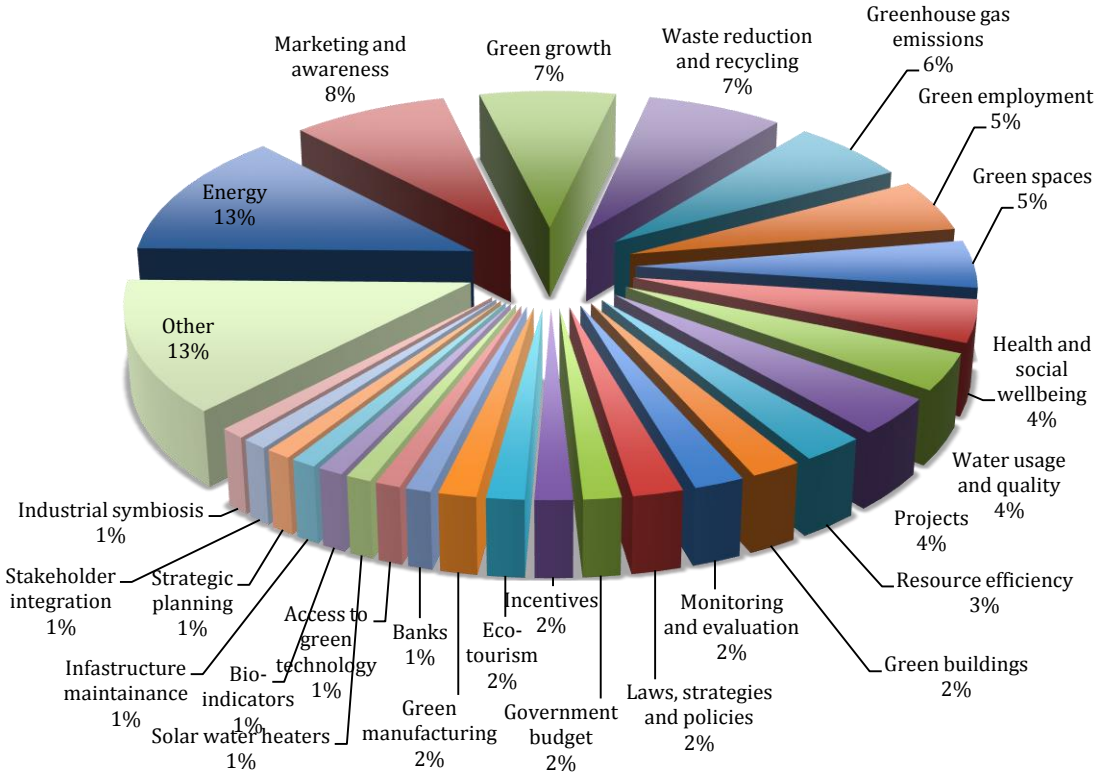

Figure 5.23: Indicators for the eThekwini green economy

5.5 Conclusion

This chapter began with qualitative data presentation, interviews and the demographics of respondents. This was followed by the tag cloud. Themes that emanated from the interviews were then discussed and included: definition of the eThekwini green economy, key components, the characteristics of the components, drivers, indicators, challenges and recommendations for stimulating the eThekwini green economy.

The following section presented the findings from focus groups which followed a similar outline as for interviews. Demographics of participants were first presented, which was followed by the tag cloud. Thereafter, the themes that emanated from the

focus groups were discussed and included: the existence of the eThekwini green economy, components, leverage points that are similar to the drivers discussed for the interview findings, interaction and learning, indicators, challenges and recommendations for growing the eThekwini green economy.

Thereafter, quantitative findings through surveys were presented. The first aspect was the response rates of the survey, followed by the components highlighted by respondents. The next sub-section discussed the manner in which respondents view key sectors' decision making, in terms of randomness. The last aspect of the quantitative findings were the indicators.

The next chapter will analyse the findings from this chapter, while triangulating data sources. Also included in the next chapter is the development of a framework. This framework will serve to demonstrate the manner in which the eThekwini green economy operates.

CHAPTER SIX: DISCUSSION

6.1 Introduction

This chapter will discuss and analyse the findings from the qualitative and quantitative data collection process, which is contained in the previous chapter. In addition, the primary data collected will be triangulated with information from chapters two and three, both literature orientated.

The first section of this chapter will discuss response rates to both quantitative and qualitative data collection methods, which will be linked to one of the key assumptions that this research was predicated on. The second section of this chapter will discuss whether the eThekwini green economy does in fact exist. Components of the eThekwini green economy will then be discussed. Following on from the discussion on components, critical leverage points for the eThekwini green economy is honed in on. The leverage points are components that will have a catalytic effect on the green economy, or a possible disastrous impact. Characteristics of components will be discussed, followed by the manner in which components interact. Challenges that face the eThekwini green economy and recommendations that should be implemented to stimulate the green economy are discussed. Indicators that were raised by respondents are synthesised into a coherent structure for the eThekwini green economy. The penultimate section of this chapter will contain the framework on how the eThekwini green economy operates. The chapter will be rounded off with a conclusion section.

6.2 Response rate: Data collection

The response rate for the interviews was 100%. The interviews were conducted with the intended experts even though appetite for participation by experts that operate on the fringe of the eThekwini green economy was tested.

It was found that focus groups were more difficult than interviews to set up. Large organisations like the SASA and the BASA were engaged and accepted requests to facilitate focus groups with their relevant members. However, reluctance was observed from their members to participate in focus groups, for various reasons.

SASA indicated that it had set up focus group appointments for two different dates. However, both focus group sessions had to be cancelled due to the unavailability of identified participants. This was despite the fact that SASA had verbally indicated that energy generation from their by-products can create at least 30,000 jobs.

The contact person at BASA highlighted that the research topic is niche and as most banks are based in Gauteng, he was doubtful that the banks would be in a position to assist. The contact person indicated that he would pass the request on to banks during their next meeting. No further response was received from any of the bank stakeholders.

The greatest cause for concern was the dismal response rate to the survey, especially given the type of people and organisations that made up the research population and sample. The response rates were: participated - 12%, responded no - 8%, uncontactable - 19% and no response - 61%.

The companies and organisations that could not be contacted triggered a further search for their contact details, i.e. a Google search was undertaken which always yielded the same contact details or no relevant information. The trend that emerged showed that telephone calls went unanswered and frequently an 'out of order' message was received. In addition, a plethora of emails bounced. Multiple respondents indicated that they were in the process of closing down or being liquidated. *"Our company has closed down and I cannot contribute to this survey at this point"* (Survey Respondent S296). *"Company being liquidated"* (Survey Respondent S299). This is not a good sign for the sustainability of the eThekwini green economy. It is the position of this research that the attrition rate of companies operating within the eThekwini green economy is high.

It was found that there was a large percentage of identified people who did not respond to the survey. Multiple people indicted that they would respond, but many did not. In addition, a lot of people said that they are too busy to participate. It emerged that the high level of non-participation is due to the fact that people do not have a thorough understanding of the eThekwini green economy, or unaware of their actual participation in the green economy. While people might own businesses or work within the green economy, they are so focused on the provision of goods and services, that they do not realise they are a part of the eThekwini green economy. This was

alluded to and confirmed by Interview Respondent I14 *"In terms of the green economy, people are doing it and they are not even aware …"* and Interview Respondent I10 *"… in developing the Durban Climate Change Strategy we found a similar sort of thing where there was quite a lot of stakeholders that had some climate change knowledge about a specific sector, but there were very few stakeholders that had a broad range of climate change knowledge"*. Respondents to the survey also highlighted similar responses. *"Unfortunately, I cannot help with this survey as I have no idea on your research topic"* (Survey Respondent S152). *"Not sure I am the right professional to answer these questions"* (Survey Respondent S186). This confirms a large part of the second assumption of the research: a thorough understanding of the eThekwini green economy does not exist. The position can be triangulated and somewhat supported by Borel-Saladin and Turok (2013) who state that due to the definition of a green economy not being widely accessible and with various definitions, there could be a varying number of jobs in a green economy unaccounted for. Further support can be drawn from Pahle et al. (2016, pg. 2), who state *"GE is a relatively vague concept that builds on a number of implicit assumptions, which have been scrutinised in scientific literature"*.

6.3 Existence of the eThekwini green economy

One of the aspects that this research was predicated on, was that the eThekwini green economy is still in its infancy and offers substantial opportunities for job creation and economic development. This assumption seemed to be validated early on in the research by Maia et al. (2011) who calculated the national job creation potential for the green economy to be 462,567. EThekwini Municipality (2013a) indicated that actual green jobs in the EMA amounted to only 6,107. A major concern observed during the data collection process is that 19% of companies initially identified by eThekwini Municipality (2013a) could not be contacted, leading to the conclusion that the companies no longer exist or are in the process of closing down. There is a small probability that the companies could have relocated. Some survey respondents indicated that they are in the process of being liquidated or closing down their operations. New organisations within the eThekwini green economy, from the time the initial scoping research was undertaken by eThekwini Municipality, were not quantified, nor were the number of jobs lost during closure of the initially identified companies, as this was out of the scope of this research.

It further emerged there was a lot of commonality amongst the focus groups and interview data. This is viewed as triangulation and as such, increases data trustworthiness and credibility. Both data collection methods have essentially proven the existence of the eThekwini green economy, but it is still in the early stages of development. This conclusion was arrived at due to input from government officials and private sector stakeholders.

There was a minority position that eThekwini Municipality does not have a green economy. A prominent member of the international climate change scientific community that is based in eThekwini Municipality commented as follows *"I do not believe that Durban has a green economy, yet. There are scattered and small scale examples of new technologies and improved efficiencies in some sectors, but that is not the same as a green economy. To my mind a green economy would be systemic in influence; focused on managing the trade-offs and synergies between sectors; prioritise issues of justice, equity; promoting climate safe development and be based on a localised understanding of planetary boundaries. A green economy would fundamentally change patterns of consumption and production rather than just trying to make the existing system slightly more efficient"* (Survey Respondent S556). This statement from the scientific leader, Survey Respondent S556, cannot be discounted. However, the response seems to imply that the existing green activities are happening at the ground level. This is in isolation from strategic or systemic change which may be driven by authority. As a result, this implies that the eThekwini green economy is unfolding in an organic manner. One of the findings of this research is that while people operate within the eThekwini green economy, they tend to be so focused on their operations that a holistic picture of the broader green economy is not developed.

Another element that emerged was that there is general optimism that while the eThekwini green economy is still in its elementary phases, there is huge potential for the green economy to develop jobs, protect the environment, contribute to the reduction of social ills and contribute positively to the larger economy. An example supporting this position, is the potential green job creation figures presented by Maia et al. (2011) and the actual green job figures presented by eThekwini Municipality (2013a).

This study can therefore also conclude that the eThekwini green economy has emerged as a result of organic processes within the broader economy, from a bottom-up approach, currently in its infancy but with a lot of growth potential. It should be noted that while there are strategy documents, such as the DCCS, that lend itself to the eThekwini green economy, there remains a massive gap in terms of actual strategic leadership and implementation that will entrench the green economy and grow it in a coordinated manner. This is leadership relating to the local government authority, i.e. eThekwini Municipality. This should not be interpreted as advocating for centralised management of the eThekwini green economy, because in terms of a CAS, centralised management is not possible, but alludes to the fact that the government sector needs to fulfil its particular role in providing direction, amongst other roles. Government intervention with regards to specific projects, such as the solar water heater programme, have had a positive impact on the green economy. However, once the programmes are concluded, suspended or stopped there is a drop in green economic activity in that sector. In addition, there were a plethora of national government white papers, plans, frameworks and strategies, as discussed in chapter two, but those related mainly to the general intended direction (National Planning Commission, 2012; Department of Energy, 2011; Department of Energy, 2016b; Department of Economic Development, 2011b; Department of Trade and Industry, 2017; Republic of South Africa, 2017). The translation of these documents into actual implementation is scarce. The lack of policy documents, specifically, within local government was noted in the literature and highlighted by government officials during the data collection phase. Lastly, government officials indicated that government direction is not translating into action because of the lack of policy.

6.4 Components of the eThekwini green economy

Before discussing the components of the eThekwini green economy, it will be prudent to summarise the components identified through the literature review, quantitative and qualitative data collection process.

There were six sectors presented by Burkart (2009) that make up the green economy, these are: renewable energy, green buildings, sustainable transport, water management, waste management and land management. Furthermore, the following were discussed in chapter two: green buildings (United States Environmental Protection Agency, 2016; Gibbs and O'Neil, 2015), food waste (Oelofse and Nahman,

2013), informal economy (Smit and Musango, 2015b; Davies and Thurlow, 2010), environmental activism (Cock, 2014), technology (Kaggwa et al., 2013), mining for minerals needed for the manufacture of green goods (Montmasson-Clair, 2012), agriculture (Musvoto et al., 2015), eco-tourism (Bricker, 2017; Gheorghe and Pârvu, 2016) and buyer behaviour (Anvar and Venter, 2014).

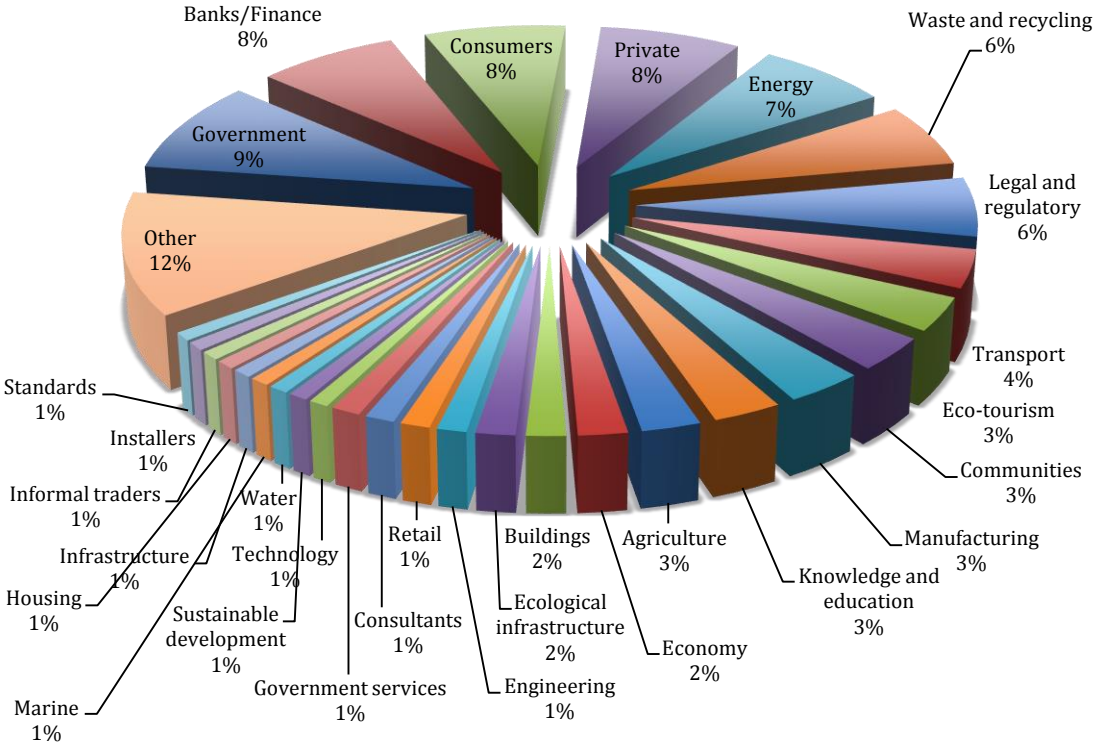

Figure 6.1: Components of the eThekwini green economy identified through the survey

Figure 6.1 summarises the components that were collected from the quantitative surveys, with the most frequent components being: government (9%), banks (8%), consumers (8%), private sector (8%), energy (7%), waste and recycling (6%) and legal and regulatory (6%).

During the interviews, respondents identified four key sectors: communities, private sector, government sector and the international sector. The community sector comprises sub-components that cover: consumption, community or social activism and provision of labour. The private sector, relates to activity by organisations other

than government, largely for profit organisations, and include the following sub-components: agriculture, automotive, real estate, petro-chemicals, manufacturing, banks, technology, eco-tourism, transportation, energy and waste and recycling. The public sector, which are the elements related to government operations, are comprised of the following components: three levels of government, legislation, policy, enforcement, incentives, energy, waste and recycling and water. The international sector largely relates to agreements amongst national governments and organisations that have an international footprint.

The aggregation of components into larger sectors did not emerge as clearly during the focus groups, when compared to interviews. As a result, the components are not categorised and include the following: behavioural change, rural green economy, vested interested in business as usual, energy, innovation and technology, natural environment, government, policy, regulations, enforcement, consumers, education and awareness, private sector, banks, incentives and implementation.

The scoping assessment of green companies and jobs that are based in the EMA, according to eThekwini Municipality (2013a), merge well with the components that emanated from the survey, interviews and focus groups, but have missed some of the components that have been highlighted in this research due to different key research questions. Nevertheless, the sectors identified and measured by eThekwini Municipality (2013a) are: energy, waste management, general services, natural resources, property, agriculture, water, manufacturing and skills development. A slight difference in breadth between natural resources, as per eThekwini Municipality (2013a), and ecological environment, identified through this research, which is more encompassing and not only relates to nurseries and landscaping aspects, but involves the protection of natural resources and green spaces.

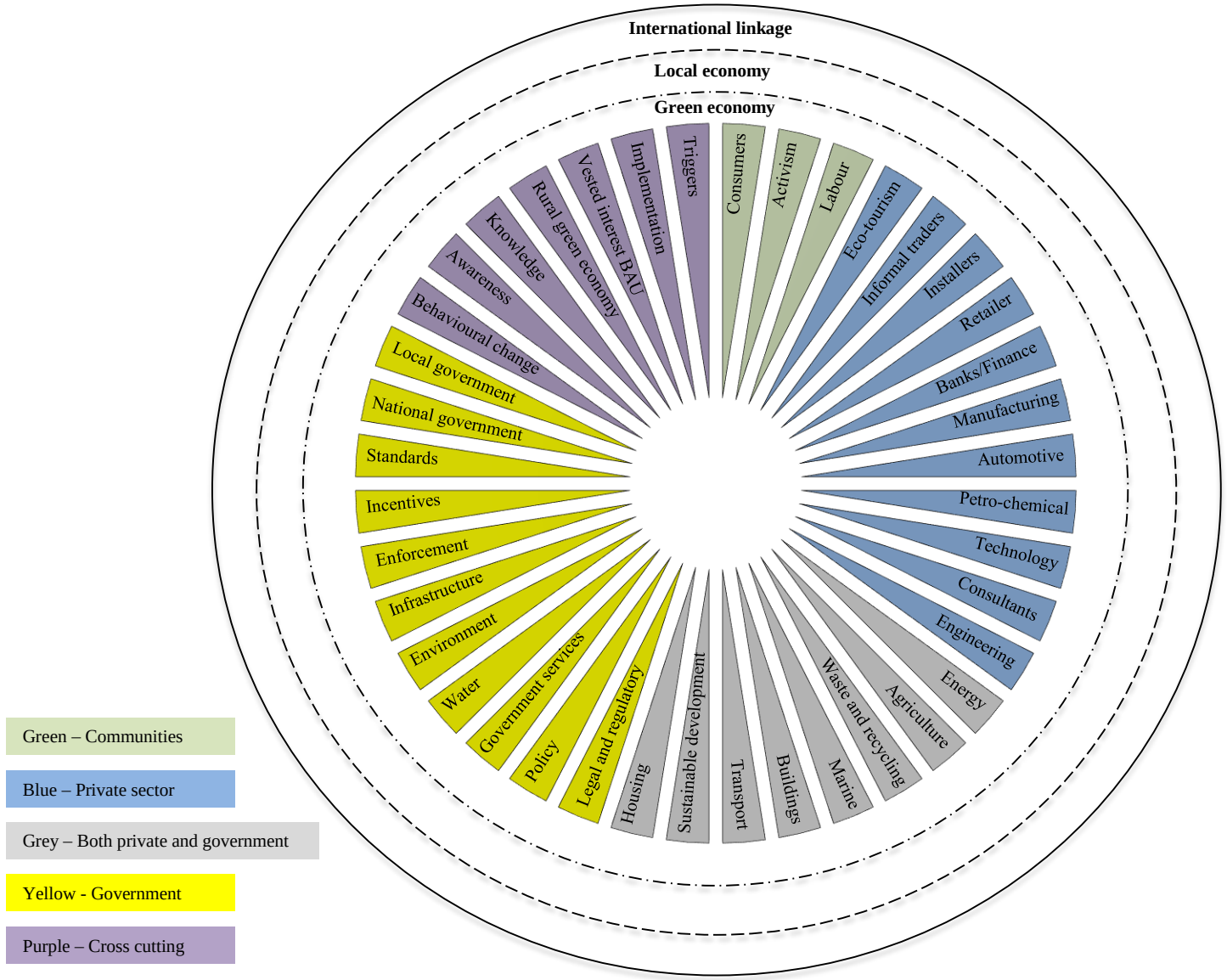

Figure 6.2: Components of the eThekwini green economy

When components from all data sources, as highlighted above, are triangulated the number of components that emerged are seven, with forty two sub-components, as depicted in Figure 6.2. This total figure is comprised of three components that are classified under communities, eleven under the private sector, eight that have overlap between the private and government sectors, eleven that form the government components, seven that are overarching and two that can be seen as encompassing the green economy.

It is important to specify how the data was triangulated. Respondents highlighted individual components, thereafter, similar components were clustered. For example, energy mix and energy generation were deemed to be similar and were clustered. Once the common components were clustered, they were grouped into large clusters or sectors that share fundamentals and where they inherently reside from a conceptualisation point of view in the green economic system. To provide an example, once aggregated, incentives and policy is inherently a function of government and were clustered under the government sector. The basis for clustering came partly from data collected from surveys, interviews and focus groups where respondents highlighted linkages. Examples include: *"I think government is number one in terms of legislation and governance. We need private sector, when I say private sector I am specifically looking at private companies and banks …"* (Interview Respondent I2) and *"Other countries have incentives to do this and is driven by government"* (Focus group Respondent FG3B). Existing ACE models have been relied on to guide some of the clustering of components, such as Cincotti et al. (2011); Basu et al. (1998) and Riccetti et al. (2015).

An important point that needs to be kept in mind is that while components and sub-components have been identified through this research, there is a very real possibility of further disaggregating the sub-components. As an example of the sub-component standards: under the government component, can include building standards that will be relevant when new buildings are being constructed (Klausbruckner et al., 2016; Turok and Borel-Saladin, 2016) or Electrical Grid Code which would be relevant when renewable energy generators connect to the eThekwini Municipal electrical grid (Sewchurran and Davidson, 2017; Relancio et al., 2016). *"I am involved in the technical committee that is involved in Grid Code compliance and power plants being connected to the grid. So, that is happening at a national level, but eThekwini is also*

doing that" (Interview Respondent I12). Another example is the manufacturing sub-component, which can be segmented into the various goods that are being manufactured or assembled within the EMA. These include solar water heaters and photovoltaic panels, which utilise different materials and manufacturing processes. The identification of components to that minute level or detail is out of the scope of this research, as it would involve qualitative data collection from each of the sub-component stakeholders, who were contacted via quantitative methods during this research. In addition, the time required for one researcher to undertake such an arduous tasks across forty two sub-components would not possible the timeframe for this research. As a result, sub-components will be utilised for this research as the focus, of the research, is on structural aspects of the eThekwini green economy.

It should be noted, the remainder of this thesis will utilise the word 'component' to make reference to both components and sub-components.

The components that have been identified by the primary data collection process and triangulated with secondary literature provide a rather comprehensive identification of components that make up a green economy. In addition, all core components that would be essential for the operation of an economy have been identified. This can also correlate to the EURACE model (Deissenberg et al., 2008), revised Aspen model (Basu et al., 1998) and to an extent the model developed by Silvestre et al. (2016).

It has emerged that sectors need to be thought of in terms of 'life cycle' benefits and impacts, not just the immediate contribution to the financial, social or environmental aspects of the green economy. An example of this is eco-tourism, which in itself will result in a number of positive impacts for the eThekwini green economy, but when taking into account the distance and mode of transport that tourists utilise, namely, fossil fuelled flights and cars, to arrive in the EMA then the total environmental flow to the eThekwini green economy is likely to be negative, while financial and social flows are likely to be positive. *"Of course, the one down side of tourism, is that it does rely heavily on tourists coming from quite far afield and that still has quite a heavy carbon footprint"* (Interview Respondent I13). Scott et al. (2010) and Higham et al. (2016) further support this argument.

This study emphasises that caution must be exercised, not just by eThekwini Municipality, but by all developing nations and cities when developing the green

economy. The starting point for the green economy gaining momentum was when developed nations were trying to find a response strategy to the financial crisis of 2008/2009 (Musango et al., 2014; Faccer et al., 2014). This is being raised and must be read within the context of respondents highlighting manufacturing as important for the eThekwini green economy. However, manufacturing activities are unlikely to take place within the EMA when demand by eThekwini stakeholders and markets that can be served from this locality are subdued. Foster et al. (2016) and Sierzchula et al. (2014) highlight the importance of demand for local manufacturing facilities. The lack of local manufacturing will result in importation of goods from other economies, which by definition will result in an outflow of funds from the eThekwini economy. When there is a level of demand that is below a trigger for initiating manufacturing in the EMA, then a situation will arise where the market will only be satisfied by perpetual imports.

Another specific sector, mentioned by respondents, is agriculture. *"Agriculture is a very small sector in eThekwini, I was thinking in terms of changing agriculture processes in terms of being intensive, more greenhouse type of operations that are space intensive using water drip kind of operations rather than spraying"* (Interview Respondent I6). The notion that agriculture is a small sector within the EMA seems to be confirmed by eThekwini Municipality (2017c) which states that of the 2,555m^2 that eThekwini Municipality covers, only about 6.8% is made up of commercial farms and Municipal open spaces. An interesting figure provided by eThekwini Municipality (2017b) is that the eThekwini agricultural sector contracted by -7.4% in 2016. Furthermore, eThekwini Municipality (2017a) has calculated the GHG emissions for agricultural, land use and forestry, within the EMA for the 2015 calendar year, at 87,868tCO_2e or less than 1% of all emissions that take place within the EMA. As a result, agricultural activity itself is unlikely to be undertaken at wide spread commercial scale, due to the limited availability of suitable land. This then begs the question: why did respondents highlight agriculture? An argument could be made for agricultural activities utilising new techniques, such as greenhouses that focus on urban agriculture and small-scale farmers. The only components that would benefit from sustainable agricultural activities are likely to be wholesalers and retailers, within the eThekwini green economy, as they will be able to charge a premium for their organic produce.

In many instances, components will be waiting for a stimuli from other components in order to undertake their inherent functions. However, components can also operate without specific external stimuli. When the flow of the eThekwini green economy is mapped, it can be noticed that there are a few critical points which if not activated, cause the entire system to become stagnant. For example: in Cincotti et al. (2011); Basu et al. (1998); Riccetti et al. (2015) households supply labour to manufacturers, who supply goods to households, while government taxes the transaction. The process needs to be initiated at a specific point, not just for modelling and simulating purposes but in reality as well. As a result, an enabling legal and regulatory environment becomes critical, which is under the control of government.

One of the key tenets of a CAS is that no agent or component has the ability to robustly understand the entire system on its own (Ellis, 2011; Brady, 2014). The second tenet is that CAS is managed in a decentralised manner and not from a centralised position (Bristow and Healy, 2014; Bale et al., 2015). A legion of components have been identified as being a part of the eThekwini green economy. When all these components play their inherent role in a manner that is effective, transparent and perhaps in a collaborative manner, will the eThekwini green economy have a chance of flourishing.

It was found that alignment of components are critical. What this means is that there needs to be consideration of inputs and outputs from components, in a coordinated manner by all components. This will allow the components to better align themselves, which would then be one of the ways for greater efficiencies to be achieved.

As components have numerous objectives and goals, it is inevitable that there will be clashes. As an example, government is responsible for setting general direction and using tools such as legislation and policy to achieve objectives (Swilling et al., 2016; Cock, 2014) and business entities seek to maximise profit (Baker, 2015; McAfee, 2016). It is the position of this research that these clashes can best be addressed by focusing on strategic direction of the entire eThekwini green economy. When there are clashes, components need to adopt an approach of compromise and collaboration where stakeholders are working towards a common goal. Another tenet of CAS states that each agent or component is inherently heterogeneous to other components (Ellis, 2011; Filotas et al., 2014).

No respondent, whether through survey, interview or focus group, was able to identify all components contained in Figure 6.2, on their own. This does not necessarily mean that the respondents are narrow minded, but rather confirms a key tenet of CAS, i.e. no agent on its own can comprehend the entire system (Ellis, 2011; Brady, 2014). This is also evidence that the correct research approach was adopted. When all of the responses were aggregated and synthesised, a fairly complete picture of the eThekwini green economy started to emerge. Furthermore, the components highlighted through the various primary data collection processes and secondary data source, i.e. literature, seem to converge into recurring elements. The components listed in Figure 6.2 were not prioritised. The next section will discuss components that were classified as leverage points.

6.5 Leverage points of the eThekwini green economy

Another critical aspect of this research was to identify leverage points of the eThekwini green economy. Leverage points according to Meadows (1997, pg. 1) are *"... places within a complex system (a corporation, an economy, a living body, a city, an ecosystem) where a small shift in one thing can produce big changes in everything".* The knowledge of what the leverage points are will allow the relevant stakeholders and authorities to allocate resources and efforts there in order to push on those leverage points. In addition, components will be made aware of the added responsibility and thoughtfulness that will need to be applied, as their decisions will have far reaching consequences. There has been numerous studies undertaken to find and highlight leverage points, such as: Winkler et al. (2015) which looks at various development pathways and focused on sustainable development with relatively lower emissions and by honing in on leverage points that can change development pathways; Brown and McGranahan (2016) studied the informal economy and the manner in which informal settlement inhabitants and informal economy workers can leverage their contributions to ensure positive social and environmental equity; and Castree and Christophers (2015) studied leverage points for utilising finance capital for climate change adaptation and mitigation. The term leverage point refers to aspects and components that have the ability to stimulate all aspects of the eThekwini green economy in a catalytic manner. It should be noted, that if the leverage points are neglected the stimulation of the eThekwini green economy will not be able to leap-frog in terms of development, but would rather have to pursue a path of incremental

growth or possibly result in a retrogressive situation. The work of Abson et al. (2017) and Luederitz et al. (2017) on leverage points revolve around Meadows (1999), who highlighted twelve critical points that act as levers within a system. In descending order of importance: the power to transcend paradigms; the mind-set or paradigm out of which the system arises; the goals of the system; the power to add, change, evolve, or self-organise the system structure; the rules of the system such as incentives, punishments and constraints; the structure of information flows; the gain around driving positive feedback loops; the strength of negative feedback loops, relative to the impacts they are trying to correct against; the length of delays, relative to the rate of the system change; the structure of material stocks and flows; the size of buffers and stabilising stocks relative to their flows; and constraints, parameters and numbers.

The methodology in which primary and secondary data was processed and translated for the identification of leverage points was a critical issue for this research. There was no widely utilised methodology found in the literature that could be easily adopted but examples include: Buchholz et al. (2007) who utilise Multi-criteria Analysis to identify leverage points in an adaptive system; Deelman et al. (2005) who presented the Pegasus framework; and Elsawah et al. (2015) who essentially utilises cognitive mapping to facilitate the extraction of a detailed overview of various agent's mental models, the way they are structured in the system and the manner in which they interact with each other. No guideline was found to be suitable to guide this study. As a result, components were plotted, manually on pieces of paper and their flow mapped. This was undertaken with multiple formats, i.e. causal diagrams, hierarchical structures and mind mapping. The various outputs were triangulated with the frequency of which components were mentioned, their key function and perceived importance for the eThekwini green economy. The mapped processes often resulted in similar findings, which are discussed in this section.

While ten leverage points have been identified, as depicted in Figure 6.3, it is the position of this research that there is one critical leverage point that is of tantamount importance, not just for the growth of the eThekwini green economy, but also for the general well-being of residents in the EMA. This ultimate leverage point is a grouping of interrelated aspects that revolve around decreasing unemployment levels, increasing GDP per capita, increasing discretionary income levels and decreasing the gini coefficient. The leverage point relates to the ability of the population to afford

green goods and services. As highlighted in chapter one of this thesis, a large portion of eThekwini residents are unemployed and GDP per capita is lower than Tshwane Municipality (Statistics South Africa, 2016; eThekwini Municipality 2017b). In such a situation where people are struggling to survive, there is no possible way they can be expected to participate meaningfully in the green economy, particularly when green goods and products come at a financial premium over traditionally less environmentally friendly options. No amount of awareness raising and marketing, in such a situation, will be able to stimulate the eThekwini green economy. It will not be possible to develop any sizeable market, as the fundamental ability of consumers to afford green goods and services will not be in place. The position that inequality has a negative impact on economic growth is illustrated by Cingano (2014) who researches countries that are members of the Organisation for Economic Co-operation and Development. Gründler and Scheuermeyer (2015) has similar findings, but from a larger dataset and Njindan Iyke and Ho (2017) find that in Italy, inequality has a negligible negative impact in the short-term and a significant negative impact on growth in the long-term.

The respondents indicated that national and local government act as a critical leverage point, given its vast authority of setting the strategic direction of the country and aspects that impact the local green economy. National government acts as the author and custodian of legislation and national level regulations which guide the entire country (Klausbruckner et al., 2016; Morris and Martin, 2015). On the other hand, local government is responsible for local bylaws, regulations and implementation in terms of various aspects of service delivery (Reddy, 2017; Khale and Worku, 2015). Even though aspects of the green economy can be adequately included in various strategies and legislation (Department of Energy, 2016b; Department of Economic Development, 2011b; Department of Trade and Industry, 2017), it needs to be accompanied by relevant supporting aspects such as policies and regulations. Without this alignment, it is unlikely to stimulate any growth in the green economy, especially for high value green goods such as photovoltaic panels. Lastly, government plays an integral role in the provision of incentives that have the ability to stimulate specific areas of interest (Dippenaar, 2018; Olubunmi et al., 2016), for example, a financial rebate that serves to reduce the price of a solar water heater to the end-user. Incentives are important and a critical leverage point to bring the price of green goods and

services below perceived financial thresholds that will trigger purchasing behaviour. This is due to the widely held notion that green goods and services are more expensive than traditional goods and services (Dippenaar, 2018; Foster-Pedley and Hertzog 2017). This research has found that in terms of impact for stimulating the green economy, incentives can be ranked in the top three most important leverage points, within and for the eThekwini green economy. It is also important to note that both national and local governments are able to provide incentives, though the exact format of the incentives might differ.

Another important leverage point is triggers. This is an encompassing term that can include a variety of components and aspects. In terms of this research, triggers are viewed as once-off events or situations that act as a strong influence on behaviour change, and can include both man-made and natural events. According to Farmer et al. (2012) *"Small changes have the capacity to trigger large scale events"*. This can be further supported by Rosser (1999)*"Final demands are randomly arriving and set off chains of response through the economy that can occasionally trigger 'avalanches' larger than the initial changes in final demand"*. These triggers can unfold in short bursts or over a prolonged period of time. As a result, the impact on change in behaviour can be almost instantaneously or unfold in a delayed manner. Triggers can include acts of god, climate change induced storms, load shedding, drought situations and man-induced aspects such as key legislation and financial incentives. The ability to capitalise on triggers, when they occur, will require a lot of skill and resources, particularly when unplanned triggers occur that negatively impact people's way of life, which will act as a huge motivator for people to adopt sustainable practices and green goods and services.

Consumers refer to consumption by individuals or organisations. In this context it largely relates to consumption by communities, i.e. ultimate end-users. When consumption patterns change, entire value chains often have economic incentives to satisfy those evolving needs (Sachdeva et al., 2015; Katiyar et al., 2017). However, behaviour change is first needed for the uptake of green goods and services. This is a function of a number of elements, which include awareness and education. However, if consumers are not in a position to satisfy their basic needs financially, they will not be able to satisfy higher level needs – which links back to the critical importance of increasing per capita GDP, increasing discretionary income, decreasing gini

coefficient and decreasing unemployment levels. This can be supported by Pahle et al. (2016, pg. 3), *"Even in areas where renewable based options are competitive, they may still be unaffordable for poor rural households"*.

Respondents highlighted that often, organisations and government are forced to undertake certain actions, when faced with mobilised communities. Community activism, inclusive of environmental activism, can often put organisations into politically incorrect positions, which act as a huge motivator for the organisations to overcome the challenge (Binder and Blankenberg, 2016; Shear, 2014).

This research found that people are the most constant theme that underpins leverage points. Ensuring the right skill level is available in existing labour markets is another leverage point. Without expertise to undertake manufacturing processes or technical analysis, even the best regulations will come to naught, especially when the vital implementation leg of the process is not possible (Baker and Sovacool, 2017; Du Plessis, 2015).

It is the position of this research that the ability to afford green goods and services is critical, this is supported by Newbery (2016) and Brundtland et al. (2012). This is true, not only in terms of goods and services, but also for the cost of financing purchases for which cash is not available. As a result, the banking and financing sector, have a leveraging role to play within the eThekwini green economy. One of the primary ways is by providing access to affordable finance for individual and organisational consumers (Bak et al., 2017; Wilson et al., 2014).

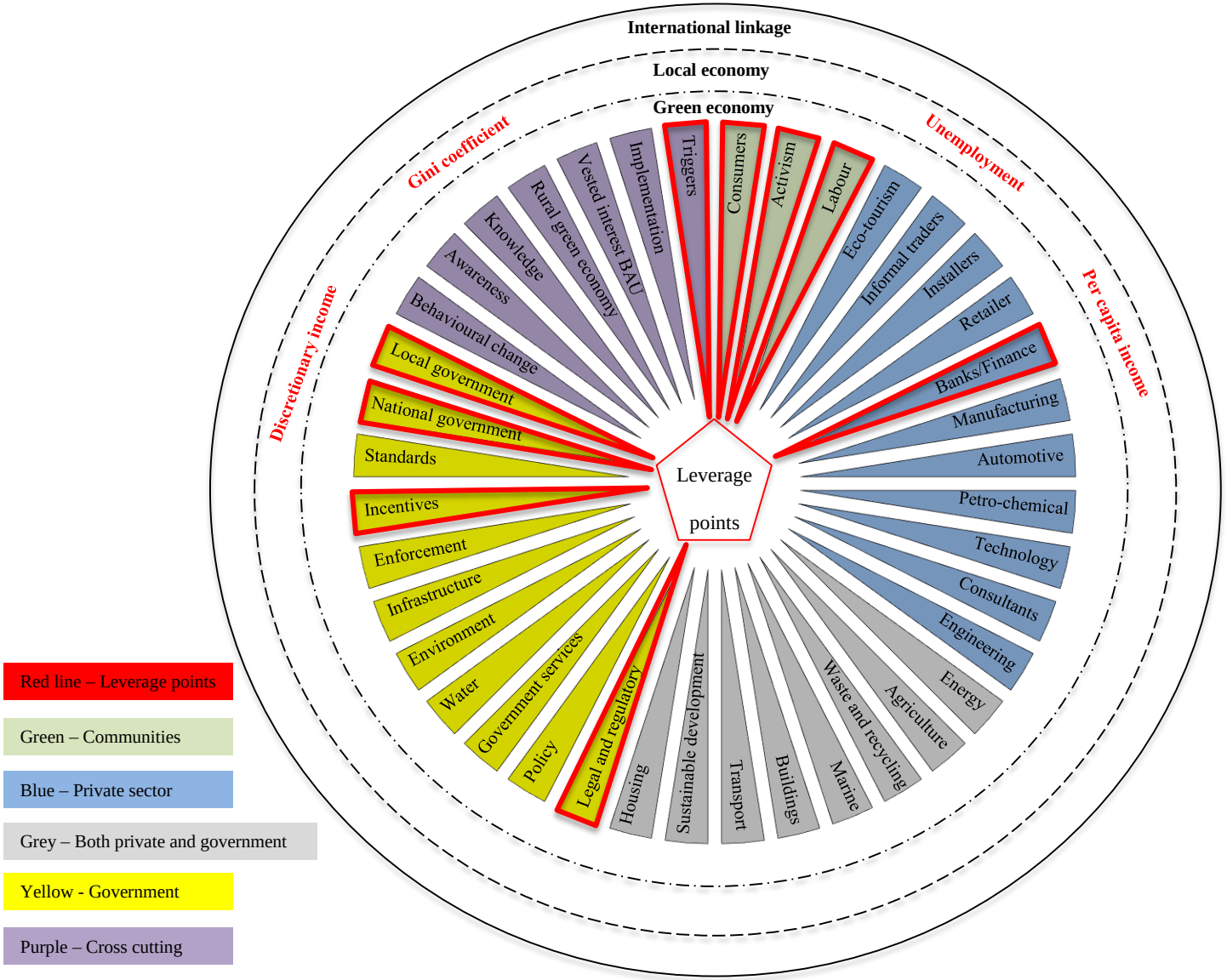

Figure 6.3: Leverage points of the eThekwini green economy

It should be further noted that the leverage points have been identified with a long term and sustainable scenario for the eThekwini green economy in mind. This would seek to ensure all three elements of a true green economy materialise in the EMA. This is in line with the eThekwini Municipal vision *"By 2030, eThekwini will enjoy the reputation of being Africa's most caring and liveable City, where all citizens live in harmony"* (eThekwini Municipality 2017b). If a shorter term focus was chosen, there could very well be other better suited leverage points for that particular scenario. With a longer term view, where certain aspects are thought to evolve organically, such as awareness of technologies and the benefits of pursuing a green standard of living, structural matters such as GDP per capita and gini coefficient would need attention, within a developing context. Nadal et al. (2003, pg. 13) *"... when the social influence is strong enough, there is a regime, where, upon increasing the mean willingness to pay, or decreasing the production costs, the optimal monopolist's solution jumps from one with a high price and a small number of buyers, to one with a low price and a large number of buyers"*. This does not mean that creating awareness is not important.

Of vital importance, when it comes to leverage points, is that each of these components are often independent of other components, but dependent upon each other at the same time. Components aggregate to a sum far greater than their individual values and certain aspects can emerge which would not be the case if there was no interaction (Bale et al., 2015; Held et al., 2014). This research postulates that for the leverage points to be effective in stimulating the eThekwini green economy, each relevant component needs to ensure that they undertake their necessary tasks required for pushing on the leverage points, which also needs to be undertaken according to ways that will be appropriate for that specific time and context.

6.6 Characteristics of the eThekwini green economy

Characteristics of components are not tailored for each component. Rather, a number of common characteristics that cut across all components have been identified and will be discussed below. It is important to note that these characteristics largely relate to components that have a social or human element. Components like technology, regulation and incentives that may have been developed by human ingenuity do not inherently have the ability to act themselves but rather their passiveness needs to be input into other processes for specific outcomes, are not included in this section. The

position of this research is that, due to the green economy still being in its infancy, it has had a corresponding impact on knowledge available in the eThekwini green economy. If details of each component were to be extracted through research, in the eThekwini green economy at this stage of its life cycle, detailed interviews with all sector specific stakeholders would have been required.

The following characteristics are listed and discussed in no particular order of importance.

This research found that all components, in the eThekwini green economy, either have a direct or indirect financial characteristic that make up the component. This characteristic most often involves whether the identified initiative or action is feasible or not. The financial characteristic has been included in previous ACE research, such as Nadal et al. (2003), where system agents are designed around idiosyncratic willingness-to-pay, where individual agents have the ability to either purchase ($w_i = 1$) or to abstain from purchasing a single item. Essentially, the agent endeavours to maximise the individual 'surplus function' (V_i), which is represented in the following equation:

$$\max_{w_i \in \{0,1\}} V_i = \max_{w_i \in \{0,1\}} w_i (H + \sum_{k \in \vartheta_i} J_{ik}\, w_k - P)$$

where H_i represents the preference and P represents the price of a single good. Each agent (i) has a neighbour (k), which influences the decisions of i, through k's own preference w_k and where J_{ik} is the weighted impact of k on i. In addition, Cincotti et al. (2011) discusses the EURACE model where consumption goods manufacturers have the ability to access credit from banks in order to finance production and cover any other financial commitments. An important feature built into the model, is that if or when consumption goods manufacturers cannot access credit when it is needed, then the manufacturer will be closed. This feasibility can be further disaggregated into two aspects: feasibility of the intervention for the component that has initiated or has to action the initiative and the second relates to a situation where the action might not be feasible to the component that has to implement or undertake the action but where there will be feasibility for other components, this often relates to initiatives undertaken by government for social programmes (Aarøe and Petersen, 2014; Moffitt,

2015) and corporate social responsibility initiatives by companies (Tai and Chuang, 2014; Cook et al., 2015).

It is the position of this research that motivation and benefits that are derived by specific components is another characteristic. Naturally, these benefits vary with the broad type of components. It should be noted in various instances there are likely to be exceptions to the rules, not just for this characteristic but all other characteristics as well. The private sector is most often primarily driven by profit (Freeman and Ginena, 2015; Ismail, 2016) and as a result it is most probable that courses of action will be pursued if it is able to either generate additional income or lower overhead expenditure, the result of both will be increased profitability. The government sector in most instances has to balance a legion of focus areas (eThekwini Municipality, 2017b; Borchers, 2015) and has to take the best average decision in most instances. This would result in a situation where the interest of business, provision of services and providing a social safety net for vulnerable people all converge in a manner where none are left worst off. However, this is largely dependent on the political philosophy that is prevalent at the time.

This research also found that another characteristic is dependency, it is not a matter of whether a component is dependent of other components or not but rather to what degree is the dependency. There is no component that can be considered completely independent, the converse holds more true, components have a relationship with other components (Wollmann and Steiner, 2017; McKenzie, 2014). There are two broad ways in which this dependency can be conceptualised: direct or indirect.

It emerged that all components, for the foreseeable future, need people to function. The type of people that make up components play a big role in the manner in which the components will operate. As a result, it is imperative that the skill level of people adequately matches the inherent specific needs of the components. As a simple example, a photovoltaic manufacturing company needs exceptionally skilled people (Rajoria et al., 2017; Cabezas et al., 2016).

Decisions are another critical characteristic of components, specifically the manner in which decisions are made. It emerged from this research that there are three ways in which components in the eThekwini green economy can make decisions. They are: strategic and proactive, reactive and completely random. Respondents further

highlighted that the manner in which decisions are made can switch between the methods components utilise to make decisions. For example: decisions can be made in a proactive and strategic manner but switch to a reactive or even random manner when a trigger is encountered, such as a climate change induced natural disaster. Components and organisations that are large, and more regulated, tend to make decisions in a more proactive approach as opposed to reactive and random decisions.

The amount of time it takes components to perform their functions and interact with other components varies a great deal. As a general rule of thumb, the government sector takes a great amount of time for various actions (Atwell et al., 2011; Holmes et al., 2012). On the other hand, the private sector generally responds quicker (Atwell et al., 2011; Meza-Ruiz et al., 2017). However, as with most characteristics, there are exceptions to the rules, time taken for action to occur by government can be greatly reduced in times of disasters and the private sector can take a lot longer to conduct certain activities, like research and development.

6.7 Interaction

It was found during this research that no component of the eThekwini green economy operates in complete isolation within the economy, i.e. without interacting with other components.

Respondents highlighted that all components have to interact with other components for their survival. This interaction seems to largely mirror interaction of stakeholders in any standard economy, the only difference in the green economy is that we have to now factor in environmental and social flows in addition to economic flows.

The interaction between components has been described as a web of agents with direct and indirect linkages between different types of components. This distinction between direct and indirect linkages seem to be no different than for interaction that occurs in the broader economy or findings from previous research on the green economy and ACE research such as Deissenberg et al. (2008); Basu et al. (1998) and Riccetti et al. (2015). This is likely due to the fact that most of the components which are present in the broader economy are also present in the green economy and have to abide by the established norms, but would now have to be cognisant of environmental and expanded social considerations.

It emerged from the research that the predominate flow, in terms of authority and direction, is from top, i.e. national government to local government and to private organisations. This results in a situation where legislation, regulations and policies then impact on various practices that result in green goods and services. However, respondents also indicated that there is a bottom-up channel that exists and can actually be categorised as a feedback mechanism from where implementation happens to where strategic decisions take place. This feedback loop is not singular but manifests in a plethora of little information flows that include sales figures from companies and concerns from activist groups.

This study further found that the strength of the linkages between components of the eThekwini green economy seems to be weak and not as strong or active as they could be. This can be linked to the notion that the eThekwini green economy is still in its infancy which would result in all relevant structural aspects also following similar development trajectories.

It emerged during the study that the interaction amongst components can be classified as being: neutral, synergistic or antagonistic in nature, which would largely depend on the conflict of fundamental motivation and benefits of each of the components. To illustrate an example, government imposes a tax on the private sector so that government can deliver on its obligations (Alton et al., 2014; Pahle et al., 2016). The relationship between the private and government sectors could become antagonistic for a variety of reasons, that include the funds not being utilised as intended and would result in a tax revolt (Karodia et al., 2016; Burg, 2004). This antagonistic relationship would initially be one way, from private sector to government sector, but it would be highly probable that it would become two-way if there was a reduction in taxes collected.

A strong theme emerged that each component has its own unique makeup, which consists of varying characteristics. Each component strives to make the best decision for itself, in terms of its own inherent position and objectives (Aziza et al., 2016; Bonabeau, 2002). This means that private sector organisations strive to maximise profit and environmental activists seek to ensure the lowest environmental footprint. When the best decisions, which all unique components have taken for themselves, are aggregated we get an emergence at the macro level. If the interaction between

components is not managed strategically, that emergence at a macro level can result in a situation where none of the core objectives of the green economy are met. However, according to Albino et al. (2016, pg. 10) *"Thanks to the alignment of the incentives, making a decision improving a local gain at the same time assures that the best decision for the system as a whole is taken"*.

6.8 Challenges of the eThekwini green economy

This study found a number of challenges that face the eThekwini green economy. A number of those challenges have also been identified as leverage points. These are legal and regulatory, high cost of green goods and services and disposable income, lack of appropriate skills, incentives and accessible finance. Even before a discussion on the bulk of the challenges, a massive problem is encountered: five out of the ten leverage points of the eThekwini green economy, that are vital for the success of the green economy, have been raised as challenges. This automatically puts the growth of the entire eThekwini green economy at risk, not just of subdued growth but also its very survival. While not taking away from the importance of these challenges, particularly since they have been identified as critical levers in the eThekwini green economy – it is highly probable that the main reason that they have been identified as challenges can be linked to the fact that the green economy is still in its infancy and the necessary structural support is yet to be developed or yet to mature and lack of coordinated leadership also result in a lack of coherent policy.

As was raised in the interaction section, the predominate flow of strategic direction is from national government to provincial and then to local government (Murray and Nakhjavani, 2006; Malan, 2005). A critical challenge is that there is a lack of consistent direction from government, in terms of what is being articulated and advocated for and work that is materialising (De Jongh et al., 2014; Montmasson-Clair and Ryan, 2014). In addition, this research found that there is a general misalignment with what the market requires and the general direction of government interventions. These miscalculations lead to policy uncertainty, which ultimately leads to reluctance by investors to commit resources.

In general terms, as most of green goods are financially more expensive than traditional goods (Kwok et al., 2015; Kanchan et al., 2015), it takes time for the total costs to be recouped before financial savings are banked. As a result, there are no

materially discernable financial benefits for consumers. This challenge, with a lack of awareness of relevant information (Joshi and Rahman, 2015; Maniatis, 2016) and perceptions (Doran and Ryan, 2016; Kwok et al., 2015) towards a number of specific technologies can have a positive or negative impact on behavioural change towards adoption of green goods, services and general behaviour. It is the position of this research that there will then be a knock-on effect of subduing the market and, as a result, demand for green goods and services will decrease. The limited market and demand for such goods and services have a further knock-on impact of acting as an inhibitor for the prevention of the establishment of manufacturing facilities to cater for the demand for goods. This then implies that the eThekwini green economy will continue to import goods from other economies, frequently from Asia, to satisfy demand and this results in constant outflow of funds from the eThekwini economy. A negative perception of the green economy must be avoided, especially in a situation where the green economy is uncoordinated, as there are feedback loops which will result in a perpetual negative cycle.

The bulk of perceptions by all components, and decisions made, are currently based on a lot of subjectivity. There does not seem to be any detailed local level indicators that currently track the progress made within the eThekwini green economy. The indictors do not exist in any consolidated format, even though the raw data definitely does exist. This can be supported by Diga (2017, pg. 6) *"Much of the previously published works have been descriptive in nature when examining the evidence of poverty reduction dimensions within climate change projects. There has not been clarification within best practice principles at the global nor local level of appropriate indicators"*.

The last major challenge is that it is currently being pursued via an unstructured and reductionist approach, which is partially as a result of a silo mentality (Tomaselli et al., 2017; Chirisa et al., 2015). Perhaps, this can also be rationalised on the basis that the eThekwini green economy is still in its early development phase, however it still remains a challenge that needs to be rectified.

6.9 Indicators for the eThekwini green economy

Due to the various sources of data for indicators that would be relevant for the eThekwini green economy, i.e. literature, survey, interviews and focus groups, it will be beneficial to first briefly summarise the indicators before the discussion occurs.

From the literature review, two models were identified that can serve as a good platform from which to develop specific indicators for the eThekwini green economy. The first is the Global Green Economy Index developed by Dual Citizen LLC (2016) and depicted in Figure 6.4. While it is appropriate for national and international level reporting and tracking, it is the intention of this research to ensure that any indicators developed at a local level are able to dovetail into other reporting streams.

The second model discussed in the literature chapter of this research was a model developed by Siemens (2015) and depicted in Figure 6.5. This model was specifically developed for cities but has noticeable gaps in terms of social elements of the green economy.

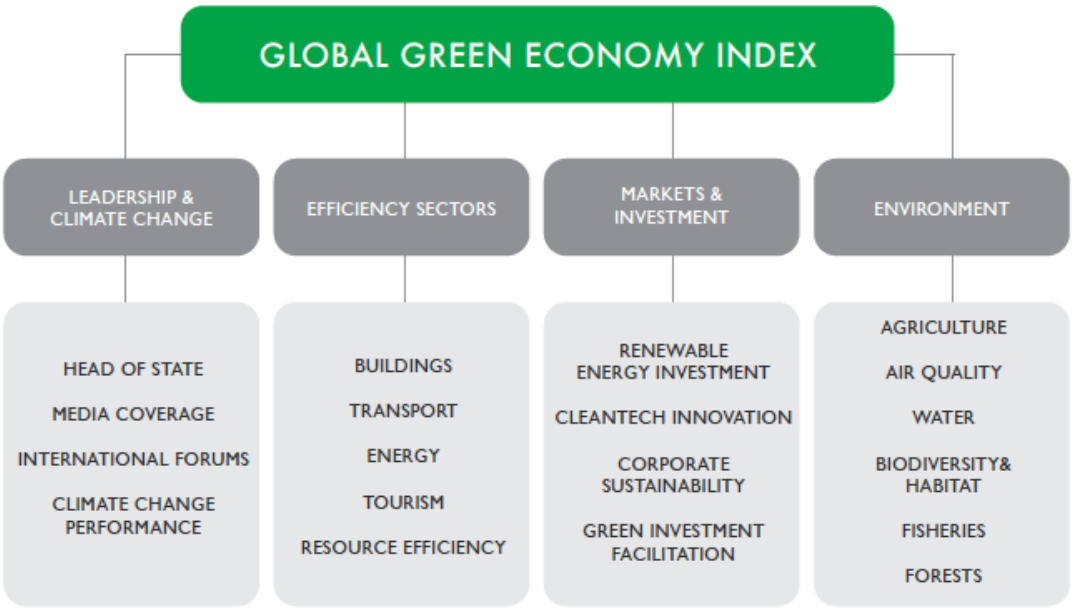

Figure 6.4: Global Green Economy Index: Indicators

Source: Dual Citizen LLC (2016).

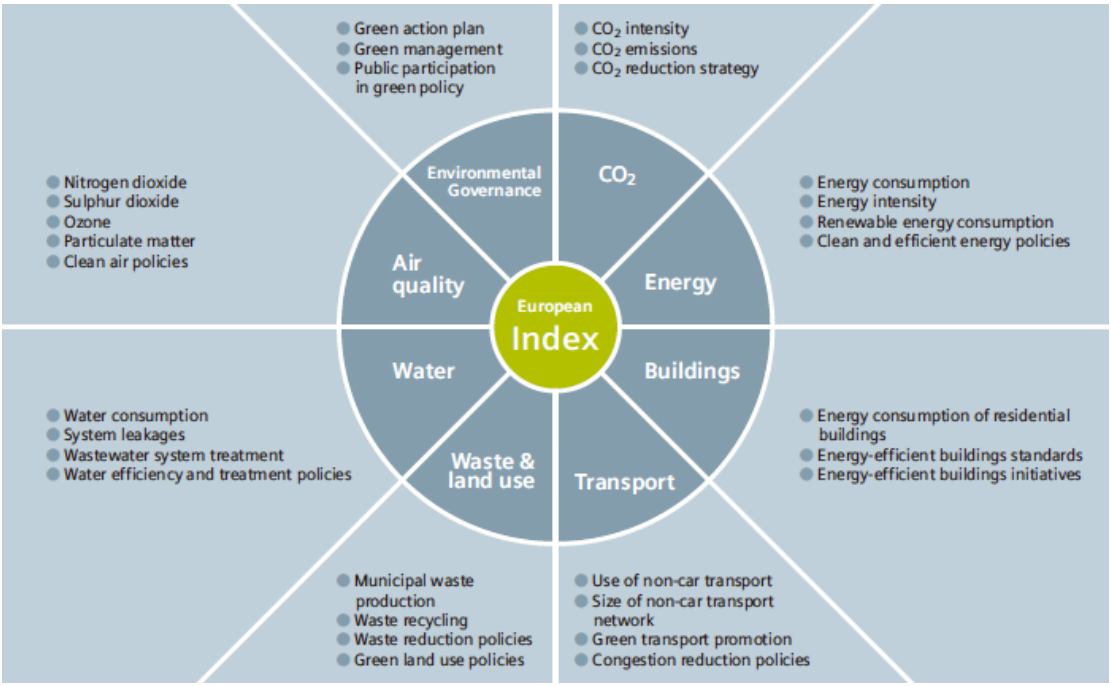

Figure 6.5: Green City Index: European Index

Source: Siemens (2015).

The SDGs provided some good indicators that can be adopted locally, the SDG indicators are largely more applicable to a national level though. Specifically, SDG 7 indicators include the percentage of the population with access to clean or renewable energy and energy as an intensity figure against GDP. The level or amount of investment for energy efficiency interventions as a share of GDP is also considered important. Importantly, SDG 7 also aims to track the amount of funds received by developing countries for research and development purposes. SDG 8 focuses on the percentage of tourism and relevant jobs created relative to GDP. Indicators for SDG 11 includes the percentage of the population that has access to public transportation. In terms of natural disasters, deaths per 100,000 and consequential economic loss is to be calculated and tracked. SDG 13 relates to waste, specifically food loss and waste. More broadly, waste per capita is considered a key indicator of the efficiency of the entire system. Tons of material recycled is also included. A basic count of organisations and companies that report on sustainability practices is the last relevant indicator.

The indicators gathered through the surveys are listed in Figure 6.6. Even at a glance it can be noticed that the indicators cover the three major components of the green economy.

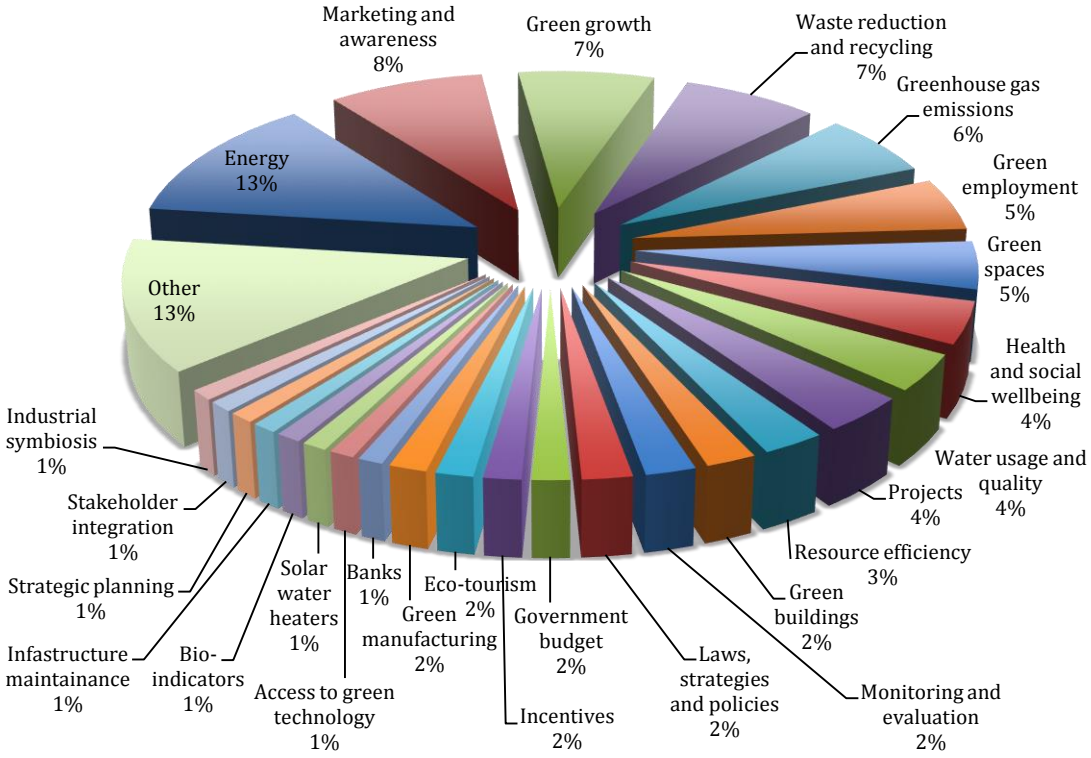

Figure 6.6: Indicators for the eThekwini green economy identified through the survey

It should be noted that within each of these key indicators, intensity figures and percentage growth have been mentioned but is presented in this format for ease of reference.

Respondents who participated in interviews, highlighted the following indicators: green economy contribution to GDP or GVA; number of green companies, financial value invested into the green economy, number and type of projects, integration of the green economy sectors and stakeholders, carbon credits and carbon tax, net value created by green economy initiatives, SDGs, GHG emissions and reduction progress, resilience, number of people employed within the green economy, financial value spent on development of human capital, awareness levels and adoption rates of green technologies and services.

The focus group respondents mentioned fewer indicators, the indicators that were identified for the eThekwini green economy are: awareness and marketing, mind-sets, recycling and water reduction, implementation of policies particularly for buildings, projects and initiatives being undertaken, energy efficiency broadly and the energy mix. It was also mentioned that the indicators need to be presented in a dashboard format, so that it is easy to read.

Due to the large number of components that make up the green economy and as a result of differing types of operations that take place in many thematic areas, there will be a need to categorise indicators. There seems to be various ways in which the components can be classified, as noted by examples such as Dual Citizen LLC (2016) and Siemens (2015). However, both of those models are very thin on social indicators, which are critical for a developing city's green economy.

While the indicators as highlighted in Figure 6.7 were being analysed, it was noted that a number of indicators can be directly linked to one of the three key elements which make up the definition of a green economy, i.e. social, environment and economy. As a result, those key indicator categories were used as a start for the development of an indicator framework. In addition to those three indicator themes, two more emerged during analysis: operational and underpinning. Operational indicators cover aspects that cannot be easily categorised into the social, environment or economic segments but rather related to sectors of the green economy such as waste, energy, building, water and transportation. The last category of indicators, underpinning, play an overarching role that would form part of the basis on which the components of the eThekwini green economy operate on.

It should be noted that the bulk of the indicators can easily be monitored via a quantitative method which would take the subjectivity out of routine monitoring and assessment. The qualitative indicators and quantitative indicators that will be difficult to calculate and monitor should not be adopted immediately, but focus should be on what is within the realm of feasibility. Once the eThekwini green economy has further developed, only then should the tricky indicators be collected.

Social	Health and mental wellness	A	**Economic**	Green investment	A
	Social development	B		Green economy contribution - GDP Revenue generated Percentage of eco-tourism Green manufacturing Gini coefficient	B
	Poverty reduction Economic empowerment	C			
	Informal settlement reduction	D			
	Crime reduction	E			
Environment	GHG emissions GHG reduction GHG of individual businesses	A		Green jobs Productivity of workers	C
	Resilience	B		Carbon credits Carbon tax	D
	Green spaces Health of nature Water security and health	C		Research and development	E
				Incentives	F
				Number of companies	G
	Extreme weather events	D		Participation of banks	H
Operational	Projects being implemented	A	**Operational**	Recycling of water Water intensity	F
	Energy efficiency Renewable energy capacity Energy mix Energy consumption trend Energy intensity	B		Industrial symbiosis	G
				Use of public transport Low emission vehicles	H
				Eco tourism	J
	Resource efficiency	C		Percentage of waste recycled Waste intensity Reduction of waste to landfills	K
	Solar water heater uptake	D			
	Number of green buildings	E			
Underpinning	Awareness Marketing and adverts Mind-sets Behaviour change				A
	Policies, laws and regulations Enforcement				B
	Government expenditure Less reliance on government				C
	Technology adoption				D
	Green infrastructure Maintenance				E
	Feasibility of development Cost				F
	Integration of sectors				G

Figure 6.7: Indicators for the eThekwini green economy

Data for the bulk of the indicators are readily available, through various sources. To illustrate the availability of data, eThekwini Municipality annually calculates its GHG emissions (Sustainable Energy Africa, 2017; eThekwini Municipality 2017a) and crime reduction statistics by Statistics South Africa (Statistics South Africa, 2017). However, what will be critical is that the annual updating of the indicator framework needs to be taken ownership of, i.e. some key stakeholder within the eThekwini green economy would need to take responsibility for collating the updated indicators and quantify indicators that are not calculated through existing mechanisms. The most appropriate component within the eThekwini green economy to perform this function seems to be the eThekwini Municipality. It should also be noted that the eThekwini Municipality reports annually to the Carbon Disclosure Project (Hickmann and Stehle, 2017) and the mechanism for collecting data within Municipal structures already exists.

Data for some indicators will already be collected via other processes, for example, the economic data on gini coefficient or unemployment data. It will not be possible to have indicators for all the critical leverage points identified. For some indicators such as triggers, it will not be practical to develop an indicator as triggers would be too diverse. It would be possible to provide a count of triggers that occur in a year. This would be a rather subjective exercise, as no set methodology exists for the classification and identification of triggers. The strategic direction and decisions of national and local government will not be possible to monitor in a quantitative manner and any attempt would be subjective.

The practicality of collecting data for each of the indicators was also considered, in addition to the specific format of the indicator, e.g. percentage or number. It should be noted that it is possible to collect, analyse and process data into the required format from existing data sources, or dovetail into similar processes to collect the required additional raw data.

Communication channels for popularising the indicators have also been thought of, and it is suggested that this should unfold in four parallel processes. The first would be utilising the indicators in any formal and informal reporting process that the eThekwini Municipality has committed itself to. The second would be to ensure that key stakeholders and components of the eThekwini green economy receive a detailed

publication of the indicators in addition to supporting documents that would serve to further spur positive action from those components. It is vitally critical that a mass media approach be engaged so that each resident or citizen of the EMA is aware of progress being made within the green economy. This would also serve to increase the residents' awareness of green principles. Thirdly, it has to be kept in mind that the eThekwini green economy is still in its infancy. Due to this fact, the relevant structures, components and availability of data is also still in its development phase. This had been taken into account when formulating the indicators. The indicators have been kept simple and there remains scope for the indicators to be revised when the green economy enters the maturity stage of its development. Lastly, the indicators will be critical for planning purposes.

6.10 Framework for understanding the eThekwini green economy

This section of the chapter aims to present a framework of the manner in which the eThekwini green economy operates. It will first present the manner in which a component is conceptualised in the eThekwini green economy and this will include key contributions and three types of flows that could be either positive or negative for the entire green economy and other components. Thereafter, a structural overview of the eThekwini green economy will be presented. Core components, which will include leverage points, will be individually discussed. This framework has been developed in a manner that will allow further research to develop a simulation model based on ACE.

It is important to note that while this framework was being developed, a plethora of design options, layouts and formats were utilised to try to display the framework on one illustration. All attempts to compile the framework onto one consolidated Figure failed dismally due to the complexity of flows that emanate from components. The resulting flow lines quickly became illegible. This resulted even with only the core components being utilised for the development of the framework. If all the components were to be included in the framework at this stage the complexity of the illustration would be unfathomable.

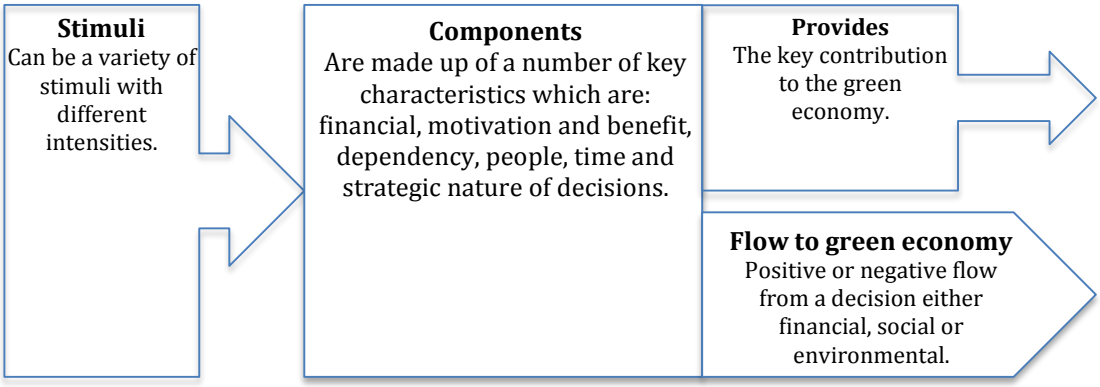

Figure 6.8: Component of the green economy

As indicated in Figure 6.8, before any component can be activated there needs to be stimuli from the green economy. These stimuli can be in multi forms, with varying intensities. For example, there could be a low financial incentive from government, or there could be a substantial incentive from government for the uptake of a certain green good. It is possible, in reality, for a multitude of stimuli to impact on a component at any one time – in fact it is highly probably that this is the case. It is not the intention of this research to go into the full realm of possibilities of reality when it comes to components of the green economy, but it could also be theoretically possible for the stimuli to come from the component itself. This stimuli is then processed by the component, which is made up of a number of core characteristics such as financial, motivation and benefit, dependency, people, time and manner in which decisions are taken. The consequence of such characteristics will result in outcomes and provides certain core elements that other components and the rest of the eThekwini green economy will rely on. Parallel to those outcomes, there could be three flows that result in either positive or negative contributions to the green economy, these are: financial, social or environmental.

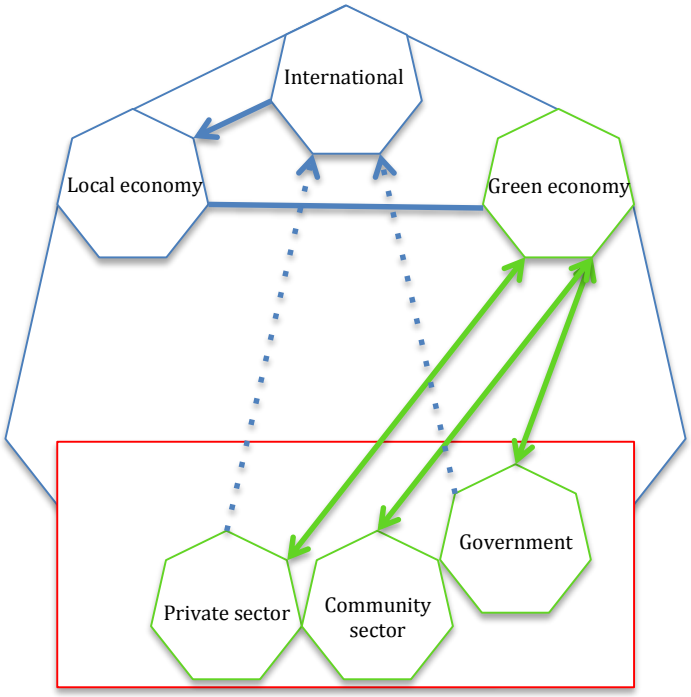

Figure 6.9: Boundaries of eThekwini green economy

Each of the heptagons represent a component in Figure 6.9, which would function as indicted in Figure 6.8. As can be seen in Figure 6.9, the international sector sits right at the top in terms of flow of information. That component then directly interacts with the economy in terms of filtering down information, agreements and trends. There could be a component called national in between international and economy, but due to the focus of this research on a city green economy the national component is not seen as critical.

However, the legal and regulatory outcomes that would be relied upon are critical for the green economy, but are included as a component in the government sector, which will be discussed shortly. The green economy then sits within the local economy, i.e. the green economy's existence is predicated on the existence of the local economy as it has grown or evolved from it.

The green economy is then made up of four key components: private sector, community sector and government. The fourth component is the overarching components that would envelope the entire green economy and is indicated by the red rectangle. It is important to note that the green economy on its own cannot interact with the international sector, but some of its components do have international linkages, i.e. private sector and government. The reasons why there is a dotted line

connecting these components to the international sector is twofold: not all components that make up the private sector or government have the linkage and secondly, there is a feedback loop that takes information to the international level which would further result in impacts to the local economy, i.e. there are cyclical flows that are observed. It should be observed that this entire system is depicted within a larger heptagon, which indicates a spatial conceptualisation of the framework. This is similar to the EURACE model as alluded to by Deissenberg et al. (2008) and Naciri and Tkiouat (2016).

It has been observed in the data that the green economy would function holistically, similar to a traditional economy. This means that components would still predominately, play their core roles. Tax is not incorporated into this framework, as it is already a part of the larger economy.

The Figures and discussion below will revolve around specific components of the eThekwini green economy that aggregated into components as indicated in Figure 6.9.

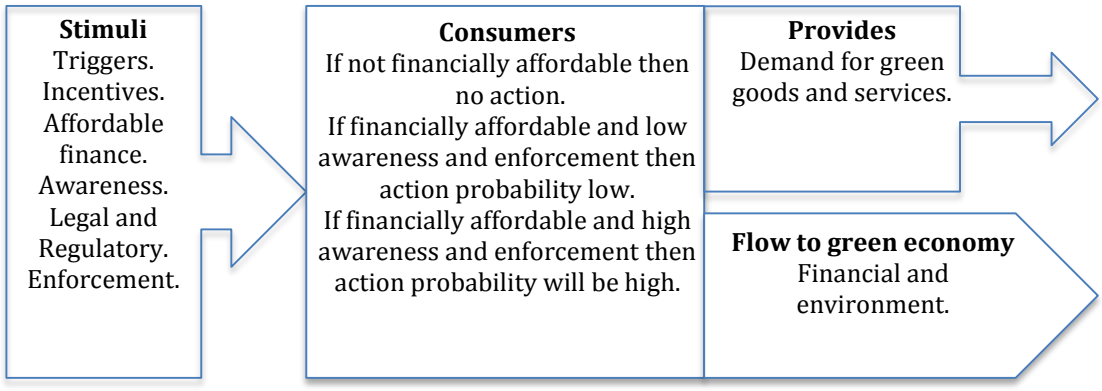

Figure 6.10: Consumer component

Consumers, Figure 6.10, activism, Figure 6.11, and labour, Figure 6.12, are sub-components of the community sector as indicated in Figure 6.9. There are a number of stimuli that can activate consumers demand for green goods and services, which can be seen in Figure 6.10. However, demand will only be possible, not guaranteed, if the consumer is able to afford the green good or services, which normally comes at a premium over tradition goods and services at this stage. It should be noted even if there is parity between green and traditional equivalent, there will be no guarantee that consumers will opt for green alternatives due to the high degree of randomness in their decision making processes. Affordability is the critical characteristic of

consumers that can be accompanied by varying levels of awareness or any other characteristics, indicated in Figure 6.10, which will result in demand for green goods and services. However, the inverse does not hold true. Even if there is full awareness and complete strategic decision making on the consumers characteristics with no affordability then demand will always be close to zero. It should be noted that probability for demand is not a straight yes or no outcome, but will fall on a continuum of low probability to high probability. The direct flows from consumers decisions will further stimulate the financial aspect of the eThekwini green economy or result in a neutral impact and either will result in a contribution to environmental degradation or environmental protection. There is no direct social flows that emanate from consumers decisions. The number of consumers that can afford to participate in the green economy should be thought of as a function of unemployment, per capita GDP, discretionary income and gini coefficient. It should be further noted that even if the legal and regulatory components mandates consumers to undertake a green initiative, there is no guarantee of action, particularly if there are low levels of enforcement from government. However, triggers can play a critical role especially triggers that have the ability to endanger consumers quality of life. Then, even if consumers are not able to afford something, they will tap into affordable credit lines. Very few consumers procure green goods and services due to their consciousness. Lastly, it is highly probable that multiple stimuli can impact on a consumer at the same time, in which case the possibility and degree of action increases. It is important to note that Figure 6.9 is indicative of individual heterogeneous consumers and not consumers as a homogenous component. Perhaps the only characteristics that would hold fairly stable for consumers are their random decision making tendencies. There is a critical link between demand for goods and the rest of the eThekwini green economy. If it is substantial it will trigger manufacturing to be undertaken locally, otherwise green goods will be imported.

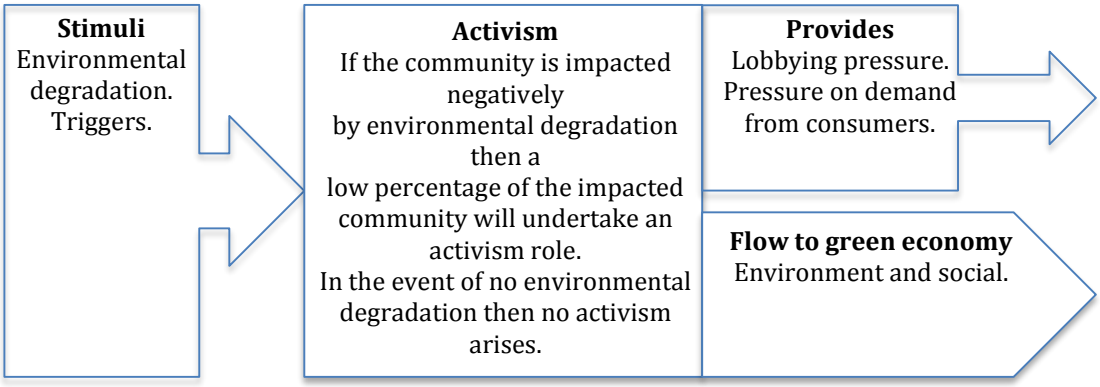

Figure 6.11: Activism component

Activism from within the community emerges if they are affected by impacts of environmental degradation or certain triggers. In rare instances will activism emerge in the absence of the previously mentioned stimuli and as a result of the community's consciousness. This results not only in lobbying pressure on the source of the degradation but also on other authorities that have power to rectify the situation. In addition, there is likely to be a consequential temporary negative impact on demand for goods and services that are directly linked to the source of the degradation, if it is consumed in the community. There always remains the possibility that temporary negative impact could be made permanent if the reaction from authorities is not undertaken properly. If the good is critical to the way of life, then there is likely to be a negligible impact on demand. The flow contribution from activism can only be positive on environment and social flows for other components and for the entire eThekwini green economy. However, there could very well be negative secondary consequences if no activism takes place when environmental degradation is present. It is not feasible, or quite possibly impractical, to indicate activism at an individual level. As a result, activism needs to be considered at an aggregated level, either at physical suburb or city level.

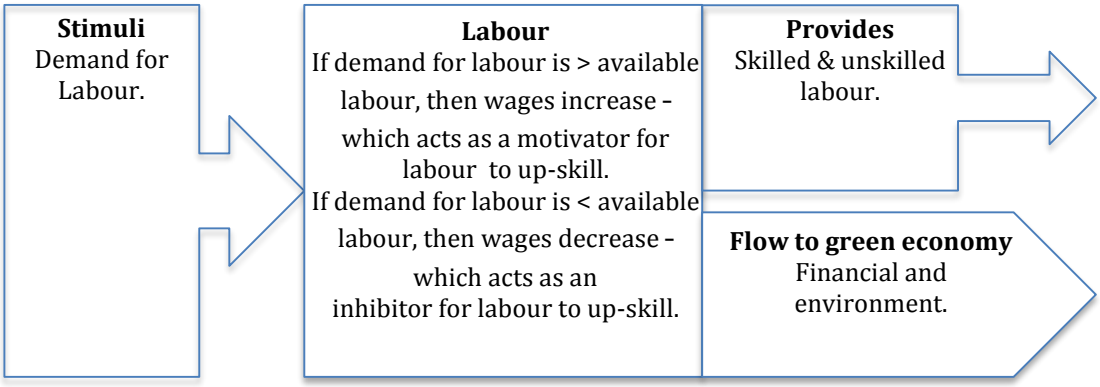

Figure 6.12: Labour component

The third component of the community sector is labour, as depicted in Figure 6.12. The only stimuli that activates labour is demand. Immediately there will be a noticeable feedback loop, i.e. demand for goods and services will result in a demand for labour. It should be noted that government will also require labour. Individuals are motivated according to the level of wages that can be exchanged for their expertise. However, not all individuals will be highly skilled and there is a further motivator to increase skills levels, which would result in increased wages for the individual. The labour component either provides skilled or unskilled labour to the market, which has to be largely framed as a function of education. The direct results on the eThekwini green economy, from labour, are either an increase in financial flow for the green economy or neutrality will remain in the case of unskilled labour. In terms of environmental flows, it will be negative with unskilled labour and positive with skilled labour. Labour needs to be framed at an individual level, as the number of skilled workers will have a key impact on the success of the components and the eThekwini green economy.

For the framework, the private sector is made up of banks, manufacturing and services components. The primary reason for this is due to the infancy of the eThekwini green economy. At this stage, an understanding of how the system operates is best served with a framework at a level that is not too disaggregated and where the emphasis on leverage points will not be diluted.

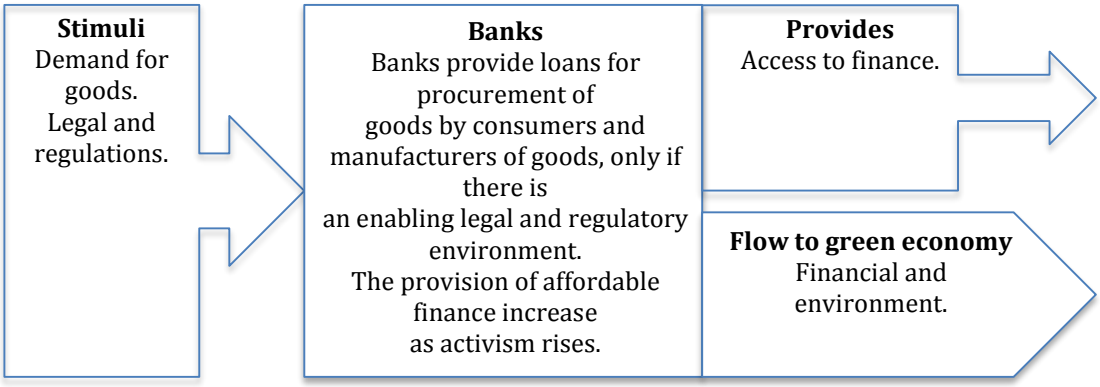

Figure 6.13: Bank component

Banks will not engage with the green economy and financing of relevant goods outside of existing mechanisms, especially if there is no demand and no legal basis for the green goods, as it will pose a serious risk to the security of their capital. It is important to note that banks can also be impacted by activism that arises from the community, but only spurred into action to an extent that will not jeopardise their capital. There are no direct social flows from mainstream banking and finance activities. There could be an argument that there is a negative social flow as certain people are excluded from the financing sector, but that is beyond the scope of this research. The financial flow will either contribute to the green economy, or remain neutral. In instances, if finance is supporting traditional goods that are fossil fuel based or harmful to the environment, that in a sense is a lost opportunity for the green economy, but would also result in negative environmental flows to the green economy. Investment in green goods are widely seen as positively contributing to environmental flow in the green economy.

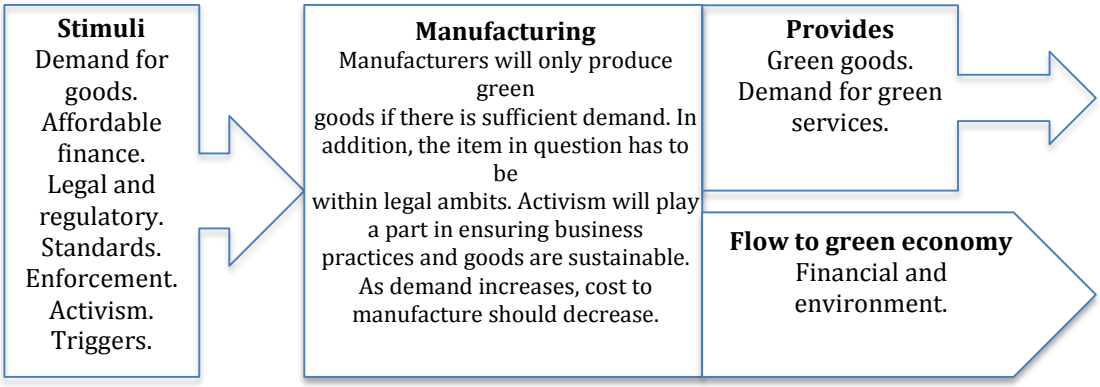

Figure 6.14: Manufacturing component

It is important to note that the manufacturing component is comprised of a number of goods or sectors, which includes automotive, petro-chemicals, energy equipment and generation. Manufacturing could be stimulated by a number of aspects, but the most prominent and important is demand for goods. The processes of existing manufacturing companies and goods produced can be forced to become green if there are sufficient levels of activism or if it makes financial sense for manufacturers. Importantly, and similarly to banks, manufacturers are highly unlikely to produce goods that would be considered illegal or the installation of which would be illegal. The result from this component is green goods and demand for green services that are needed in the production process of green goods, but this needs to be better analysed and framed per sector in subsequent research. There are financial flows to the green economy from the manufacture of green goods. If there are no green goods then there is a neutral financial impact, but if there are unsustainable goods being produced then it should be seen as a lost financial opportunity for the green economy. The same applies to environmental flows, green goods will result in positive environmental flows or neutral impacts. However, it can be posed that there will be negative environmental flows if no green goods are being utilised and traditional equivalents are filling the need. It is important to note that as much as a green good can be produced, equally important is the manner in which the good is being produced. It also has to be sustainable and will result in greener environmental flows.

An important point that needs to be reiterated is that if demand is not high enough to trigger local manufacturing of goods, then the demand will be satisfied by imports. This will also result in an increased financial outflow from the eThekwini economy as green goods are generally considered more expensive. In such a cycle, a small amount of demand will be satisfied in the market at each time period and will therefore result in a situation where there is never enough demand to trigger local manufacturing. This is possible if local cost is equal to foreign manufacturing costs.

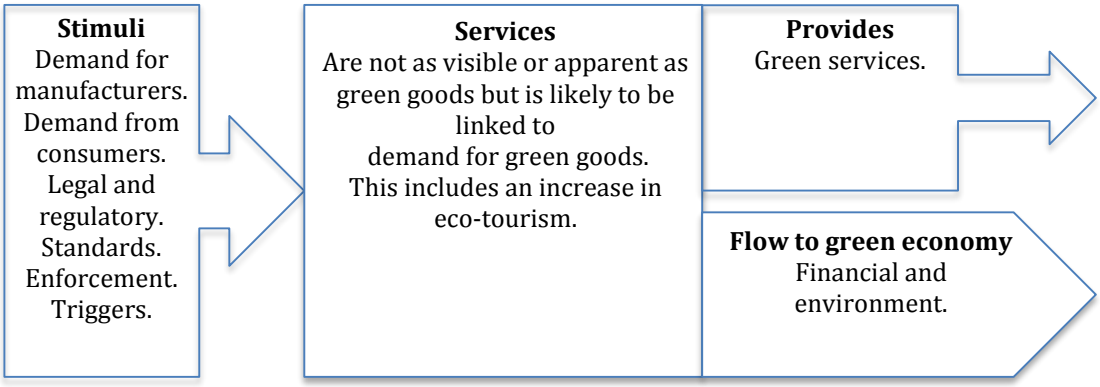

Figure 6.15: Services component

Services have also been aggregated and would consist of very different types of services such as installers, consulting engineers and even eco-tourism. However, eco-tourism is a little more complicated because it will mostly likely rely on some sort of infrastructure such as restaurants or hotels, which would also have to be environmentally friendly. Demand for green goods would be one of the stimuli for green services in addition to direct demand from end consumers, as can be seen in Figure 6.15. Service providers do not have a lot of lock in and can adapt relatively quicker than manufacturers. As such, the legal and regulatory and standards components can play a critical stimuli role in getting fairly quick action. The flows from services are financial, which can be positive or neutral and environmental which can be positive or neutral.

The government sector is made up of the legal and regulatory, policy, standards and incentives components. The services that government provides, such as energy waste and recycling and water provision, are not included in the framework as they are too operational and will unnecessarily complicate the discussion and take away the key objective of understanding the leverage points and developing a practical framework.

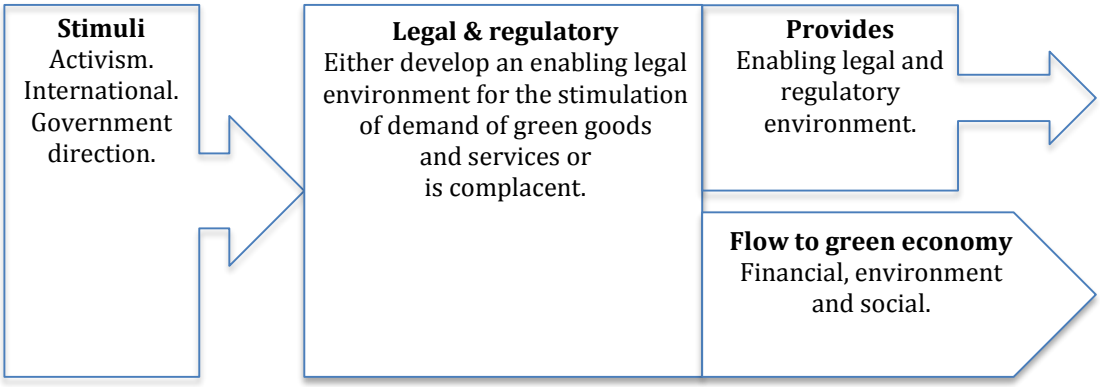

Figure 6.16: Legal and regulatory component

The legal and regulatory component functions relatively slowly. It is primarily guided by the strategic direction of government, which is inclusive of a function of international factors, as indicated in Figure 6.16. Activists can also play a big part to ensure that the correct enabling legislative environment is put in place, especially with the collaborative approach within cultures that are predominate in South Africa and eThekwini Municipality. Alignment is critical not just of regulations and programmes but to the actual law that would support them. In addition, local alignment to the national level is just as important. If there is misalignment, the intended outcomes are unlikely to materialise at the local level. The resulting flows from the legal and regulatory component are financial, environment and social. It is unlikely that government would take a direction that would result in macro degradation to the environment, negative impacts to specific localities might occur for some activities. The same principle would apply for social flows. However, financial flows are not always likely to be positive, this would be dependent on the prevailing monetary and fiscal policies at the time, which would impact not just the green economy but the broader local economy as well.

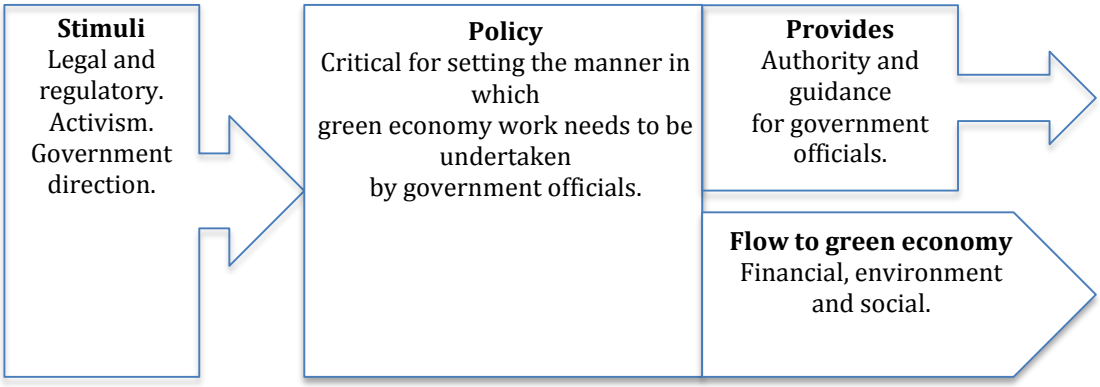

Figure 6.17: Policy component

The policy component, illustrated in Figure 6.17, could have been included under the legal and regulatory component. However, given its importance, specifically for government officials, does not have direct significance for other components in the eThekwini green economy, in taking the process that last mile, it has been kept separately. Policy sets out the manner in which something must be done. Even in the presence of enabling legal and regulatory environments, government officials are reluctant to undertake processes for which there is no laid out step-by-step guide for implementation of new initiatives. This seems to be a result of the risk aversion that government officials have developed, perhaps also inherent in bureaucracy. This policy environment can result in positive flows for financial, environmental and social. It could remain neutral if there is no policy, but will be negative as soon as the continuous use of traditionally unsustainable products, services and behaviour is brought into the framework as a result of policy misalignment.

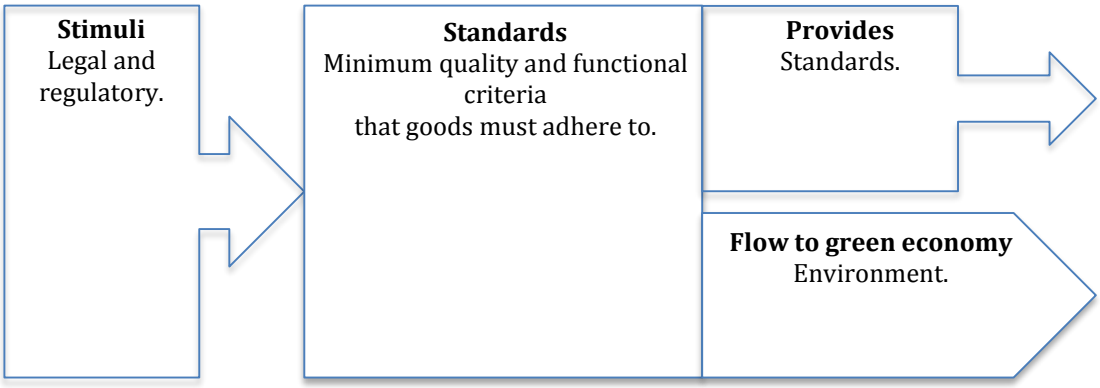

Figure 6.18: Standards component

Standards, as seen in Figure 6.18, is geared to address the minutiae of the system as it will be responsible for classifying a good or service as green or otherwise and setting

criteria that needs to be adopted. The legal environment primarily stimulates the standards component. Technical expertise and skilled labour is vital for this component. Direct outflow from this component is enhancement of the environment.

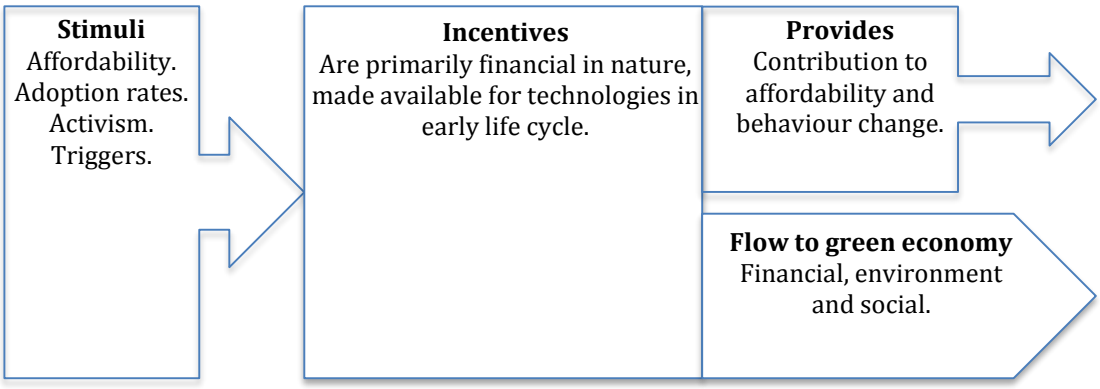

Figure 6.19: Incentive component

Incentives are only offered if products are early in their life cycles and there is no demand for the goods that have exceptional benefits, or there is a serious problem that government needs to rectify which can be rectified by the adoption of particular products. In addition, activism by communities can spur incentives. It is important to note that incentives can be positive in nature, such as a rebate, or regressive or negative, such as a tax. This research was only able to explore the positive incentive that would contribute to enhancing affordability of green products and services by consumers and stimulating behaviour change. Incentives have positive flows, broadly, to financial, environmental and social aspects of the eThekwini green economy, but would differ for the type of incentive and intended audience in terms of social benefit.

There is an overarching sector or component that affects the community, private sector and government sector of the eThekwini green economy which was indicated as a red rectangle in Figure 6.9. The components of this overarching sector will be unique to each component that it encompasses, i.e. awareness levels of consumers could be different to awareness levels of manufacturers. However, the key manner in which these overarching components operate are likely to remain the same.

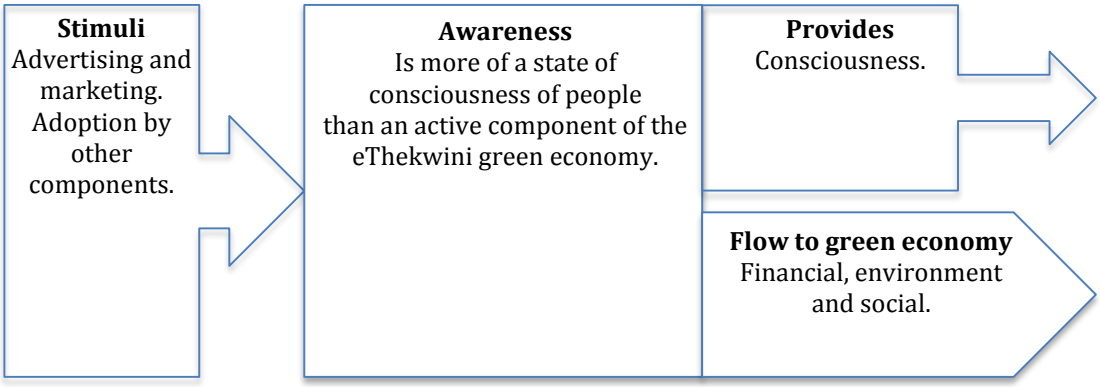

Figure 6.20: Awareness component

Awareness is a dynamic component of the system, but also a measure of how receptive and conscious people are to green principles. It is a function of advertising and marketing, but awareness will also be increased as adoption levels of the green economy rises. From a heightened state of awareness will flow positive impacts on all three flows, i.e. financial, environmental and social. If awareness is low, the flows are likely to be neutral for financial and social but negative for environmental flows.

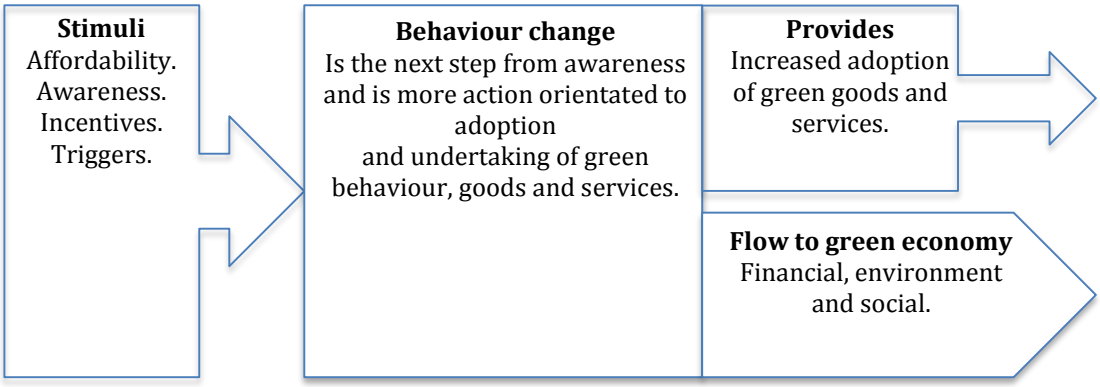

Figure 6.21: Behaviour change component

Ultimately, all actions from all components need to positively contribute to behaviour change, which would see an increase in adoption of green goods and services. In addition, consumption patterns and actual usage behaviour is envisaged to be positively impacted. Behaviour change is a result of affordability, awareness, incentives and triggers. There are positive flows for all three elements: financial, social and environmental. It is important to note that due to feedback loops even if there is positive behavioural change, the system would then have to be maintained at that level, otherwise regression is quite possible.

6.11 Conclusion

This chapter served to discuss findings of data that was gathered during the primary data collection process, in addition to triangulating that data with relevant literature.

Response rates to all three data collection tools were first discussed. It was raised that the response rates to interviews were perfect. The focus group sessions encountered some challenges from members of associations, although the association themselves seemed intent on assisting. Low response rates for the surveys was a challenge. It is postulated that companies and people provide services that can be classified as being part of the eThekwini green economy, but are not actually aware that they are contributing to the green economy and as a result felt they were not in a position to undertake the survey. In addition, a large percentage of companies were not contactable, which led to the conclusion that the companies are no longer in existence.

Thereafter, the existence of the eThekwini green economy was discussed. It was concluded that the eThekwini green economy does exist, due to organic growth in the market and not as a result of local government intervention. It was further noted that while the eThekwini green economy is still in its early life cycle stages, there remains considerable scope for the development of the eThekwini green economy.

Components that make up the eThekwini green economy were then triangulated from all data sources and a total of forty two components were identified that can broadly be classified under key sectors or components. Thereafter, the ten leverage points that were observed and emerged from the data were discussed. It should be noted that the most important of those leverage points are a cross section of four aspects, which are discretionary income, gini coefficient, unemployment and per capita income.

Characteristic classes that are common across most components were then analysed. It is important to note that each component will have a unique position for specific characteristics. This was followed by interaction rules. It was noted that no component operates in isolation. Challenges for the entire eThekwini green economy were then discussed. Indicators followed and it was proposed that there should be five key segments or classification of indicators. These are: social, environmental, economic, operational and underpinning.

The framework depicting the manner in which the eThekwini green economy operates was then developed and presented. It is important to note that not all components and characteristics were included in the framework. There needed to be a balance struck to not complicate the framework, but at the same time explore some depth to understand the more structurally important components of the eThekwini green economy. This served to answer the key research questions of this study. Importantly, it is proposed in the framework that financial, social and environmental flows, which can have a possible positive, neutral or negative impact, be included. The complexity of discussing the framework results in multiple Figures being utilised for illustration purposes as it was not possible to utilise one consolidated Figure, even after multiple attempts. The important components were then discussed within the context of the framework.

The next chapter serves to act as a summary of the entire thesis and will capture salient points of the thesis. This will be followed by key findings that relate directly to the key research questions. Thereafter, recommendations will be presented which will include recommendations for future research.

CHAPTER SEVEN: CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This is the final chapter of the thesis. It will serve to summarise chapters one to six and provide theoretical and practical recommendations for future research and initiatives. This summary will unfold in a sequential manner. As a result, the first section will highlight the context and background, which was contained in chapter one. Thereafter, the two literature chapters will be discussed, starting with the green economy and business risks followed by the literature on CAS and ACE. The research methodology that was utilised for data collection and analysis will then be summarised. The results and findings from quantitative and qualitative data collection processes, as contained in chapter five, are succinctly presented. The entire thesis culminated in chapter six, which is where the discussion took place, including triangulation of data. The three key research questions will then be discussed. Thereafter, recommendations will be presented.

It is important to note that no literature or previous research was found, that undertook to develop a framework or model for the eThekwini green economy, specifically utilising a complexity lens. As a result, there was not much existing relevant literature to reference.

In addition, bringing together a number of different theoretical and practical disciplines will always add an additional layer of complexity, especially in the fashion in which the different elements interact with each other. Nevertheless, important findings have been documented and will lay the foundation for future research to build on.

7.2 Context and background

A number of scientific sources were provided at the start of the thesis that sought to demonstrate that climate change is indeed taking place and is a direct result of anthropogenic activity (Intergovernmental Panel on Climate Change, 2014; Salinger, 2005). Two consecutive years of Global Risks were discussed, both of which rank climate change and related environment linkages as being high (World Economic Forum, 2016; World Economic Forum, 2017). These risks would not only be faced by

the general population, but is also being increasingly faced by business (Hoffman, 2016; Gasbarro and Pinkse, 2016; Amran et al., 2015). The nexus between climate change, business and communities will have far reaching consequences for business operations. It was further highlighted that cities account for a large portion of GHG emissions (Carbon Disclosure Project, 2015; United Nations Habitat, 2011). The GHGs are primarily responsible for the greenhouse effect (Riebeek, 2011; Malhi et al., 2002). An increase in the greenhouse effect leads to global warming (Pachauri et al., 2014; Cook et al., 2016). It was noted that while there are substantial risks as a result of climate change, there are also a plethora of opportunities that can be capitalised on (Montmasson-Clair, 2012; Cosbey, 2011; Barbier, 2016). These opportunities include the green economy, which can achieve economic, environmental and social objectives.

Once the introduction to the thesis was complete, climate change was discussed in more detail. It was noted that while Earth has experienced climate change before, the key difference during the current episode of climate change is the much shorter time period within which it is taking place (Australian Academy of Science, 2015; Oppenheimer and Antila-Hughes, 2016; Riebeek, 2010). The various types of GHG were briefly mentioned, along with a disclaimer that these gases are emitted from natural and human activity. The GHGs in turn accumulate in the atmosphere and contribute to the severity of the greenhouse effect (Riebeek, 2011; Malhi et al., 2002). The greenhouse effect is responsible for warming the Earth to a habitable temperature (Demarée and Verheyden, 2016; Anderson et al., 2016). The increase of the greenhouse effect has a knock-on effect on global warming (Pachauri et al., 2014; Cook et al., 2016) which then results in climate change. Impacts of climate change that cities can be faced with were then presented (Arnell et al., 2016; eThekwini Municipality, 2014a; Douglas et al., 2008; Roberts and O'Donoghue, 2013; Oppenheimer and Antila-Hughes, 2016; Yang et al., 2014; Wheeler and von Braun, 2013). Climate change mitigation which endeavours to minimise GHG emissions and climate change adaptation which seeks to respond to the harmful impacts of climate change, were also discussed.

The GHG emissions profile of eThekwini Municipality, both for local government operations and everything that takes place within the EMA, was then presented (eThekwini Municipality, 2017a). Importantly, eThekwini Municipality's per capita

GHG emissions were compared with other cities from around the world and it was observed that eThekwini ranked very high when compared with much more developed cities. This indicates that activities that are undertaken within the eThekwini Municipality are not very resource efficient (Sustainable Energy Africa, 2015).

The pre-eminent piece of the climate change puzzle at the international level, the Paris Agreement, was then discussed (United Nations, 2015). This included one of the key objectives of limiting temperature increases to 1.5°C above pre-industrial levels (Dimitrov, 2016; Rajamani, 2016). Also highlighted was that the South African government made contributions which could be reasonably achieved.

It was then mentioned that the Paris Agreement is very broad and many stakeholders were unsure what pathways need to be followed for the broad goals to be achieved. C40 thereafter undertook research, Deadline 2020, that sought to translate the manner in which member cities can decrease their emissions (C40, 2016). In addition, Deadline 2020 also highlighted key areas that offer cities high emissions abatement potential.

In order to contextualise the research, the green economy was briefly discussed (United Nations Environment Programme, 2010; Schandl et al., 2016) and the importance of decoupling GHG emissions from economic growth was presented (United Nations Environment Programme, 2014). Six key sectors of the green economy were brought into the discussion (Burkart, 2009). South African national green job potential was presented (Maia et al., 2011), followed by a scoping study that sought to determine the number of green jobs that were in existence in the EMA (eThekwini Municipality, 2013a). A detailed discussion on the green economy and sectors that make up a green economy was included in chapter two.

An overview of the EMA provided context as to location, size and population of the jurisdiction of eThekwini (eThekwini Municipality, 2017b). It was noted that there is still a large number of illiterate people in eThekwini, which is also accompanied by low levels of tertiary education (eThekwini Municipality, 2017b; Statistics South Africa, 2012). There seems to be varying positions on the percentage and number of informal settlements in the EMA (eThekwini Municipality, 2017b; Statistics South Africa, 2012). Access to basic services also had different backlog figures, according

to the four key service delivery areas. This was followed by a brief presentation of the current economic climate in the EMA, which included GDP, unemployment rate, gini coefficient and income levels (eThekwini Municipality, 2018; eThekwini Municipality, 2017b). Also mentioned was that eThekwini Municipality is home to the busiest port in Africa (eThekwini Municipality, 2015b) which had a stimulating effect on transportation and warehousing. While total electricity consumption has been steadily declining over the past few years, the vast majority of the electricity is derived from fossil fuels (eThekwini Municipality, 2015b; eThekwini Municipality, 2016; eThekwini Municipality, 2017a). The consumption of liquid fuel, petrol and diesel which is also fossil fuel derived, seems to be following an increasing trend (Department of Energy, 2015; Department of Energy, 2016a; Department of Energy, 2017).

The problem statement of the research was discussed. It was proposed that an understanding of the eThekwini green economy, according to its dynamic and complex characteristics, does not exist. In addition, there is a dire need for the development of ways in which ACE can be framed on, in Africa (Nwaobi, 2011). The importance of transitioning to a cleaner economy, for amongst other reasons, the sustainability of business and the economy, was touched on (United Nations Environment Programme, 2012; Stern, 2006). It was noted that this research needed to be able to be utilised in a practical manner by key stakeholders, who will have the ability to push on levers. It was noted that the bulk of these stakeholders will not be in a position to utilise complicated ACE simulation models and as a result, a framework has been developed.

The key research questions for this research were presented and are as follows:

1. What are the components of the eThekwini green economy and their key characteristics that affect business growth and the reduction of GHG emissions?
2. How do the components interact with other components of the eThekwini green economy and what are the leverage points?
3. Can a framework be developed to depict and set the basis for simulating the components of the eThekwini green economy and the manner in which they interact?

As with most research, this research also had a number of limitations. The most severe limitation was a tiny pool of people who have any meaningful insight into the eThekwini green economy. Linked to the first point, is that private sector stakeholders are so tuned to offering their goods and services, that the bulk of private stakeholders do not have a broader understanding of the eThekwini green economy. In many cases they did not even perceive themselves as participating in a green economy. There also seems to be a concerning attrition rate amongst companies from the eThekwini green economy itself. Large important institutions have their headquarters located outside of the EMA and as such were reluctant to participate for a number of reasons.

The research was predicated on two assumptions: the eThekwini green economy is still in its infancy and as a result, offers huge opportunities for job creation, economic development, environmental protection and social equity.

The academic significance of this research is that it would be developing rules on which an ACE model, for an African city, can be developed. The practical significance of this research is that practitioners in the eThekwini green economy will have a better understanding of the eThekwini green economy from a holistic perspective and know where the leverage points of the green economy are, through interacting with the framework that will be developed.

7.3 Literature

This first literature chapter, chapter two, began with a short discussion on the definition of economics. An important point raised is that an economy can be considered as a complex and dynamic system, as a result, it will require an appropriate theory that can engage with those characteristics.

7.3.1 Green economy

The first literature chapter then continued with a discussion of the green economy. In recent years the green economy concept has been gaining an increased amount of attention and can be traced to 2009, when the Global New Deal was developed (Musango et al., 2014; Kaggwa et al., 2013). This deal sought to respond to the financial crisis through the green economy. One of the critical documents that set the trajectory for the green economy was a UN resolution title “The future we want” and the ‘Green Economy Report: Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication’ (Cock, 2014; Musango et al., 2014).

There are various definitions of what a green economy is, however, all definitions have three critical elements in common (United Nations Environment Programme, 2010; United Nations Economic Commission for Europe and United Nations Environment Programme, 2011; Southern African Development Community, 2013). These three elements are: economic stimulation, environmental protection and social equity.

There were two types of green growth identified in the literature. The first would result in an initial inhibiting of economic growth which would subsequently be inverted and the second type of green growth is where economic growth can be immediately stimulated (Bowen and Hepburn, 2014). Also highlighted were three worldviews that can be utilised to frame the green economy and would as a result, have an impact on the types of interventions and paths that are travelled to stimulate a green economy (Faccer et al., 2014). These worldviews are Incrementalist, Reformist and Transformative.

Thereafter, sectors of a green economy were discussed. It was found that an often relied upon source identified six components that make up the green economy which are: renewable energy, green building, sustainable transport, water management, waste management and land management (Burkart, 2009). The aspects of a green economy could also be classified into a number of domains, such as financial, institutional, regulatory and green cultural economy (Bailey and Caprotti, 2014). However, after perusing the literature a number of additional aspects of the green economy were identified and include: linkages to the informal economy (Smit and Musango, 2015b; Davies and Thurlow, 2010), labour structures (Cock, 2014; Musyoki, 2012), environmental activists (Cock, 2014), technology (Kaggwa et al., 2013; Mithas et al., 2010), mining for material required for green goods (Montmasson-Clair, 2012; Unmüßig et al., 2012), agriculture (Musvoto et al., 2015; Donnik et al., 2016), eco-tourism (Gheorghe and Pârvu, 2016; Pan et al., 2018) and buyer behaviour (Anvar and Venter, 2014; Liverani, 2009).

Thereafter, indicators that are utilised to measure national and local green economies were discussed (United Nations Environment Programme, 2014; Dual Citizen LLC, 2016; Green Growth Knowledge Platform, 2013). It was pointed out that it is important that indicators have the ability to dovetail into each other at the various

levels and ideally take its lead from the SDG indicators. It was also highlighted that indicators are not homogenous and there can be different indicators for different purposes such as for issue identification, policy formulation, policy assessment and policy assessment (United Nations Environment Programme, 2014). Two existing indicator models were then presented, one at a national level and another at a local level (Dual Citizen LLC, 2016; Siemens, 2015). The main finding is that there always seems to be key indicators that are made up of sub-indicators. Thereafter, the SDGs were discussed, but specifically of objectives and indicators that could be relevant for the eThekwini green economy. The important SDGs that were discussed are 7, 8, 11, 12 and 13.

A discussion followed on the national, provincial and local government supporting documents for the green economy. It is important to note that actual Acts were not included, neither were specific programmes and projects. The discussion centred on strategies, plans and frameworks. It was immediately noticeable the there is no one central government department that acts as a repository or that has total ownership of green economy enabling documentation and direction. It is spread across a number of government entities. The documents discussed included the South African Constitution (Republic of South Africa, 1996), National Development Plan – Office of the President (National Planning Commission, 2012), IRP – Department of Energy (Department of Energy, 2011), IEP – Department of Energy (Department of Energy, 2016b), New Growth Plan – Department of Economic Development (Department of Economic Development, 2011b), Industrial Policy Action Plan – Department of Trade and Industry (Department of Trade and Industry, 2017), National Climate Change Response White Paper – Department of Environmental Affairs (Department of Environmental Affairs, 2011a), Renewable Energy White Paper (Republic of South Africa, 2003), LTMS (Energy Research Centre, 2007), South Africa's response to the International crisis – NEDLAC (Republic of South Africa, 2009), Medium Term Strategic Framework (Republic of South Africa, 2014), National Waste Management Strategy – Department of Environmental Affairs (Department of Environmental Affairs, 2011b), National Strategy for Sustainable Development and Action Plan – Department of Environmental Affairs (Department of Environmental Affairs, 2011c), National Energy Efficiency Strategy – Department of Energy (Department of Energy, 2016c), Minister of Finance's 2018 budget speech (Minister of Finance, 2018),

Carbon Tax – National Treasury (Republic of South Africa, 2017), Provincial Growth and Development Strategy – Provincial Planning Commission (Provincial Planning Commission, 2016), IDP – eThekwini Municipality (eThekwini Municipality, 2017b), Strategic Development Framework – eThekwini Municipality (eThekwini Municipality, 2017c), DCCS – eThekwini Municipality (eThekwini Municipality, 2014b) and the Economic Development and Job Creation Strategy – eThekwini Municipality (eThekwini Municipality, 2013b).

It was noted that businesses do not exist in isolation of the broader environment and will be susceptible to negative impacts of climate change (Gasbarro and Pinkse, 2016; United Nations Global Compact, 2011). Critical risks identified include: physical and operational, regulatory and legal, financing, market, political and reputational (Edwards et al., 2016; United Nations Global Compact, 2011). Another key risk that businesses could face include being boycotted, due to high carbon intensity of goods and services (Cohen and Vandenbergh, 2012) and this can be extrapolated to an entire carbon intensive economy.

OD will be important if businesses are to adequately respondent to climate change risks, particularly since businesses themselves can be classified as CAS.

7.3.2 Theoretical foundation of this research

The second literature chapter, chapter three, began by stating that a specific problem, topic or system can be scrutinised with a plethora of academic theories (Maduliat et al., 2015; Bailey and Caprotti, 2014). However, it is vitally important that the academic discipline has to have the ability to process that in question (Dolores Sánchez-Fernández et al., 2014; Armiger, 2015). As the green economy is a system that can be characterised as being complex and dynamic in nature, a theoretical underpinning that is able to incorporate intractable characteristics has to be adopted for this research.

The concept of economic equilibrium was briefly discussed (Wing, 2004; Barzilai, 2016). Some challenges that arise from using an underpinning theory that makes a situation tractable were presented (LeBaron and Tesfatsion, 2008). This was followed by a very short presentation on micro and macroeconomics (Dominique, 2017; Manuel, 2006; Dacheux and Goujon, 2011; Mankiw, 2010). Thereafter, the key tenets of the theoretical foundation that would be suitable for this research was discussed. A

theory that can fully accommodate a complex and dynamic system and not simplify matters was sought. Ecological economics (Van den Bergh, 2001; Sutton et al., 2016) and Environmental economics (Folmer and Johansson-Stenman, 2011; Sandmo, 2015) were both presented and ruled out for this research. Behavioural economics is unable to explicitly intertwine complexity (Whittle et al., 2014; Never, 2014) and was also ruled out. Evolutionary economics was ruled out due to there being more appropriate theoretical options.

Game theory has been utilised in economics to understand conflict and cooperation, and is largely designed around finding an equilibrium state (Turocy and von Stengel, 2001; Tesfatsion, 2006a), something that this research did not intend to do. Conflict and cooperation was likely to be one aspect of the research and not the totality and game theory was dismissed as a result. System dynamics was the next closest theoretical underpinning for this research as it is able to accommodate complexity and dynamism through a stock and flow approach (United Nations Environment Programme, 2013; Forrester, 1994). However, it is more difficult to include heterogeneous agents of the same agent classes in system dynamics frameworks and models and as a result was not adopted for this research.

Thereafter, CAS was discussed. These are specific types of systems that consist of two or more heterogeneous agents that work towards a certain cause and exhibit dynamic and complex behavioural traits (Holland, 1992; McKenzie, 2014; Wollmann and Steiner, 2017). Some of the key tenets were discussed in order to properly frame CAS, these include: management of the system is decentralised (Bristow and Healy, 2014; Bale et al., 2015), co-evolution (Ellis, 2011; Brady, 2014), agents with unique schemata (Ellis, 2011; Filotas et al., 2014), sensitive dependence (Grus et al., 2010; Speakman, 2017), path dependence (Bale et al., 2015; Held et al., 2014) and emergence (Bale et al., 2015; Held et al., 2014). Economics, social systems, cities and the physical environment were classified as forms of CAS (Balint et al., 2017; Furtado et al., 2015). ABM was then discussed and some of the major advantages (Helbing and Balietti, 2011; Bergerson et al., 2016) and shortcomings (Rai and Robinson, 2015) were discussed.

ACE, which brings CAS and ABM together was then discussed (Tesfatsion, 2003; Levy, 2009). Critical structural aspects of such models were discussed and includes

the actual components or agents, interaction rules and the environment in which the system operates (LeBaron and Tesfatsion, 2008; Corredor, 2007; Van Dinther, 2008; Li, 2013). Some previous examples of ACE were presented. These include EURACE which sought to model the European economy it is entirety (Deissenberg et al., 2008; Naciri and Tkiouat, 2016; Cincotti et al., 2011). The Aspen model, developed a long time ago, included a rudimentary economic model but was nevertheless important (Pryor et al., 1996). The research that was presented in chapter three was critical for lending their frameworks for this research, even though this research does not take the process to the stage of developing the simulation model.

The need for ACE was then discussed and this includes contribution to the huge reform task that Africa faces (Nwaobi, 2011). There is a critical need for insight into rules that can govern agent-based models within the African context (Nwaobi, 2011). While there have been attempts to collect primary data for the development of ACE models, none have been found specifically for the eThekwini green economy.

7.4 Research methodology

The fourth chapter dealt with the research methodology that was utilised for this research. It was noted that there is a lingering challenge that involves the conversion of empirically collected data into structures for agent-based models (Filatova et al., 2013; Klabunde and Willekens, 2016).

There are four dominate worldviews, through which the world can be framed and this has a corresponding impact on research methodology (Creswell, 2014). These are: postpositivism, constructivism, participatory and pragmatism (Creswell, 2014). A worldview is essentially a mental model of how the world and everything in it operates (Creswell, 2014; Hussein, 2015; Wright et al., 2016). The four worldviews were discussed and a conclusion reached that pragmatism would be most suitable for this research due to the fact that it can incorporate both quantitative and qualitative data collection methods. More importantly, the worldview is able to take into account that research is always set within larger contexts and that there is likely not one single reality but a multitude of realities (Christ, 2013; Johnson and Onwuegbuzie, 2004).

The three types of strategies of inquiry were presented: quantitative, qualitative and mixed methods (Creswell, 2014; Yilmaz, 2013; Noyes et al., 2015; Venkatesh et al.,

2013). Mixed methods was chosen for this research which links to the pragmatism worldview.

The population for the quantitative aspect of this research was identified through a previous scoping study undertaken of eThekwini businesses that are involved in the green industry (eThekwini Municipality, 2013a). The companies numbered three hundred and fifty nine. However, due to a bad response rate, for the survey, the population was increased to four hundred and sixty two. It should be noted that due to the small population size all identified people and organisations were included in the quantitative research. In addition, the qualitative component had a population of sixteen people, again, due to the small population size all people were included in the sample. In addition, a population was not assigned for focus groups, but twenty two people participated in three focus group sessions.

Quantitative data was collected through standard surveys. The survey was developed on QuestionPro and a standard Excel document. A pilot survey was undertaken to ensure that the tool worked. Interviews were semi-structured and conducted face-to-face with audio recording of all interviews. Focus groups were also conducted in person and recorded.

Once data was collected they were transcribed and analysed according to a six-step process, as advocated by Creswell (2014). Descriptive statistics were predominately utilised to analyse data collected through surveys. Thematic analysis was utilised for data collected through interviews and focus groups. Once all data was analysed it was envisaged that a discussion would juxtapose and discuss both data sets in an integrated manner. Processes and steps to ensure the validity and reliability of both quantitative and qualitative data were then discussed.

The last part of the chapter dealt with bias and ethical considerations. It was planned that researcher bias would be decreased through the use of SPSS for quantitative data and Nvivo for qualitative data analysis. In addition, all participants in interviews and focus groups were requested to sign a consent letter and their identities would not be discussed in this research but their demographics would be included. Furthermore, ethical clearance was granted by the University of KwaZulu-Natal for this research and gatekeeper letters were obtained from KSEF and the eThekwini Municipality.

7.5 Key findings and results

The findings from quantitative and qualitative data collection exercises were presented in chapter five.

7.5.1 Survey

The response rate to the survey was a major cause for concern, even after numerous attempts by the researcher to elicit a response. A total of 61% did not respond to the survey, a further 19% were not contactable, 8% had the decency to indicate that they would not participate in the research and only 12% returned the survey. The most frequently mentioned components were: government, banks consumers, private, energy, waste and recycling and legal and regulatory. The component that has the most amount of collaboration with the economy, according to respondents, is banks followed by the energy and legal and regulatory sectors. Respondents are of the notion that the legal and regulatory sector can make the greatest contribution to the green economy, which is followed by banks. The legal and regulatory sector was again rated the highest by respondents according to the rationality of decisions made, followed by banks, with consumers being rated as making the least rational decisions. The legal and regulatory sector was rated as having the highest importance for the green economy followed by the waste and recycling sector, government and banks. In terms of the size of the components, the private sector was rated as the largest. Banks and legal and regulatory are rated as the second and third largest components in the eThekwini green economy. In terms of degree of direct interaction with the eThekwini green economy, it seems like the energy sector, private sector, legal and regulatory and consumers have the most direct interaction. Consumers seem to be able to respond the quickest to stimuli from the eThekwini green economy, with the legal and regulatory sector taking the longest. The decisions made by banks, energy sector and the private sector seem to have the most intense impact on the entire economy. The question on whether components make decisions at random was asked differently in a later question in the survey, and all responses are broadly equal to earlier responses. Lastly, the components highlighted by the respondents are generally representative of the different elements of the green economy. The most frequently mentioned indicators are as follows: energy, marketing and awareness, green growth waste and recycling, GHG emissions, green employment, green spaces and health and social wellbeing of eThekwini residents.

7.5.2 Interviews

All intended people participated. In terms of demographics there were six Europeans, six Indians and four African participants. There were three female participants. The tag cloud of word frequency indicated that ‘people’ was the most commonly utilised word, other than words that were intrinsically linked to the research, such as ‘economy’, ‘green’ and ‘components’.

There were a number of themes that emerged through the data analysis process. These themes are discussed below.

Definition of the green economy was the first theme to be discussed. There was broad convergence of opinion that the eThekwini green economy is in existence but remains in its early development stages. Related to this, there remains a huge opportunity for growth and social equity to be achieved, in addition to protection of the environment. It was noted that no interview participant on their own was able to provide a robust and comprehensive definition or overview of the eThekwini green economy but when responses are aggregated, a fairly complete picture begins to emerge.

The second theme to emerge was key components that make up the eThekwini green economy. These components include communities, which can be further disaggregated into activism, consumers and labour. The private sector was made up of: agriculture, automotive, real estate, petro-chemicals, manufacturing, banks, technological innovation, eco-tourism, transportation, energy, and waste and recycling. The government sector, as indicated by respondents was made up of: legislation, policy, enforcement, incentives, energy, waste and recycling and water. In addition, the international sector and triggers were mentioned.

Characteristics of the key components, was the third theme that makes up the eThekwini green economy, to emerge from the interview sessions. The main characteristics that were identified are: financial, benefits, dependency, people, decisions, quality of information, time, buy-in and motivation. It was noted that while these characteristics would be present in most components, it mainly related to components that have a social element. Furthermore, the specific make up of components’ characteristics would naturally differ between each component.

The fourth major theme that emerged was the drivers of the eThekwini green economy. These are components that have the ability to move the entire eThekwini green economy in a catalytic manner with only a small stimuli. The drivers are: communities, consumers, workers, funding, companies, international, government and triggers.

A theme around measurement of the eThekwini green economy was also highlighted, as the fifth theme, in the form of indicators. Specific indicators have already been mentioned twice in this thesis and further repetition will be avoided from listing them again. Indicators that emerged span the three main parts that make up the definition of a green economy, i.e. financial, environmental and social. Specific indicators that respondents raised were primarily quantitative in nature, with a minority being qualitative.

The sixth theme identified was on challenges facing the eThekwini green economy. These challenges include: lack of direction, legislation, accessing funding, revenue of government, cost, affordability, lack of knowledge, skilled people, no immediate benefit, not pervasive, market and demand, silos, no proper definition, lack of awareness, negative perception, poor indicators and monitoring.

When challenges were raised, recommendations or possible solutions were also raised. However, the recommendations that emerged were noticeably less in number than challenges raised. The recommendations are: a top-down approach should be followed, specific action plans must be developed, there needs to be an ability to implement projects, acquire buy-in of stakeholders, acquire the buy-in of politicians, preservation of open spaces, education and awareness raising and a systems thinking approach should be instituted.

7.5.3 Focus group

Three focus groups sessions were conducted, with a total of twenty two participants. The spread of participants included business owners, academics, municipal officials and students. It was observed during the focus groups sessions that not as many components were raised, when compared to the interview sessions.

Seven major themes emanated from the focus group sessions, the first of which was the existence of the eThekwini green economy. It was largely agreed on by all

participants, in the three focus group sessions, that there is a green economy in the EMA, albeit the green economy is still in its early stages and it lacks large scale visibility.

Key components that make up the eThekwini green economy was the second major theme to emerge. The themes are: behavioural change and culture, urban migration, financial motive to retain business as usual, energy, innovation and new technology, natural environment, government, policy and regulation, consumers, education and awareness and the private sector.

Interaction and learning, the third theme to arise, states that all components in the eThekwini green economy interact with other components of the economy. There is no component that operates in isolation. In addition, while there is learning amongst components, the level of learning is currently minimal.

An important part of this research was to determine leverage points of drivers of the eThekwini green economy. This was the fourth theme to emerge from focus group sessions. The key leverage points identified through focus groups are: consumers, external triggers, incentives, regulations and the government sector.

Another major theme was indicators for the eThekwini green economy, which are: awareness and marketing, mind-sets, recycling and water reduction, implementation of policies particularly for buildings, projects and initiatives being undertaken, energy efficiency broadly and the energy mix.

Challenges and recommendations also clearly emerged as distinct themes from focus groups.

The challenges facing the eThekwini green economy includes: funding constraints, no indicators, weak government leadership, buy-in from stakeholders, expensive, behavioural change and perceptions, lack of incentives, short-term focus, lack of legal and regulatory framework, implementation and compliance, unstructured approach, lack of skills and silos.

The recommendations for enhancing the eThekwini green economy include: taking a holistic view, identify and understand drivers, collaboration, incentives, leadership by

the eThekwini Municipality, up-skilling, policy development, funding, compliance, systems approach, measurement, awareness and end corruption.

7.6 Discussion and analysis

To avoid duplication in subsequent sections, the key research questions that were discussed in the analysis chapter will not be summarised in this section. The discussion on key research questions will be presented in the subsequent section to ensure that the questions are clearly answered.

The chapter began with a discussion on the response rates of qualitative and quantitative data collection methods. The intended participants identified for the direct face-to-face interviews all participated in the interviews. The focus group sessions were a lot trickier to set up. Although associations were eager to assist with coordinating their members, their members displayed an obvious disinterest in participating. Nevertheless, three focus groups were eventually recorded. The major cause for concern, not just for this research but for the inherent implications for the eThekwini green economy, was the bad response rates from the quantitative survey. It emerged that the two major reasons that people did not respond to the survey were due to the companies and organisations closing down or being liquidated. The second is that the bulk of respondents not being of the view that they participate in the green economy, as they are so focused on their operations that they do not understand the larger linkages. The analysis by the researcher as to whether stakeholders are actually participating in the eThekwini green economy was undertaken according to the widely utilised definition of a green economy, *"an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarciti*es*"* United Nations Environment Programme (2010, pg. 5).

Both quantitative and qualitative data collection methods triangulated almost perfectly on the question of whether the eThekwini green economy exists or not. This study found that the eThekwini green economy does exist, but is very early in its life cycle. However, the green economy that exists is the result of organic processes in the larger economy and there is a severe need for leadership from the eThekwini Municipality. According to complexity theory, specifically CAS, leadership by eThekwini Municipality on its own will not be sufficient to adequately address the numerous challenges facing the eThekwini green economy (Bristow and Healy, 2014; Bale et

al., 2015). It is the position of this research that in order for the entire system, the eThekwini green economy, to be effectively managed - all components need to effectively manage themselves and perform their inherent tasks to the best of their ability.

The major sectors listed by Burkart (2009) have been confirmed as being part of the eThekwini green economy, by survey, interview and focus groups participants. However, as highlighted in Chapter 2, the sectors listed by Burkart (2009) are not comprehensive. As a result, a number of additional sectors that are part of the eThekwini green economy were also identified by survey, interview and focus group participants. Some of these sectors were highlighted by Smit and Musango (2015a) – informal green economy; Kaggwa et al. (2013) and Mithas et al. (2010) – technology; Montmasson-Clair (2012) and Unmüßig et al. (2012) – green mining jobs; Musvoto et al. (2015) and Donnik et al. (2016) – agriculture; Gheorghe and Pârvu (2016) and Pan et al. (2018) – eco tourism.

There were more challenges than recommendations raised by respondents. At the beginning of this research, the identification of specific challenges and recommendations was not included, as a high level understanding was being pursued. Perhaps, according to the CAS underpinning this should have been explicitly included, as according to McKenzie (2014) and Wollmann and Steiner (2017) each component impacts other components and the system at large. There was a lot of consensus on the challenges and recommendations amongst respondents. However, what became apparent is that it seems like there is an expectation for government to provide the financial motivation and reduction of bureaucracy or red tape.

The major concern with challenges is that of the ten leverage points identified through this study, five have been highlighted by respondents as being challenges for the stimulation of the eThekwini green economy. A gap identified in the literature is that there is no widely adopted or recognised methodology or process that has the ability to convert primary data, or even secondary data, into frameworks or equations that can be utilised as a basis for development of definitive models. It is important to note, however, that good direction is provided by Buchholz et al. (2007), Deelman et al. (2005) and Elsawah et al. (2015).

The development of proposed indicators for the eThekwini green economy had to be triangulated with existing literature and models and primary data from qualitative and quantitative data collection processes. The indicators highlighted through this research are disaggregated into five key types of indicators: social, environmental, economic, operational and underpinning. This approach largely relates to the approach of other indicator models developed for the green economy, such as Dual Citizen LLC (2016) and Siemens (2015). However, while Dual Citizen LLC (2016) and Siemens (2015) have largely revolved around quantitative indicators, there is a mix of qualitative and quantitative indicators that have emanated from this research. It should also be noted that many of the indicators are already being measured, but would need to be collated into the dashboard developed through this study. In addition, there are some indicators that are not currently being calculated or monitored, on a wide scale relevant basis, and would need to be addressed. These indicators include: mind-sets, behaviour change and integration of sectors.

While ACE provided a good theoretical platform for this research, there are a number of gaps that still remain in the ACE literature. The basic tenets of ACE are easy to grasp, however, the actual final product of ACE is normally a highly specialised programme that can be utilised by a few people and probably understood by even fewer. The potential advantages of ACE, when utilised correctly, appears to outweigh the disadvantages – particularly with providing insight into unanswered questions (Gräbner, 2016). However, a theoretical aspect that needs to be addressed is the manner in which findings from research are converted into useable equations and findings that can be utilised to develop either frameworks or models, such as Elsawah et al. (2015). The importance of this cannot be understated, as advanced models such as EURACE (Deissenberg et al., 2008; Cincotti et al., 2011) and Aspen (Pryor et al., 1996) cannot be utilised by average or normal practitioners that do not have programming skills. As a result, the benefits are likely to be lost. Perhaps, until programing skills become widespread to no longer act as a barrier, ACE models need to be developed at a level that the average person can understand and internalise the tenets.

The next section further discusses the answers to the key research questions of this research.

7.7 Key research questions

The key research questions for this research are as follows:

7.7.1 What are the components of the eThekwini green economy and their key characteristics that affect business growth and the reduction of greenhouse gas emissions?

This study triangulated data from literature on the green economy, climate change more broadly, ACE models that have been developed and collected primary data through interviews, focus groups and surveys.

After collating components, the various components were aggregated multiple times to determine the best and most representative manner to display them. The components can be classified into seven primary components which are: international, local economy, communities, private sector, government sector, a cross section where government and private sectors overlap and cross cutting. There is a component that relates to overlap between government and private sector as there are sizeable operations taking place by both components in numerous specific sub-sectors. The components of the eThekwini green economy that were highlighted by this study is indicated in Figure 7.1. The components are not listed in any order of importance.

It is important to note that the components were primarily assessed by the final impact on the green economy in regards to the contribution to social, financial and environmental benefits. Albeit, full life-cycle of the components and activities that would be related need to be assessed and taken into account. To illustrate this point, eco-tourism is a component highlighted by numerous respondents, in terms of the benefits it has for the eThekwini green economy, for environmental and financial gain. However, should the transportation GHG emissions from people that travel to the EMA be taken into account then eco-tourism's contribution to the environmental aspects of the holistic green economy, not necessarily the eThekwini green economy, is likely to be negative.

The characteristics of the components that emerged from this study, relate to components that have a human or social element such as government. Components such as technology are not likely to be impacted and driven by a number of the characteristics. All components have either a direct or indirect financial

characteristics, where they are driven to derive profit for themselves or to generate a positive financial situation for another component.

The second characteristic is motivation and benefit. These include the reasons for the components being in existence. There is always an objective, or multiple objectives that various components seek to achieve. For example, environmental activists would strive to decrease the environmental degradation taking place and businesses would seek to maximise profit.

It was also found that dependency is another characteristic of the components. There is always a degree of dependency displayed by components, no component operates in isolation.

People emerged as a key characteristic of components. To a large extent many of the components are controlled and staffed by people. As a result, it is critical that the right skill level of people is present in relevant organisations.

An interesting characteristic that emerged from the study is the manner in which decisions are made by components. These decisions can either be strategic and proactive, or random, or reactive. The majority of larger components, such as government and businesses, seems to by default, make strategic and proactive decisions. It emerged the component that is most prone to random decisions making is consumers.

The last characteristic that emerged is the time in which components take to respond to stimuli. According to respondents, consumers seem to be able to respond the quickest in the eThekwini green economy. While elements such as government and related aspects take a longer time to respond.

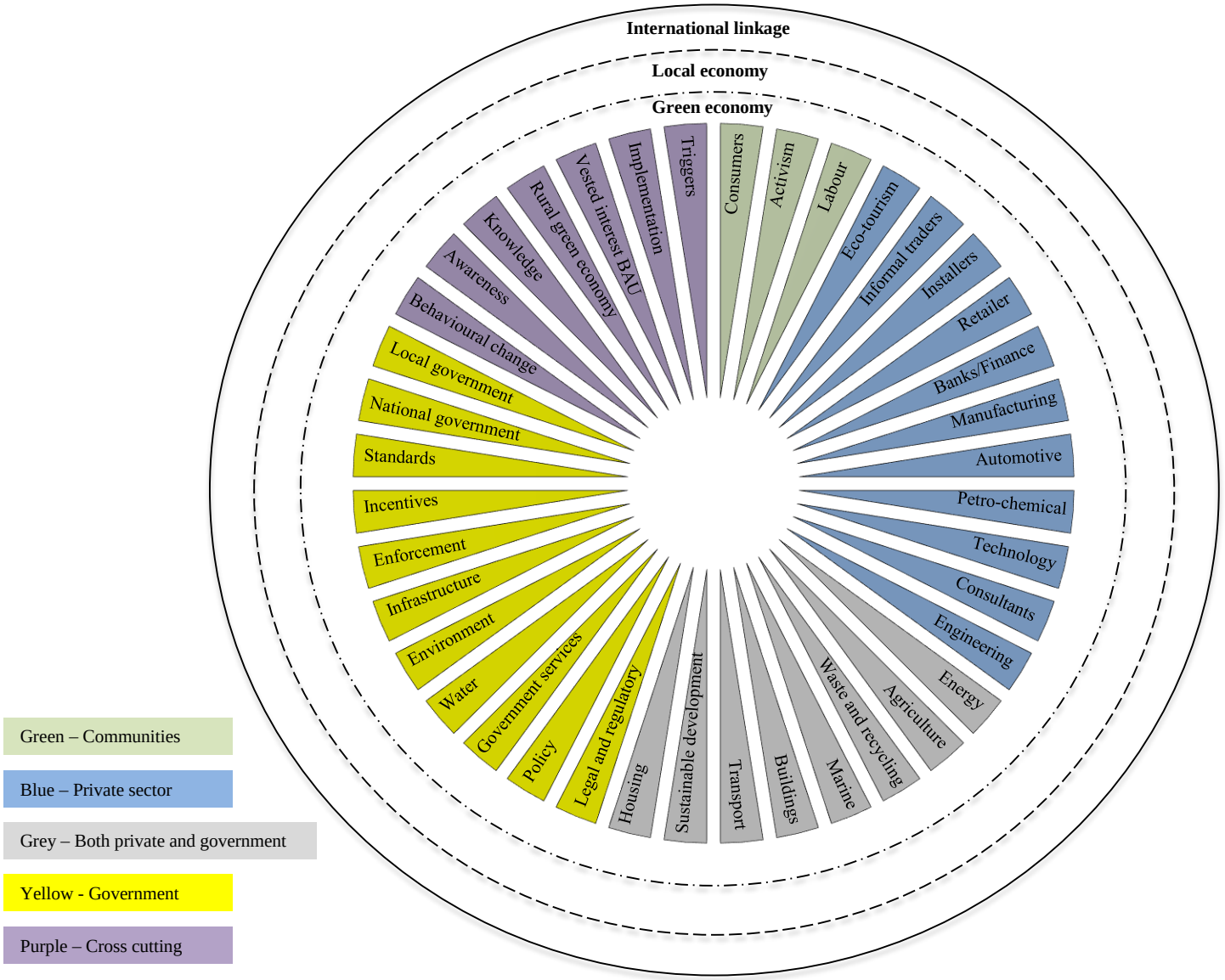

Figure 7.1: Components of the eThekwini green economy

7.7.2 How do the components interact with other components of the eThekwini green economy and what are the leverage points?

The study did not find any component of the eThekwini green economy that operates in isolation of other components. Interaction can be framed as being critical for survival.

Interaction within the eThekwini green economy follows established interaction rules, in the broader general economy, generally. To illustrate this, manufacturers have to interact with banks for loans, manufacturers interact with standards to ensure that there is compliance and labour has to interact with employers. It was found that the components take instruction from authority, i.e. government and regulations, and flows to components that are subservient. However, due to the eThekwini green economy still being in its infancy, the strength of interaction is not as strong as it could be. It is likely to strengthen as the eThekwini green economy matures.

There were two types of interaction observed during the study. These are components that have a synergistic or antagonistic relationship with other components. It is likely that for any component there will be a mix of both types of relationships. In addition, the type of relationship between components has the very real possibility to switch to the opposite when conditions become unfavourable or favourable. While it did not emerge during this study, it can be theorised that any interaction between components can also be neutral in nature, especially if there are two extremes identified.

Each component strives to make the best decision for themselves. When the sum of the best decisions are aggregated it will result in a likely bad macro situation. This is especially true when the social and environmental flows, which were introduced in the development of the framework, are not taken into account when individual components are making decisions.

This study identified a total of ten critical leverage points for the eThekwini green economy. As indicated in Figure 7.2, the leverage points are: consumers, activism, labour, banks and finance, legal and regulatory, incentives, national government, local government and triggers. The tenth leverage point should be thought of as an index made up of discretionary income, gini coefficient, unemployment and per capita GDP. It is the position of this study that this index will fundamentally indicate the ability or affordability of consumers, primarily end-users.

It is vitally important to note that a long-term view was taken when the mapping exercises where being undertaken to identify the leverage points. As a result of a long-term view being taken, structural aspects were focused on, and through enhancing or addressing those structural aspects other important aspects will be automatically addressed. If a short-term view was taken, the leverage points are likely to have been different. As an example, if a short-term view was taken then education and awareness would probably have been identified as a leverage point.

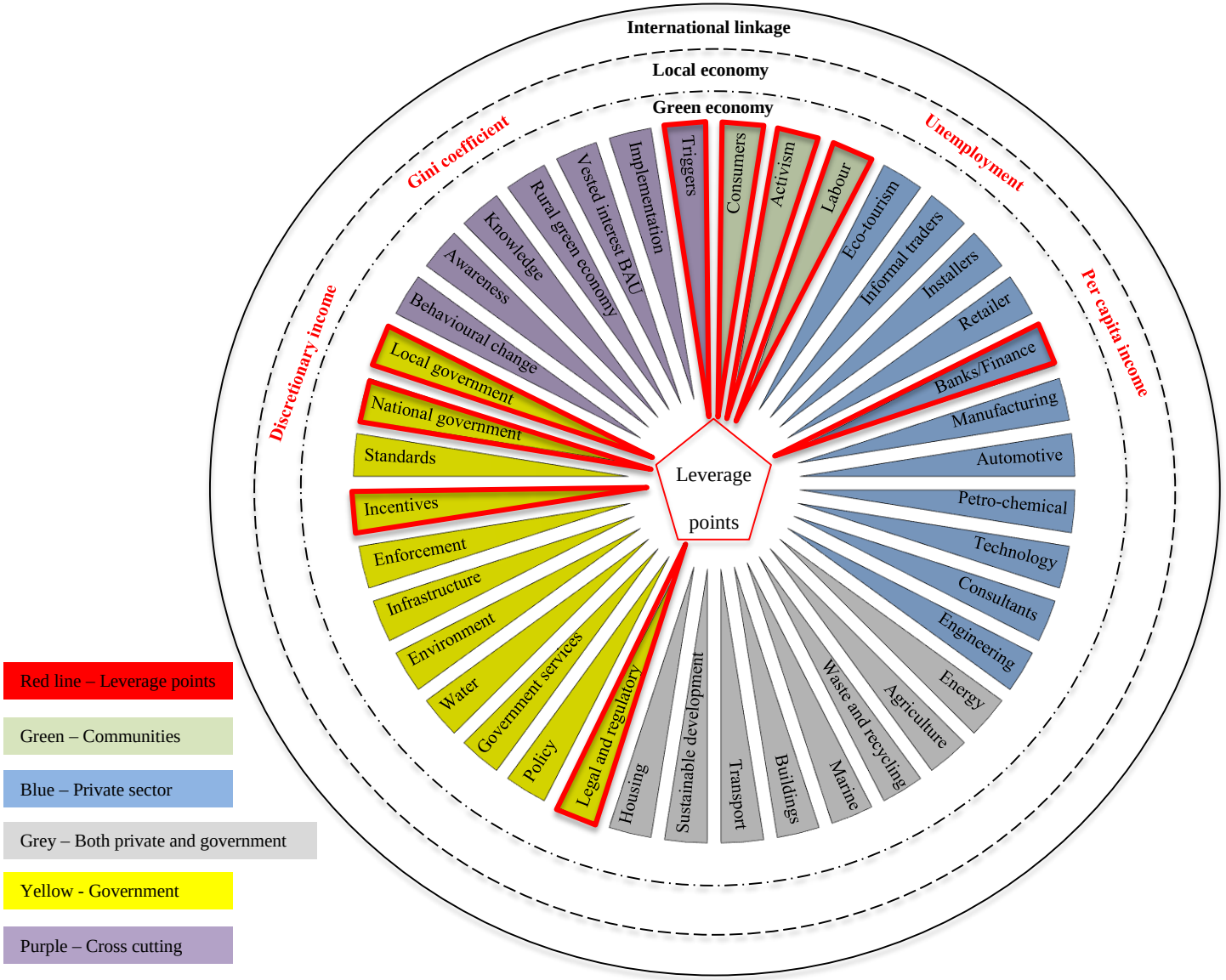

Figure 7.2: Leverage points of the eThekwini green economy

7.7.3 Can a framework be developed to depict and set the basis for simulating the components of the eThekwini green economy and the manner in which they interact?

Yes, it was possible for a framework to be developed, that illustrates the manner in which the eThekwini green economy operates. However, the illustration of this framework proved to be extremely complex.

It emerged from this research that each component's contribution to the eThekwini green economy can be framed according to the stimuli they received, either from other components or the economy. The stimuli is then interpreted and processed according to the characteristics of the individual component. The outcomes from the process are two-fold, the first results in tangible contributions to the eThekwini green economy, which could be the development of a regulation or the manufacture of a finished green product. The second outcome is the flow, which can be negative or positive, into the eThekwini green economy and includes: social, environment and financial elements. This is illustrated in Figure 7.3.

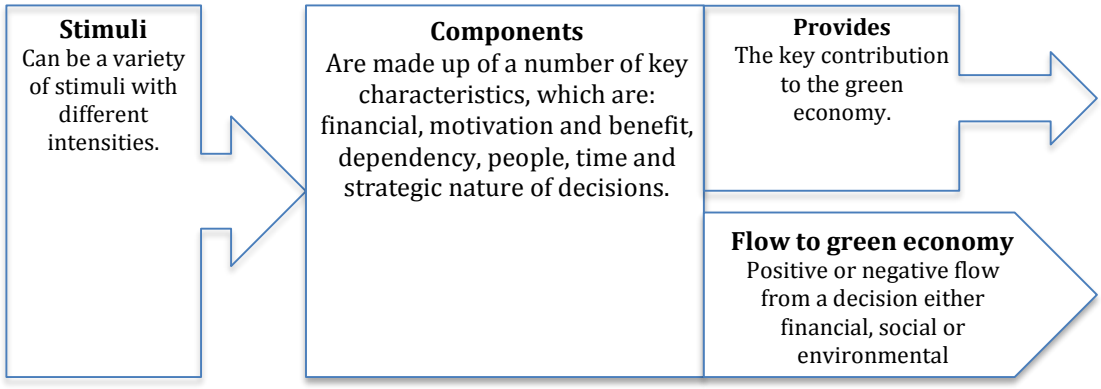

Figure 7.3: Components of the eThekwini green economy

This study identified a total of forty two components. The complexity to develop a framework, at this point, for all forty two components will be vast. As a result, the number of components that are incorporated into the framework are decreased to twelve. It should however be noted that for the consumer component, the affordability index will be inherent. In addition, national and key government direction will undoubtedly influence the legal and regulatory and policy components. Thereby bringing the total number of components incorporated into the framework to fifteen.

The twelve base components that are included in the framework are: consumer, activism, labour, bank, manufacturing, services, legal and regulatory, policy, standards, incentives, awareness and behaviour change.

7.8 Contribution of the research

The first contribution of this research is that the existence of the eThekwini green economy has been confirmed and there remains a huge potential for growth. It was further highlighted that none of the research participants were able to robustly define or identify all components of the eThekwini green economy, which relates to a key tenet of CAS. In instances, businesses that by definition would be part of the green economy are so focused on delivering goods and services to their customers that the people who manage some of the business are not even aware that they are part of the green economy. Importantly, this research appears to be the first formal research that sought to study the eThekwini green economy holistically utilising a complexity lens.

This study also found that no component of the eThekwini green economy operates in isolation and this would often put various components with numerous objectives in conflicting or contradictory situations. To overcome possible negative situations it is vitally important that components adopt a collaboratory mental model when making decisions. This is critical when components make the best financial decisions for themselves, without taking into account social and environmental flows. Those best decisions are likely to aggregate into bad macro situations for all components that are part of the eThekwini green economy.

While there are elements of the eThekwini green economy in existence, this seems to be from organic processes within the broader economy. There is a dire need by local government to play a larger leadership role in directing the eThekwini green economy.

The key practical contribution of this research was the identification of leverage points that will have a catalytic impact on the eThekwini green economy. This disproves the often articulated view that awareness is of tantamount importance, which is not the case, especially where people cannot afford the premium carried by green goods.

From a theoretical perspective, this study developed a framework which serves to depict the manner in which the eThekwini green economy operates, from an ACE perspective. This is in response to Nwaobi (2011), who advocates ACE to be utilised for African economies. Furthermore, this framework sets a base from which similar research can be undertaken in other regions, which would further assist not just the development of further theoretical research, but also have practical benefit for green economies. *"The paper shows that for the green economy to succeed, there is a need for regionally specific research …"* Musyoki (2012, pg. 13). It is intended that this framework, the components that are a part of the framework and the manner in which the components function will be internalised by eThekwini green economy stakeholders. This will result in decisions which are favourable to the strengthening and expansion of the eThekwini green economy. It is also envisaged that the framework developed would be a step closer to developing an actual simulation model of the eThekwini green economy, and as a result, the specific equations that govern the behaviour of components within a green economy of an African City. Importantly, an element that emanated from the research is that not only financial flows need to be included in the framework but must also include environmental and social flows. Decisions made by components will result in either positive, neutral or negative flows, which would then impact other components and the entire green economy. Furthermore, each flow would be accounted for at a macro level which would serve as input into further decisions by components.

From a methodological perspective, it was found that qualitative approaches are critical, given the lack of existing specific information about African cities green economies. If quantitative approaches are utilised they must follow from the completion of qualitative data collection and analysis, i.e. findings from qualitative data must be utilised as input for quantitative research. In the absence of detailed specific information, mapping of components and the manner in which they interact, in multiple formats, resulted in the flows between components. This research also found triangulation of data collection methods and existing broader research, to be extremely useful to compensate for a lack of data.

7.9 Recommendations for the eThekwini green economy

Recommendations largely mirror the challenges that have been raised by respondents and discussed above. In addition, there are aspects that recur from both interview and

focus groups data collection methods, which can be found in Sections 5.2 and 5.3 respectively.

An element that does not appear in challenges, raised by respondents, are the eThekwini green spaces. However, the green space aspect does fall under the definition of a green economy. The preservation of eThekwini Municipality's green space, while not under severe direct threat at the moment, has been highlighted as critical for the development of the eThekwini green economy, sustainability of tourism, eco-tourism and general wellbeing of the eThekwini Municipal residents.

Interestingly, the high cost of green goods and services, and the ability to afford such, have been iterated by a number of respondents as a problem, amongst all data collection methods. However, it has not emerged how the cost of the green goods and services within the eThekwini green economy should be decreased, apart from incentives and increase the ability for resident to afford such. While other aspects and components have been raised as a challenge or problem, they have at times been accompanied with a matching solution, from the other end of the spectrum. This was not the case for the cost of green goods and services and the ability of eThekwini residents to be put into a position so they can afford the premium over traditionally priced goods and services. It is likely that this is due to the magnitude of the solution and respondents tended to keep the discussion within a realm that seemed controllable and realistic. On the opposite side of the continuum lies the commercial and industrial sectors who generally need access to more affordable sources of financing. This is due to the interventions in the green economy, generally, being able to pay off their capital investments from operational savings.

It is critical that government departments liaise with each other, especially keeping in mind the plethora of government departments that house green economy related enabling strategies, policies and plans. The alignment of the legislative and regulatory aspects of the green economy is a necessity, so as to allow all aspects to synergise and result in an enabling environment for the green economy. To illustrate the point: an ambitious strategy for photovoltaic rollout in South Africa will only result in implementation if the relevant standards and processes are also put in place. However, it is important to note that the various pieces needed, often do sit in various places within government. This will necessitate collaboration amongst all relevant

government stakeholders. Even private stakeholders will need to be consulted to determine what is most suitable for industry practices.

The translation of strategies into detailed action plans, for specific interventions, needs to occur as soon as possible after the development of strategies. In addition, the action plans need to be realistic and implementable. Implementation is another area that is lacking both within the public and private sectors. The ability to implement projects and initiatives is generally a function of two things, experience and academic training. As a result, focus needs to be directed to firstly ensuring that the required technical skills are being developed from early childhood all the way through to university level.

Another complicating factor in developing an enabling environment for the eThekwini green economy is that by only having strategies, plans and standards in place, implementation is still not guaranteed. Stakeholders will have a wide array of reasons for not implementing initiatives. This then raises the need for effective enforcement which is not currently being undertaken by government.

In this light, it is important for the eThekwini Municipality to lead by example when trying to stimulate the eThekwini green economy. In addition, government officials require policies that specify how, when and by whom an action must be undertaken. These policies that would be relevant to the green economy, do not seem to be in existence within the eThekwini Municipality. The policies need to be developed post-haste. It is important to note that individual policies would ideally be required around the components, so as not to over simplify each thematic area.

All eThekwini green economy stakeholders need to be educated so they may become aware of green principles. During this research, businesses were contacted to participate in the survey but declined while citing the research as irrelevant and indicated that they are not involved in the green economy. These awareness campaigns needs to assume that stakeholders have zero knowledge on the green economy and develop necessary elementary concepts, which should be adjusted as stakeholders become better-versed with the green economy.

It should be noted that due to the CAS approach that was taken for this research, a large amount of components and aspects that need to be enhanced have been

identified. This would imply that no one stakeholder of the eThekwini green economy is able to rectify all shortcomings by themself. The success of the eThekwini green economy is only possible through all identified stakeholders undertaking the necessary action that lies within their direct control. When a system, the eThekwini green economy, is classified as a CAS, it immediately subscribes to the tenets of CAS. One of the tenets is that a CAS cannot be controlled from any central point. It then stands to reason that if a system cannot be controlled from a central point, when there is an endeavour to stimulate or enhance that system, it cannot be achieved by only one agent, or type of agent. It will take collective action from all agents and components that form the eThekwini green economy, particularly those that have direct control of critical leverage points within the system.

One of the aspects that was raised frequently during this research, mainly by private sector stakeholders, is that government needs to provide incentives that will serve to stimulate the green economy. The incentives should largely be financial in nature, but non-financial incentives such as shortened service response times for green initiatives should be implemented at all levels of government. Incentives will act as a trigger for uptake of identified green technologies and services.

Focus needs to be directed to the leverage points or key drivers of the eThekwini green economy. While enhancing and addressing these leverage points might seem like a daunting task, the intervention will still be the most favourable for sustainable growth of the eThekwini green economy.

The adoption and switch to green economy principles inevitably involves change and adjustment of a number of aspects within organisations. As a result, this transition can be more effective if a change management process is formally instituted in organisations. The process is likely to culminate in greener organisations and also positively impact employees' behaviour and perceptions towards green principles outside of official organisational duties.

Lastly, it is vitally important that the green economy is monitored and evaluated. This monitoring and evaluation on a continuous basis will allow the necessary adjustments to be made to further stimulate the eThekwini green economy. The green economy indicators compiled through this research should be updated on an annual basis. As this task is a non-profit generating task, it is only likely to materialise if an institution,

such as eThekwini Municipality, takes ownership of the monitoring and feedback process.

7.10 Recommendations for future research

As was noted in the literature, there remains a need for the development of a technique or process that allows for the data collected to be translated into information that will serve as the basis for the development of frameworks and ACE models. This research found multiple stages of mapping and triangulation useful for the conversion of information. However, there is still a need for future research, perhaps also building on the processes utilised for this research, as it remains rather qualitative.

Regarding future research, it is recommended that a qualitative approach be utilised to assess the minute detail of the leverage points identified through this study, which can be combined with the framework for the eThekwini green economy. This will then result in the formulation of equations that will govern the specific interactions with other components which would thereafter make the development of a simulation model for the eThekwini green economy possible.

Furthermore, similar research should be undertaken in other African cities that want to further stimulate their green economies, but lack the required information of how a green economy actually operates. This research should also revolve around CAS as opposed to more traditional theories. This is because trying to simplify the research will result in the loss of a comprehensive understanding.

7.11 Conclusion

This research was initiated to analyse the eThekwini green economy according to its dynamic and complex components for identifying leverage points. Specifically, primary data was collected from eThekwini green economy stakeholders from which components and aspects that make up the eThekwini green economy were identified. Thereafter, the characteristics of components were identified, most components share basic characteristics but to differing degrees. Interaction pathways emanated from multiple mapping exercises which, importantly, led to the identification of leverage points within the eThekwini green economy. These outcomes resulted in the

development of a framework that illustrates the manner in which key components of the eThekwini green economy and the entire eThekwini green economy operates.

The importance of leverage points within the eThekwini green economy should not be underestimated. However, as the eThekwini green economy is considered a CAS, it therefore operates in a decentralised manner. As a result, no one component, even government, can operate and stimulate the eThekwini green economy on its own. All components need to fulfil their roles and objectives in pursuit of green principles. It is likely that conflict and contradiction will arise between components, as there will undoubtedly be a legion of objectives. In this regard, collaboration and compromise is a prerequisite and this can only materialise in an environment of trust.

This chapter provided an overview of all preceding chapters, beginning with the first chapter which served to set the context and key research questions of this research. The summary then covered the two literature chapters, which was followed by the research methodology which guided this study. The chapter on findings from data collection was then presented, followed by the sixth chapter which contained the analysis and discussion of findings. Thereafter the key research questions of this research were specifically answered. Recommendations were then presented.

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ANNEXURE ONE: FORMAL REQUEST FOR SURVEY PARTICIPATION

---------- Forwarded message ----------
From: **Magash Naidoo** <210549919@stu.ukzn.ac.za>
Date: Thu, Sep 29, 2016 at 11:07 PM
Subject: UKZN: Doctorate Research Survey Invitation
To:

Hello,

I, M K Naidoo, am a Doctorate of Business Administration student in the Graduate School of Business & Leadership (GSB&L) at the University of KwaZulu-Natal. You are invited to participate in a survey for a research project titled "Modelling the eThekwini Green Economy according to its dynamic and complex characteristics for identifying leverage points".

The aim of this research is to develop a simulation tool that will enable business and government to simulate the implications of their decisions on their objectives and those of other stakeholders. The fundamental research objectives are:
1. To ascertain the components of the eThekwini green economy and their key characteristics;
2. To determine and formulate the manner in which the components interact with other components and the economy as a whole; and
3. To construct a simulation tool of the eThekwini green economy.

Your participation in this project is voluntary and by completing the survey you are consenting to participate in the study. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from completing this survey. Confidentiality and anonymity of records identifying you as a participant will be maintained by the GSB&L, UKZN.

Start Survey

Should you require further clarification, please contact: Student: M K Naidoo (083 777 3837), Supervisors: Dr. Gerwel-Proches (031 260 8318), Research Office: Ms Ximba (031 260 3587).

Thank You
Regards
Magash

ANNEXURE TWO: SURVEY

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Survey:_____

Please 'save as' before starting the survey otherwise answers might get lost

Topic: Modelling the eThekwini Green Economy according to its dynamic and complex characteristics for identifying leverage points

Student: M. K. Naidoo (210549919) / Supervisors: Dr. C. Gerwel-Proches & Dr. A. Kader

1/10 How would you describe the eThekwini Green Economy?

2/10 Please list 10 components that directly make up the eThekwini green economy? Examples of components: Banks, Consumers, Legal, etc.

Please use one word to describe each component, those answers will be auto-populated in subsequent questions. Detailed explanations can be included in the second column.

	One word description	Explanation or vierview of the one word description
Component 1		
Component 2		
Component 3		
Component 4		
Component 5		
Component 6		
Component 7		
Component 8		
Component 9		
Component 10		

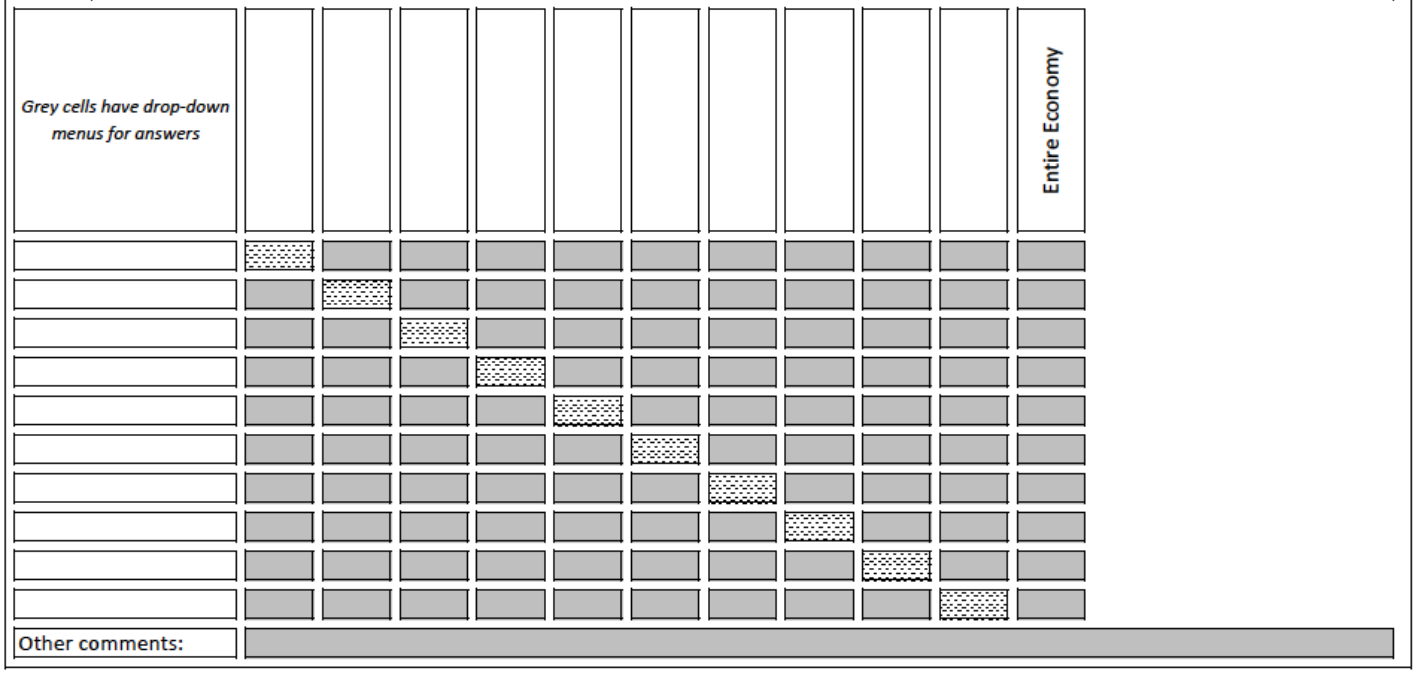
Other Comments:

3/10	Please rate the 10 components that you identified in Question 2 on a scale of 1 to 5. (1=Very Low, 2=Low, 3=Neutral, 4=High, 5=Very High.				
Grey cells have drop-down menus for answers	Collaboration with other components	Contribution to the green economy	Decisions made in a rational manner	Importance for the green economy	Size of the component (not relative to others)
Other comments:					

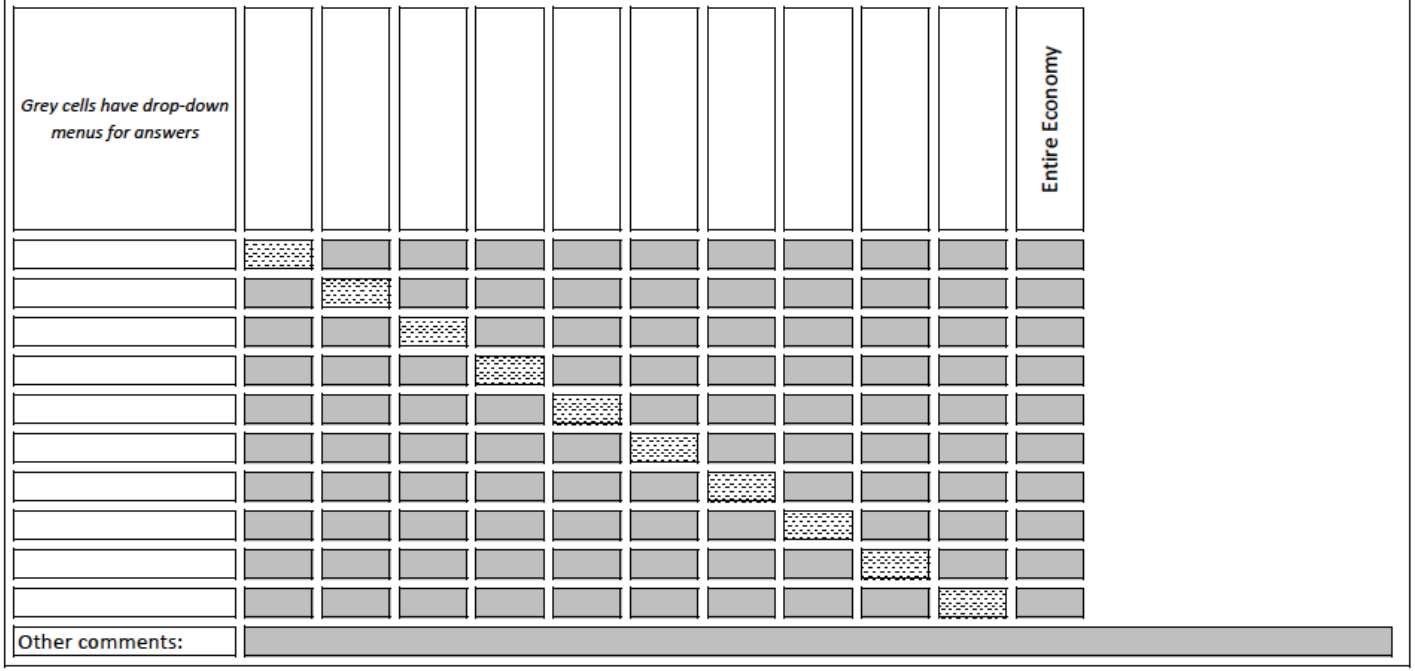
4/10	How do the 10 components, that you identified, interact with each other and the economy as a whole?
	No interaction = 0, Indirect interaction = 1, Direct interaction = 2. Please note that if A to B is 2, B to A does not have to be 2.

Grey cells have drop-down menus for answers											Entire Economy
Other comments:											

5/10	Please identify the time lag between stimuli from a component and a response from a corresponding component
	No impact=0, Immediate impact=1, short-term impact=2, long-term impact=3. Please note that if A to B is 2, B to A does not have to be 2.



6/10	What is the intensity of the impact of decisions by the components on other components?
	No impact=0, Not intense=1, somewhat intense=2, Intense=3. Please note that if A to B is 2, B to A does not have to be 2.



7/10	Do you think that any of the components make decisions in a random fashion, without taking available information into account?	
	Please choose Yes or No from the drop-down menu.	
Other comments:		
8/10	Please list 5 indicators that will be the most suitable for monitoring the health of the eThekwini green economy?	
Indicator 1		
Indicator 2		
Indicator 3		
Indicator 4		
Indicator 5		
Other comments:		
9/10	How many minutes, approximately, did it take you to complete this survey?	Minutes
10/10	Are all the questions clear? If no, please elaborate.	

Thank you for participating in this survey. Please return completed surveys to 210549919@stu.ukzn.ac.za

ANNEXURE THREE: REQUEST FOR INTERVIEW PARTICIPATION

From:
Sent: 17 September 2016 03:09 PM
To:
Cc:
Subject: Fw: eThekwini Green Economy Research - Request for Interview

Dear XXX,

Trust that you are well,

I am currently enrolled at the University of KwaZulu-Natal for a Doctorate in Business Administration. The topic of my research is "Modelling the eThekwini Green Economy according to its dynamic and complex characteristics for identifying leverage points".

The aim of this research is to develop a simulation tool that will enable business and government to simulate the implications of their decisions on their objectives and those of other stakeholders. The fundamental research objectives are:

1. to ascertain the components of the eThekwini green economy and their key characteristics;
2. to determine and formulate the manner in which the components interact with other components and the economy as a whole; and
3. to construct a simulation tool of the eThekwini green economy.

You have been identified as a critical stakeholder of the eThekwini Green Economy. I realise that you are a busy person, but request that you spare 1 hour of your time to participate in an interview. Please see attached guiding questions for the Interview.

Thank you for your consideration.

Regards
Magash Naidoo

ANNEXURE FOUR: INTERVIEW QUESTIONS

Interview Guiding Questions

Title of the research: Modelling the eThekwini Green Economy according to its dynamic and complex characteristics

Researcher: M. K. Naidoo (083 777 3837)

1. How would you describe the eThekwini green economy?
2. What components make up the eThekwini green economy?
3. What are the key characteristics of these components?
4. How do these components interact with the other components that you mentioned and the entire economy?
5. What are the key clusters within the eThekwini green economy?
6. What are the key characteristics of these clusters?
7. How do these clusters interact with the other clusters and components that you mentioned and the entire economy?
8. Please identify the time lag between stimuli and response from the components?
9. Do you think that any of the components or clusters makes decisions at random? If yes, which components and/or clusters?
10. What do you think are the fundamental indicators of the health of the eThekwini green economy?

ANNEXURE FIVE: REQUEST FOR FOCUS GROUP PARTICIPATION

--
From:
Date: Tue, Jul 25, 2017 at 9:14 AM
Subject: eThekwini green economy research - Focus groups
To:

Hi XXX,

Trust that you are well,

I am undertaking some research (Modelling the eThekwini green economy according to its complex and dynamic characteristics to identify leverage points) for a Doctorate of Business Administration at UKZN: GSB&L. The research is also linked to some of my work at the eThekwini Municipality.

The main objectives of the research are: 1. identify components that make up the eThekwini green economy, 2. discover how the components interact, and 3. develop a modelling tool.

As we have seen, recent research indicates that the sugar industry can play a big part in generating renewable energy. I would like to build on that, and include input from your industry into the current research.

Will it be possible for SASA to coordinate a meeting with 7 to 10 stakeholders to participate in a focus group?

I will do all the ground work (drafting invitations, pre-session reading note, facilitating the session and provide refreshments).

Thanks
Regards
Magash
083 777 3837

ANNEXURE SIX: PRE-FOCUS GROUP READING NOTE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Graduate School of Business & Leadership

Doctorate of Business Administration Research

Researcher:	Mr. M. K. Naidoo (083 777 3837)
Supervisors:	Dr. C. Gerwel-Proches (031 260 8318)
	Dr. A Kader (082 901 0225)
Research Office:	Ms. P. Ximba (031 260 3587)

This document is a pre-focus group reading note, for participation in the focus group for the research being undertaken on the Durban/eThekwini green economy titled "Modelling the eThekwini Green Economy according to its dynamic and complex characteristics for identifying leverage points".

It is important to note that while you might not have an overview of the entire green economy, your experience and knowledge in your specific industry will form a critical part of this research. Perusal of this document is not compulsory for participation in the focus group.

EThekwini Municipality covers an area of 2,292km^2, with the boundaries stretching from just past Umkomaas in the South, to Hambanathi (Tongaat) in the North, and up to Cato Ridge in the West.

The biggest economic sectors in the eThekwini economy are: community services, finance, manufacturing, construction, and transportation. While the GDP of eThekwini is in excess of R 250 million, the municipality still has a high rate of unemployment.

Previous studies (Maia et. al. 2011) have indicated that the job creation potential of the South African green economy is in excess of 450,000 jobs, which would in in the following areas: energy generation, energy & resource efficiency, emissions & pollution mitigation, and natural resource management. It is important to note, that it is possible that you participate in the green economy, but do not necessarily have a holistic view of the economy, your participation is still important for your specific knowledge.

The eThekwini/Durban economy is very carbon intensive. The latest greenhouse gas emissions inventory updated by the eThekwini Municipality indicates a per capita emissions level of 8,08tCO_2e for 2015. South Africa is a signatory to the Paris Agreement, which aims to limit temperature increase to 1.5°C from pre-industrial levels. This will necessitate a precise and concerted effort to decrease current emissions.

However, often there is a notion that job creation and environment objectives are mutually exclusive; pursuing and developing a green economy can overcome this.

The United Nations Environmental Programme defines a green economy as that which culminates in "*improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities*".

There are many types of systems: open systems, closed systems, and systems that have the ability to learn and react to stimuli (Complex Adaptive Systems). An economy can be thought of as a Complex Adaptive System (CAS). Some of the characteristics of a CAS are:

1. Self organise: it is not possible to manage all components from a central point.
2. Co-evolution: due to feedback loops, as one component learns, so do the others.
3. Unique components: each component is unique, and has their own schemata.
4. Sensitive dependence: the slightest initial change will result in massive implications later on.
5. Path dependence: certain options chosen will make other opportunities available, and will make certain other options unavailable.
6. Emergence: through interaction of components, a 'state' will emerge that was not possible without the interaction.
7. Egalitarianism: all components are equal, but in regards to one aspect – which is that on their own they cannot make up, or understand the entire system.

The following questions will be used as discussion points for the focus groups:

1. How would you describe the eThekwini/Durban green economy?
2. What are the aspects/components* that make up the green economy?
3. How do those aspects/components interact?
4. Do the aspects/components learn? If yes how do they learn?
5. What are the most appropriate indicators to monitor to gauge the health of the eThekwini green economy?

* aspects/components can be defined as anything that forms part of the eThekwini green economy. It can be tangible or intangible, a person or an organisation, and even technology or laws. The words 'aspects' and 'components' are a placeholder for all relevant parts of the eThekwini green economy.

During the Focus Group

The student will facilitate the focus group. All participants will be given pseudonyms, to identify themselves during the sessions, simple numbers will be utilised. Each participant will be requested to call their pseudonym out before vocalizing their comment; this will assist with transcribing the session.

Light refreshments will be provided for the participants. This will include juices, cool drinks, and snacks.

Reference

Maia, J., Giordano, T., Kelder, N., Bardien, G., Bodibe, M., Du Plooy, P., Jafta, X., Jarvis, D., Kruger-Cloete, E., Kuhn, G., Lepelle, R., Makaulule. L., Mosoma, K., Neoh, S., Netshitomboni, N., Ngozo, T., & Swanepoel, J. (2011). Green Jobs: An Estimate of the Direct Employment Potential of a Greening South African Economy. Industrial Development Corporation, Development Bank of Southern Africa, Trade and Industrial Policy. http://www.idc.co.za/projects/Greenjobs.pdf.

ANNEXURE SEVEN: ETHICAL CLEARANCE APPROVAL LETTER

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

19 April 2018

Mr Magashen Kisanderan Naidoo (210549919)
Graduate School of Business & Leadership
Westville Campus

Dear Mr Naidoo,

Protocol reference number: HSS/0312/016D
New project title: Analysing the eThekwini green economy according to its dynamic and complex components for identifying leverage points

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 07 April 2018 has now been approved as follows:

- Change in Title

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for period of 3 years from the date of original issue. Thereafter Recertification must be applied for on an annual basis.

Best wishes for the successful completion of your research protocol.

Yours faithfully

Professor Shenuka Singh (Chair)

/ms

Cc Supervisor: Dr Abdullah Kader and Dr Cecile Gerwel Proches
Cc Adademic Leader Research: Professor Muhammad Hoque
Cc School Administrator: Ms Zarina Bullyraj

Humanities & Social Sciences Research Ethics Committee
Professor Shenuka Singh (Chair)
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Website: www.ukzn.ac.za