A SOUTH AFRICAN GREEN ENTREPRENEURSHIP MODEL UTILISING A SYSTEM DYNAMICS APPROACH

by

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Submitted in accordance with the requirements for the degree of

DOCTOR OF PHILOSOPHY IN PSYCHOLOGY

in the subject

INDUSTRIAL AND ORGANISATIONAL PSYCHOLOGY

at the

UNIVERSITY OF SOUTH AFRICA

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ACKNOWLEDGEMENTS, DEDICATIONS AND SUPPORT

My awesome God and spiritual fathers, Bishop E.B. Lekganyane, E.E. Lekganyane and Dr. B.E. Lekganyane, thank you for the teachings and spiritual guidance.

Special gratitude and acknowledgement are directed to my family:

- My late parents, Jacobeth Skakie Diale, Isaac, Solomon Makgetla, and Lucky David Diale.
- Most importantly, to my late great grand parents and grandparents, Sekota Kgetse, Simon Makgetla, Shununu Diale Dianah Mosele, Mmamosela Kgetse, Minah Kgetse, Tryphina Dikeledi Makgetla.
- Sincere thanks also go to my late uncle, *malome* Collen Ishmael Kgetse and my late brothers, *abuti* Percy Kagiso Diale and Pule Lekgetho.

I have genuinely gained angels. Mommy used to call me *Mintess, monana gabedi, So Mintess, monana gabedi* would like to thank Mommy so much for encouraging her to take pure mathematics, physical science and biology in high school. Your nurturance and parenthood were instrumental. Had it not been for the exposure I received from the STEM subjects I took in high school, I would have struggled, as the mathematics base I gained in high school played a crucial role in my studies up to PhD level. Even my current spiritual father, Dr. B. E. Lekganyane, encourages us to take pure mathematics at school.

Special dedication to my partner and little brother Keabetswe, who endured all my frustrations, excitement and successes. Sincere thanks also go to my stepmother Ouma Diane Makgetla, older siblings *ausi* Pleasure Diale, *abuti* Thabiso Diale, *ausi* Dikeledi Makgetla, *ausi* Itumeleng Tlhapane, *abuti* Patsi Makgetla, *abuti* Thapelo Makgetla and *ausi* Lerato Makgetla. Special mention also goes to my nephews and nieces, Tokelo, Omelele, Koketso, Tshiamo, Theo, Tlotlego, Boithabiso, Mbali, and to my adopted children Kabo, Letlotlo, Khanyisile, Reabetswe and Kegomoditswe. Special mention also goes to *borrangwane*, *bo rakgadi*, as well as extended aunts and uncles.

Percy, late older brother, you always supported me and gave me strength and advice to further my studies. I remember I took some time after my master's degree, and you said, "Monana, you cannot go this far and say you are taking a break while you are almost there". I then registered for my PhD in 2020; that same year, I lost him. I, however, managed to defend and pass my proposal the very same year and even though he is in heaven, his support is very much felt.

Thank you, and special gratitude goes to Prof. Von der Ohe. Even though you took over from my previous promoter, your guidance, patience and developmental approach are appreciated. Prof Von der Ohe is an industrial psychologist, he taught me during honours class as I did my undergraduate and honours at Unisa. I later changed universities to pursue my MCom in industrial psychology at the University of Pretoria, before returning home to Unisa to do my PhD. I was attracted by the multi-disciplinary researchers at the University of South Africa. Prof Von der Ohe's working style was completed by my other renowned promoter, whom I would also like to thank, an industrial engineer and an Executive Dean for Science Engineering and Technology at TUT. With both my promoters' workloads, I completed my PhD studies on time. Being supervised by two different experts in their fields created a fantastic outcome. The support I have received from my promoters is extraordinary. Prof von der Ohe and Dr Kutumba's skills in system dynamics and simulation, as well as in coding and modelling, are highly appreciated. My internal locus of control (my capability) and the external locus of control (support from promoters and family) are celebrated and will forever live within me.

The take-home message I gained throughout my PhD journey is the importance of resilience, consistency, hard work, unlearning, and relearning. The following statement is of significance to me: *If you can simplify processes, concepts, and mathematical equations, you have mastered your PhD.*

Prof Wilson Rendani Maladzhi also fulfilled an instrumental supportive role throughout my studies.

Thank you to the Eskom Learning Academy for their crash course training on system dynamics. I also have acquired knowledge of The AnyLogic modelling software. Vensim is self-taught, but the principles are similar. Training and knowledge from these software tools formed a solid foundation for my thesis.

To Prof Enocent Msindo and the previous Executive Director whom I worked with during my time at the City of Tshwane within the green economy and sustainability unit, Mr Sello Mphaga, I appreciate your guidance.

ABSTRACT

Purpose and orientation: The green economy in South Africa is perceived as a priority, as there is a need to save the planet, sustain resources for future generations, and boost the economy. Green entrepreneurship, environmental psychology and industrial and organisational psychology through the lens of system dynamics have been identified as solutions to transition into the green economy.

Methodology: The methodology used in this study was a system dynamic approach using data readily available online with a focus on quantitative methods. The focus was on the strategic level variables, which ultimately inform policy formulation. The data collection procedure followed the National Development Plan Agenda 2030, focusing on crucial prioritised green areas to aid the transition to a green economy. The green thematic areas aided the researcher in refining the criteria to enterprises within the identified key prioritised areas. During the analysis, the stocks, flows, dynamic variable, and causal loop were formulated using the Euler mathematical equation with support from the Vensim PLE for academic purposes modelling software.

Results: Some of the study's results after the simulation – green economy adoption rate, green entrepreneurship adoption rate, total early-stage entrepreneurial activity, and entrepreneurial mindset – are variables that can be used to create a green entrepreneurship ecosystem in South Africa. If these variables can be implemented, it will yield more improvement and adoption. The relationship between SA's green business, the economy and contributing factors to the green market are simulated and proven to have a positive relationship.

Contribution, recommendations and conclusion: The study contributes to the body of knowledge by demonstrating how the system dynamics approach

can be integrated into green entrepreneurship and psychology, specifically industrial and organisational psychology, to improve the adoption of the green economy in South Africa. The reinforcing causal loop simulated in the current study indicated that this industry would grow only if these variables were improved. The current study further contributes to a formulated green entrepreneurship policy.

Keywords: Green entrepreneurship; system dynamics; green economy; psychology of entrepreneurship; green infrastructure; entrepreneurial mindset; green finance; green GDP; South Africa; green policy

ABSTRACT TRANSLATED INTO SETSWANA, THE AUTHOR'S NATIVE LANGUAGE

Maikaelelo le tshomarelo: Ikonomi e e tala mo Aforika Borwa e tsewa e le selo sa botlhokwa, ka gonne go na le tlhokego ya go boloka lefatshe, go tshegetsa metswedi ya dikokomana tsa isago, le go godisa ikonomi. Kgwebo e e tala, psychology ya tikologo le ya madirelo le ya organisational psychology ka lenss tsa dynamics tsa tsamaiso di lemogilwe e le tharabololo ya phetogo mo ikonoming e e tala.

Thekeniki: Mokgwa o o dirisiwang ka go dirisa maranyane a a dirisiwang mo maranyaneng a a farologaneng a a dirisiwang mo internet. Mo go tse dingwe, go na le maemo a a farologaneng a a farologaneng, a a kwa bofelong a bontshang gore go na le maemo a a kwa godimo. Thulaganyo ya go kokoanya tshedimosetso e ne ya latela Togamaano ya Bosetšhaba ya Togamaano ya Tlhabololo ya 2030, e e tlhomileng mogopolo mo mafelong a a botlhokwa a a kwa pele go thusa phetogo mo ikonoming e e tala. Babatlisisi ba ne ba thusa babatlisisi, mme go ne ga nna le seabe mo dikgwebong tse di neng di le mo mafelong a a botlhokwa a a kailweng mo go one. Mo kgatong ya tshekatsheko, di-stock, di-golela, go fetofetoga ga maatla, le seelo se se bakang mo thutopatlisisong e, di ne di rulagantswe ka go dirisa palo ya dipalo ya euler ka tshegetso go tswa go Vensim PLE ka maikaelelo a akatemi a go dira didirisiwa tsa go dira.

Dipoelo: Dipoelo tsa patlisiso morago ga go kengwa ke tse di latelang: Kelo ya go amogelwa ga ikonomi e tala, kelo ya kamogelo ya kgwebo e e tala, palogotlhe ya kgwebo ya pele, maikaelelo a bogwebi, ditšhono tse di lemogiwang, boitlhamelo, ditiro tse di tala le kgwebo e e matlhagatlhaga. Kamano magareng ga kgwebo e e tala le ikonomi e tala e bontshiwa gammogo le dintlha tse di tsenyang mo mmarakeng wa botala.

Seabe, dikatlanegiso le bokhutlo: Thutopatlisiso e na le seabe mo mmeleng wa kitso ka go bontsha kafa mokgwa wa go dira ka teng ga mokgwa wa go dira kgwebo o o tala le tlhaloganyo, segolobogolo thekenoloji ya madirelo le ya

mokgatlho, go tokafatsa kamogelo ya ikonomi e e tala mo Aforika Borwa. Se se neng sa dira gore go nne le seabe mo thutong ya ga jaana e ne ya bontsha gore madirelo a, a tla gola fela fa go ka tokafadiwa. Patlisiso e e oketsegileng e na le seabe mo pholising e e tlhotlhomisiwang ya kgwebo e e tala.

Mafokopatlo: Kgwebo ya botala; tsamaiso dynamics; ikonomi e tala; saechology ya kgwebo; motheo wa bogwebi; thekeniki ya bogwebi; thekeniki ya bogwebi; ikonomi e tala.

ABSTRACT TRANSLATED INTO SECOND LANGUAGE NOTHERN SOTHO (SEPEDI)

Morero le tshepetšo: Ikonomi ye tala ka Afrika Borwa e tšewa bjalo ka selo seo se tlago pele, ka ge go na le tlhokego ya go phološa polanete, go tšwetša pele methopo ya meloko ye e tlago, le go godiša ekonomi. Borakgwebo bjo botala, thutotlhaloganyo ya tikologo le thutotlhaloganyo ya intasteri le ya mokgatlo ka dilentshe tša mafolofolo a tshepedišo di lemogilwe bjalo ka tharollo ya phetogo go ekonomi ye tala.

Mokgwa wa go šoma: Mokgwa wo o šomišitšwego mo nyakišišong ye ke mokgwa wa go fetoga ga tshepedišo wo o šomišago datha yeo e hwetšagalago gabonolo inthaneteng ka nepo ya mokgwa wa boleng. Nepišo ke diphetogo tša maemo a togamaano, tšeo mafelelong di sedimošago tlhamo ya pholisi. Tshepetšo ya kgoboketšo ya datha e latetše Lenaneo la Leanotlhabollo la Bosetšhaba la 2030, leo le lebeletšego kudu mafelo a bohlokwa a matala ao a beilwego pele go thuša phetogo ya go ya go ekonomi ye tala. Mafelo a merero ye tala a thušitše monyakišiši, gomme dikelo di ile tša fokotšwa gape go dikgwebo ka gare ga mafelo a bohlokwa ao a lemogilwego ao a beilwego pele. Nakong ya kgato ya tshekatsheko, ditokomane, diphallo, phetogo ye e fetogago, le selo sa lebaka thutong ye di hlamilwe ka go šomiša tekano ya dipalo ya Euler ka thekgo go tšwa go Vensim PLE bakeng sa merero ya thuto ya go dira mohlala wa softwere.

Dipoelo: Tše dingwe tša dipoelo tša nyakišišo ye ka morago ga go ekiša ke tše di latelago: tekanyo ya go amogelwa ga ekonomi ye tala, tekanyo ya go amogelwa ga kgwebo ye tala, palomoka ya mošomo wa borakgwebo wa kgato ya mathomo, le kgopolo ya kgwebo ke diphetogo tšeo di ka šomišwago go hlola tshepedišo ya tswalano ya diphedi le tikologo ya tšona ya borakgwebo bjo botala ka Afrika Borwa. Ge diphetogo tša morago di ka phethagatšwa, e tla tšweletša kaonafatšo ye ntši le go amogelwa. Kamano magareng ga kgwebo ye tala ya SA le ekonomi le mabaka ao a tsenyago letsogo mmarakeng wo motala di a ekišwa gomme di hlatsetšwe gore di na le kamano ye botse.

Seabe, ditšhišinyo, le phetho: Thuto e tsenya letsogo mmeleng wa tsebo ka go laetša ka fao mokgwa wa go fetoga ga tshepedišo o ka kopanywago ka gona go borakgwebo bjo botala le thutotlhaloganyo, kudukudu thutotlhaloganyo ya intasteri le ya mokgatlo, go kaonafatša go amogelwa ga ekonomi ye tala ka Afrika Borwa. Selo sa go tiiša sa lebaka seo se ekišitšwego thutong ya bjale se laeditše gore intasteri ye e tla gola fela ge diphetogo tše di ka kaonafatšwa. Thuto ya bjale e tlaleletša gape go pholisi ya kgwebo ye tala ye e hlamilwego.

Mantšu a bohlokwa: Bokgwebo bjo botala; mafolofolo tsamaiso; ekonomi ye tala; thuto ya monagano ya kgwebo; mananeokgoparara a matala; kgopolo ya kgwebo; ditšhelete tše tala; GDP e tala; Afrika Borwa; pholisi ya botala

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DECLARATION

Name: Carol Dineo Diale

Student number: 43687989

Degree: Doctor of Philosophy in Psychology, within the subject of Industrial and Organisational Psychology.

Title: South African green entrepreneurship model utilising the system dynamics approach

I declare that the above thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the thesis to originality checking software and that it falls within the accepted requirements for originality.

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

CD DIALE 31 January 2023

SIGNATURE DATE

CHAPTER 1: DIRECTION OF THE STUDY

This research aimed to develop a green entrepreneurship model based on a system dynamics approach to guide emerging and established South African entrepreneurs to transition towards a green economy. This could be achieved by creating an ecosystem leveraging a green economy, generic entrepreneurship fundamentals and environmental psychology to develop a green entrepreneurship model. The model should contribute to policies that would benefit public, private and non-governmental organisations. A further contribution would be to raise awareness about the value and the adoption of green entrepreneurship by integrating behavioural elements such as sustainable behaviour in the South African context using a system dynamics approach. Finding solutions within the green entrepreneurship model is challenging, considering its nature as a multifocal and complex field. The model should enable enterprises and societies at large to adopt a pro-social behaviour within sustainability. Furthermore, adopting an entrepreneurial mindset within the lenses of a green economy contributes to negotiating a transdisciplinary and multidisciplinary approach by intertwining green entrepreneurship, industrial and organisational psychology, and industrial engineering through system dynamics.

1.1 BACKGROUND AND RATIONALE FOR THE STUDY

The world is under enormous pressure to minimise climate change to ensure minimal carbon emissions, an efficient use of resources, and a pro-employment development path is materialised (Green Economy Landscape Policy, n.d). This indicates that a green economy might assist in fulfilling the above-mentioned objectives regarding climate change. The existing efforts towards transitioning to a green economy in a South African context include women empowerment and adopting the United Nations framework (Nhamo & Mukonza, 2020; Nhamo & Mjimba, 2017; 2020). Farinelli et al., (2011) advise that green entrepreneurship must feature more vigorously to ensure the viability of the green economy in both developed and developing countries. As a technology,

green entrepreneurship can be regarded as a platform that may save the earth while at the same time generating profits (Tharindu & Koggalage, 2020).

The catalytic initiative of job creation in the green economy is still in its infancy, with very little reported or documented data on a green economy orientation (Green Economy Policy Landscape, n.d). Research is yet to be conducted on green entrepreneurship and system dynamics in a South African context.

Empirical research on entrepreneurship in green industries is at the infancy stage in South Africa (Diale et al., 2019). The green entrepreneurship construct has, however, been investigated globally (Demirel et al., 2019; Ebrahimi & Mirbargkar, 2017; Grinevich et al., 2019; Mrkajic et al., 2019; Mukonza, 2020; Soomro et al., 2020; Tien et al., 2020; Vaidya & Honagannavar, 2017) with less focus on the system dynamics methodology at a strategic policy level. Existing research in green entrepreneurship focuses on defining the concept and determining what it means and consists of (Tharindu & Koggalage, 2020). Further research focuses on areas such as greening the business, for instance, how businesses are implementing green initiatives, green human resources practices, signing petitions, and signing green accords for sustainable energy (Ahmad, 2015; Amis et al., 2018; Cheema & Javed, 2017; Ivanova, 2020; Yong et al., 2019). These studies, however, do not involve job creation or green entrepreneurship concepts.

In creating a theoretical green entrepreneurship framework, Diale et al. (2019) identified variables from the literature that included but were not limited to awareness, attitude, behaviour, commitment or green entrepreneurship intent, start-up factors such as creating a market, support mechanisms, performance and management tools as well as barriers to environmental entrepreneurship. The green economy includes the circular economy and an awareness of the impact on social, economic, and environmental spheres (Turing, 2021). Green entrepreneurship needs to be based on three levels: macro, micro and meso-levels. The key variables of green entrepreneurship need to be tested and validated further to formulate a South African ecosystem.

A system dynamics approach involves studying the behaviour of a system and modelling its behaviours virtually (Diale et al., 2021a; Sterman, 2018). The current study utilises the system dynamics approach to simulate the critical drivers to South African green entrepreneurship and to determine probable ways to transition into a green economy. The study further contributes to system dynamics within industrial and organisational psychology to expand the consulting scope in the field. The system dynamics approach provides mental models and simulations and the platform to validate the mental models or the simulations using software.

As a technical tool, system dynamics is premised on systems thinking. A system thinking concept is studied in industrial and organisational psychology. Systems thinking considers an individual's interaction with the environment underpinned by a process of inputs from the environment, action, and output (Cummings & Worley, 2015; Cummings & Cummings, 2020). A system dynamics approach takes the process further by using software and technology to add meaning to the system thinking principle.

The system dynamics approach further allows solutions to complex challenges by simultaneously looking at different avenues. The idea is to integrate the system dynamics approach into the industrial and organisational psychology field. There is a need to adopt and practise sustainable behaviour to preserve resources for current and future generations to combat environmental challenges in the global sphere. Sustainable behaviour will also incorporate green practices in business strategies, organisational functioning, and ecological footprint to complement the industrial psychologist's identity and their role in assisting organisations transition into a green economy effectively. Within the global sphere, there is a need to incorporate innovation through the lens of an industrial psychologist in a green space. On the other hand, the study took an interdisciplinary role by extending to engineering, mathematics, computer science and economics as defined by Sterman (2018), Rousseau et al. (2016), Roth (2019) and Tesse (2018).

Thus, the ultimate motivation and the rationale for the study were to contribute to policies on green entrepreneurship, the green economy, and pro-environmental behaviour through the lens of system dynamics. The latter is adopted to build the framework further by expanding industrial psychologists' practice into the scope. The study will ultimately benefit entrepreneurs, non-governmental organisations (NGOs), and private and public sectors (Bianchi et al., 2020). Experts such as environmentalists, industrial engineers, and industrial psychologists can support the latter statement.

1.2 PROBLEM STATEMENT

Green entrepreneurship, together with system dynamics as contributors to the performance and efficiency of enterprises, has been overlooked in the past (Diale et al., 2021a). Research or publications on green entrepreneurship and its interrelatedness or linkages to system dynamics in the South African context are non-existent. Entrepreneurial ecosystems can be viewed through cultural and social structures, institutions, and the green legacy. The community will benefit from business incubators, accelerators, or entrepreneurship centres to alleviate poverty and contribute to the country's economy. This study will open avenues in utilising the system dynamics model to expand the scope of consulting within the industrial and organisational psychology, green entrepreneurship, and the system dynamics contexts in South Africa**.**

Even though there are programmes and activities available to transition to a green economy, the behavioural and entrepreneurial factors that focus on helping the country meet the sustainable development goals still need to be improved. Irrespective of the attempts, the programmes and the strategic plans that document the eight thematic areas and sustainable development goals are minimal. Solutions remedying the social challenges while benefiting the economy are needed. There is a paucity of research on integrating green entrepreneurship into the green economy programmes. This study will contribute to the literature by creating an awareness of the importance of incorporating green entrepreneurship based on the system dynamics approach.

The thematic areas of the green economy consist of sustainable production and consumption, sustainable energy, sustainable water, sustainable transport, green building, resource conservation and management. Of the eight thematic areas, South Africa has prioritised the key green economy thematic areas that are articulated in the National Development Plan 2030 agenda are sustainable energy, water, transport, agriculture, and waste management (Department of Environmental Affairs, n. d.).

Green entrepreneurship is a missing link in facilitating the adoption of green economy (Diale et al., 2022; Farinelli et al., 2011; Maladzhi et al., 2022). This study contributes to the literature by simulating key drivers of green entrepreneurship, utilising the system dynamics approach within the South African context. The context must be considered, especially in a multi-cultural country such as South Africa, to create meaning, identity, and environmental mastery in transitioning into a green economy.

Entrepreneurship in the social and cognitive domain is yet to be investigated to formulate social construction and capitalise on entrepreneurship as a social change within South African markets. In unpacking the social and psychological sphere, individual attributes are discussed in the psychology of entrepreneurship, environmental psychology and push-and-pull factors in chapter 2 (da Silva et al., 2017; Elliot, 2019; Fatma et al. 2021; Frese et al., 2014, 2020; Fritsche et al. 2011, 2018; Gielnik et al., 2020; Litau, 2018; Østergaard et al., 2018; Sharma et al., 2021; Sowole et al., 2018; van Rensburg et al., 2020; Urban, 2019, 2020; Wale et al., 2021; Wale & Chipfupa, 2021). The reason for including the individual attributes is to integrate the human element into the green policies and framework to minimise the challenges that are imposed by humans in causing environmental challenges.

Some efforts towards transitioning to a green economy within the South African context include women empowerment and the green economy (Nhamo & Mjimba, 2017; 2020; Nhamo & Mukonza, 2020). The formulation of the framework emanates from a national sustainable development action plan. Contextualising green economy efforts needs to be revisited as sustainable

development is socially constructed (Roundy, 2016). No research has been conducted on green entrepreneurship and the societal experiences and perceptions towards the catalytic agent of the green entrepreneurial ecosystem in the South African context, specifically with the lens of system dynamics. Some studies on generic entrepreneurial ecosystems have been conducted globally (Acs et al., 2017; Roundy, 2016; Roundy et al., 2016; Spigel, 2015). Entrepreneurship can be viewed from the ecosystem lens to complement the broad definition of system dynamics.

Even though some green economy programmes are in place in Africa (Nhamo & Mjimba, 2017, 2020), the behavioural and entrepreneurial focus in helping the country meet the sustainable development goals is needed. The green entrepreneurship model to guiding emerging and established South African entrepreneurs towards a green economy by utilising the system dynamics approach serves as a missing link.

1.3 AIMS OF RESEARCH

1.3.1. General aims of the research

The general aims which form part of the objectives of the study are:

- To develop a green entrepreneurship model based on a system dynamics approach.
- To develop, simulate and test the key drivers of green entrepreneurship in a quest to formulate a model using dynamic hypothesis.
- To simulate the variable entrepreneurial mindset to be used in adding to the green entrepreneurship ecosystem.
- To formulate a practical role on how industrial and organisational psychology can be integrated into the green economy to expand the consulting scope.

1.3.2. Aims of the research with regards to literature

- · To develop conceptualised key drivers of green entrepreneurship.

- · To conceptualise the green economy thematic areas by using the system dynamics modelling.
- · To conceptualise the green economy, the policies and the frameworks that are adopted by the global markets.
- · To conceptualise the key variables of the psychology of entrepreneurship.
- · To conceptualise the role of industrial and organisational psychology in the green economy.

1.4 DYNAMIC HYPOTHESIS OF THE STUDY

The system dynamics approach utilises dynamic hypotheses in the place of aims regarding the empirical study of the research, which is generally connoted to the social fields. Forrester (2009; 2019) asserts that possible solutions must form part of the dynamic hypothesis when formulating a hypothesis. The dynamic hypotheses of the study are:

- The key drivers to formulate the green entrepreneurship model consist of policies, finance mechanisms, green infrastructure, the gross domestic product (GDP), entrepreneurial mindset and green customers;
- The critical variables of the psychology of entrepreneurship and entrepreneurial mindset form part of the green entrepreneurship model in the South African context;
- The key drivers for the green entrepreneurship can be simulated through dynamic variables and the stocks and the flows in a system dynamics model;
- The green entrepreneurship key drivers positively influence each other in an iterative simulation through a causal loop in a system dynamic model;
- Sustainable behaviour and green entrepreneurship serve as tools to assist in fully transitioning into a green economy in South Africa;
- The role of the industrial and organisational psychology field can be integrated into the green economy.

1.5 RESEARCH QUESTIONS

This section is divided into two parts: specific research questions relating to the literature and the research questions concerning the empirical/dynamic research questions.

The research questions regarding literature are:

- What are the key drivers of green entrepreneurship?
- Which green economy thematic areas utilise system dynamics modelling?
- Which green economy policies and frameworks have been adopted by global markets?
- Which key variables of the psychology of entrepreneurship and the entrepreneurial mindset form key drivers for green entrepreneurship?
- Which industrial and organisational psychology subfields can be integrated into the green economy field?

The specific research questions with regards to the empirical study are:

- What are the key drivers of green entrepreneurship in South Africa?
- Can a South African green entrepreneurship key driver be simulated using the system dynamics model?
- Is the psychology of entrepreneurship and the entrepreneurial mindset part of the green entrepreneurship ecosystem?
- Do the green entrepreneurship key drivers have a positive or negative relationship in an iterative causal loop within a South African context?
- Are sustainable behaviour and green entrepreneurship technologies the missing links to transitioning into the green economy within the South African context?
- How can the role of the industrial psychology be integrated into the green economy?

1.6 STATEMENT OF SIGNIFICANCE

It is envisaged that system dynamics, which includes green entrepreneurship, contributes to the policy formulation and raise awareness in multi focal solutions to environmental challenges. The impact of the behavioural element of entrepreneurship in these markets is the outcome of the current study. It is further foreseen that communities will be equipped to adopt prosocial behaviour regarding sustainability through the green entrepreneurial framework. Regarding sustainability and the green economy, system dynamics principles and behavioural components should be considered. Potential entrepreneurs may learn from the envisaged policies and the framework. The study adds to the ecosystem and business incubators by expanding the scope for industrial and organisational psychologists to consult in green entrepreneurship and system dynamics. Consulting spaces within the green economy include green career guidance, green human resource psychology, the integration of industrial revolution, innovation and African trade within green practices.

Further consulting spaces where industrial psychologists could contribute are green organisational behaviour and development, green ergonomics and green consumer psychology. Using an African values lens will cement and contextualise the latter consulting roles within the green space. The Botho principles and human individual attributes in transitioning onto a green economy and attaining sustainable development goals contribute to the current study. This current thesis provides a detailed discussion on the consulting spaces in chapter 6.

1.7 STATEMENT OF CONTRIBUTION

This study contributes to industrial and organisational psychology, entrepreneurship, and system dynamics in three distinct areas: the theoretical, the methodological, and the practical level.

1.7.1. Potential contribution on a theoretical level

The field of industrial psychology may contribute to accelerating the green economy, green entrepreneurship, and sustainable development goals, which

are often overlooked. Existing research has focused on the green economy from a human resources (HR) perspective (Ahmad, 2015; Cheema & Javed, 2017; Sharma, 2016; Yong et al., 2019) with limited attention to the scientific and behavioural perspectives of the field of industrial psychology that may assist organisations in effectively transitioning to a green economy and in the adoption of green entrepreneurship.

The contribution is made by formulating a framework within the industrial and organisational psychology field with intentions of accelerating the efforts of the green economy, green entrepreneurship, and sustainable development goals, as there is minimal research and contribution of the ecosystem in the South African context.

Through a review of the literature, efforts have been made to green human resource practices such as green compensation, green rewards, green training and development, as well as green employee relations and green management (Ahmad, 2015; Yong et al., 2019; Cheema & Javed, 2017). The industrial psychologists' role, identity, and applicability have received little attention, let alone an exploration of the role of industrial and organisational psychologists (IOPs) role in accelerating sustainable development goals, green entrepreneurship, and the green economy.

1.7.2. Potential contribution on an empirical level

A potential contribution on an empirical level is the construction of an empirically tested framework to predict the adoption of pro-environmental behaviour through green entrepreneurship. The current study contributes to the framework and policies that may be used by both the private and public sectors as well as NGOs to ensure a community of best practices within green entrepreneurship.

1.7.3. Potential contribution on a methodological level

As part of strengthening the multidisciplinary nature of this study, the methodological contribution is in the form of the system dynamics as an innovative methodology. Globally, the system dynamics methodology has never been explored using psychology, industrial and organisational psychology, or

green entrepreneurship. systemSystem dynamics uses a simulated behaviour of a system with the environment consisting of stocks and flows, causal loops, reinforcing and balancing variables, and delays either in time or in information. systemSystem dynamics useuses ratios and percentages collected through policy analyses within the green economy and green entrepreneurship spaces.

1.7.4. Potential contribution on a practical level

The current study makes a practical contribution to creating a green business incubator ecosystem, turning environmental challenges into opportunities, the triple bottom effect of the economic, social and environmental spheres, and expanding the scope of practice for industrial psychologists with the lens of the green economy. The practical contributions are used to formulate the green entrepreneurship policy in the current study (see Appendix C).

1.8 THE PARADIGM PERSPECTIVE

researchResearch paradigms are the underlying patterns of examining and making sense of data or the outcomes of the results from a particular phenomenon or context (Creswell & Creswell, 2018). Philosophy focuses on the development of knowledge and on the nature of that knowledge. The philosophical perspectives that guide the proposed study are explained in the subsections that follow.

1.8.1. Philosophical perspective

A deductive approach was adopted in this study. In a deductive approach, the researcher has preconceived ideas and aims to test the theory and the models (Creswell & Creswell, 2018). A deductive approach was adopted in testing the conceptual model and in fulfilling the requirements of the system dynamics by using imaginative mental scenarios and developing hypotheses and assumptions in support of the quantitative research approach of the study.

1.8.1.1 Systems-theoretical paradigm and philosophy

The systems perspective provides a unique way to view and mentally frame what people observe. This perspective originated from the General Systems

Theory, a rigorous scientific discipline developed in 1954 (Rousseau et al., 2016; Roth, 2019; Tesse, 2018). The system dynamics study was interdisciplinary by extending to engineering, mathematics, computer science, biology, and economics (Sterman, 2018; Rousseau et al., 2016; Roth, 2019; Tesse, 2018). The central premise of the systems theory is that the ordinary laws governing the systems provide a conceptual framework for understanding the relationships and, thus, for handling any problems or changes in that system (Roth, 2019). This highlights the value of viewing a system (individual, group, or organisation) as a whole, gaining a perspective of the whole, and how the parts of a system play their role in light of the purpose for which the entity exists. The systems perspective was instrumental in the current research because of its potential for understanding and exploring the interactions among the variables, parameters, and the endogenous and exogenous variables (Sterman, 2018).

This study aimed to generate new knowledge on green entrepreneurship through the system dynamics method within the South African context. Practically, this alludes to the overall contribution to policies and strategic perspectives on the impact of green entrepreneurship on sustainable development goals and the green economy.

1.9 METHODOLOGICAL CONVICTIONS

The theoretical and methodological convictions are aligned with the research questions and the aims. The literature on the green economy, green entrepreneurship, the system dynamics, and the sustainable development goals is explored. The formulation of the green entrepreneurship model is described through the dynamic aims and the hypotheses set in the study. In the next section, the research design and the research approach are presented.

1.9.1. Research methodology design and approach

The current study followed two research phases of research designs and approaches. The first one included a review of the literature. The second phase used existing frameworks, case studies and policies to simulate and validate the system dynamics model. The current study was multidisciplinary, thereby

tapping into industrial and organisational psychology, the green economy, and industrial engineering [system dynamics].

1.9.1.1 Validity and reliability

This section briefly describes the validity and reliability of the literature and the empirical data.

The literature aligned with the research topic, as well as the problem statement and the aims of the study were used to ensure the validity of the literature review. The researcher borrowed closely related research to contribute to the current study. In addition, this study attempted to use recent literature from empirical sources to ensure that the study was valid. A theoretical, abstract system dynamics model was developed regarding the literature and empirical data.

Reliability concerning the literature review was addressed by using existing literature sources and theories. The reliability of literature was conducted by using search engines such as Ebsco host and the *Journal of Sustainability and Engineering Systems*, the *Journal of Sustainability*, the *Journal of Psychology Africa*, the *Journal of Industrial and Organisational Psychology*, the *Journal of Academy and Management*, the *Journal of Environmental Psychology*; the researcher refined the search to the most recent sources. Furthermore, Google Scholar was used to pull relevant information from various sources. A detailed literature review encompassing the context and the theoretical constructs is critically discussed in Chapter 2.

1.9.1.2 Validation process with regards to the empirical study (system dynamics)

Validity and reliability using the system dynamics model are described through a validation process. In empirical research, validity is ensured using appropriate iterative procedures and standards to fulfil the system dynamics procedures. The validation process is described in Chapters 3 and 4.

1.9.2. Units of analysis

The Vensim Modelling Software for academic purposes is used to simulate and validate the current study's dynamic hypothesis and aims. The current study

used system dynamics equations, causal loops, stocks and flows, time series and behavioural graphs to analyse the data from the reports and the frameworks. The software was used to simulate and model the behaviour of a system from the mental models and the scenarios created.

1.9.3. Ethical considerations

The researcher applied for ethical clearance to publish a paper with the ethical clearance number 2019/CSET/SOE/MGK/001. The ethics clearance is valid for five years (See Appendix A). The current study's literature and theoretical constructs are published as a conference proceeding. The review process and publishing as a conference allowed the researcher to assess the feasibility of the study. The current study, however, does not require ethical clearance as the data used is available in the public domain. The researcher did, however, acknowledge the sources in this current thesis.

As a subsequent step, the researcher reviewed the policies and the green economy frameworks to support the current study further. These frameworks are readily available on the internet and the exact source is explained in detail in Chapter 3. Further ethical approval was not required as the frameworks and policies used as part of the data collection are available in the public domain. The researcher contacted the ethics administrator, who confirmed that the researcher does not require ethical clearance if the data source is available in the public domain or on the internet. Form 3 was filled in to effect the ethical consideration suitable for the study as part of a detailed research methodology.

1.10 RESEARCH PROCESS

The research is divided into phases, which include the direction of the study, the literature review, the research methodology and design, the results and analysis, the conclusion, the limitations, the recommendations, and areas for future research.

1.11 CHAPTER DIVISION

This study is divided into six chapters as follows:

Chapter 1: Direction of the study – This chapter includes the title, the introduction, the problem statement, the research questions, the aims of the research and the dynamic hypothesis.

Chapter 2: Context and literature review – A review of the literature and the theoretical constructs are detailed in this chapter.

Chapter 3: Research methodology and design – This chapter covers the research methods and design, the appropriate data analytic strategies, the system dynamics validation process, and the ethical considerations.

Chapter 4: Results – The actual simulation of the South African green entrepreneurship key drivers is detailed. The simulation consisted of the causal loop simulated through the Vensim computer software (Vensim, n.d). The complete simulation consisting of the dynamic variables and the stocks and flows was simulated using the Vensim Modelling Software, version 8.7.10 (Vensim, n.d).

Chapter 5: Discussions – This chapter comprises the discussions and explains how the key variables were simulated in line with the direction of the study and how it is supported by the reviewed literature.

Chapter 6: Conclusion, recommendations, applications, limitations, future research agenda and reflections – This chapter consolidates and concludes on the study's key findings and presents recommendations, possible applications and limitation emanating from the study. Final reflections are consideration for future research are also presented in this chapter.

1.12 CHAPTER SUMMARY

This chapter discussed the scientific overview of the research, which included a discussion of the study's background and motivation. The problem statement, the research questions, the dynamic hypothesis, the system dynamics validation process, and the general and specific aims of the research are also included. The paradigm perspectives and the theoretical constructs were presented. The research design and the research methodology's expected contribution and limitations are introduced in this chapter. The chapter also highlighted the ethical

considerations as set out by Unisa. The intended chapters of the thesis are illustrated and discussed in detail in the subsequent relevant sections.

CHAPTER 2: CONTEXT AND LITERATURE REVIEW

2.1 CONTEXT

The chapter begins by highlighting the South African context of the green economy and proceeds to unpack the literature and constructs in contribution to the exisiting literature.

South Africa is a multi-cultural country with nine provinces: The North West, Gauteng, the Eastern Cape, KwaZulu-Natal, the Northern Cape, the Free State, Mpumalanga, the Western Cape and Limpopo (South African government, n.d). The green economy in South Africa is perceived as a priority as there is a need to save the planet, sustain natural resources for future generations, and boost the economy. The critical concept often used to cement or serve as a foundation for a green economy is the concept of sustainability, echoed by the local municipalities in South Africa. Sustainability can be viewed as the interrelatedness of the activities and the benefits with technical, economic, and environmental awareness intertwined (United Nations Environment Programme, 2018).

In South Africa, the following programmes were promulgated: the 2006 National Treasury Framework for Environmental Fiscal Reform; the 2008 Department of Science and Technology Ten-year Innovation Plan; the National Planning Commission Medium-term, Strategic Framework 2009-2014; the National Development Plan 2011; the 2011 Department of Environmental Affairs; National Climate Change Response; the 2011 Department of Environmental Affairs National Strategy for Sustainable Development Goals as well as the 2012 Department of Trade and Industry Policy Plan 2006 (Diale et al., 2019; UNEP, 2018). A shared commonality within strategies and frameworks is outlining green economy initiatives and the ways to minimise environmental challenges. However, the strategies and frameworks need to emphasise the integration of behavioural awareness and how to manage behaviour or the awareness of green entrepreneurship. The green thematic areas are green building, waste

management, sustainable energy, water, transport and mobility, agriculture, and consumption (Diale et al., 2022).

The context of the green economy can be summarised in Table 2.1. Some studies reveal that there is non-compliance with policies in the efforts to transition into a green economy (Ali et al., 2021; Amis et al., 2018; Nhamo & Mjimba, 2017, 2020; Nhamo & Mukonza, 2020), while other studies show that green entrepreneurship is still a missing link (Farinelli et al., 2011). As depicted in Table 2.1, green economy activities have received minimal attention or awareness. Table 2.1 indicates the eight thematic areas divided by provinces in South Africa. The number inside the brackets denotes the job creation percentage. The sign (-) denotes the absence of data.

Table 2.1

Statistics on green economy activity in South Africa

Province	Energy	Transportation	Agriculture	Resource conservation and management	Built environment	Sustainable consumption and production	Waste	Water
Kwa Zulu Natal	20% (1)	7% (0)	21% (18)	7% (4)	4% (2)	2% (0)	8% (6)	5% (1)
Western Cape	24% (3)	10% (0)	14% (10)	3% (1)	14% (2)	3% (0)	4% (2)	1% (0)
Gauteng	26% (1)	18% (0)	5% (4)	-(-)	6% (1)	6% (-)	8% (6)	- (-)
Eastern Cape	15% (2)	3% (0)	16% (13)	7% (5)	3% (0)	1% (0)	3% (3)	3% (0)
Limpopo	4% (0)	1% (0)	14% (11)	1% (1)	- (-)	2& (0)	2% (1)	- (-)
Mpumalanga	5% (-)	- (-)	11% (11)	1% (0)	- (-)	1% (0)	3% (1)	-(-)
Northern Cape	6% (2)	-(-)	8% (7)	1% (1)	- (-)	2% (0)	1% (1)	-(-)
Free State	5% (1)	-(-)	5% (5)	-(-)	1% (0)	-(-)	2% (2)	1% (0)

North West	2% (-)	1% (1)	6% (6)	- (-)	-(-)	2% (0)	3% (3)	-(-)

Source: (Green Economy Policy Landscape, n.d)

2.1.1. Context on the green economy

South Africa is transitioning into a green economy. However, it is still in its initial stages. The catalytic initiative of job creation is still in its infancy, and no data has been reported or documented on a green entrepreneurship orientation. It is evident from the statistics on the thematic areas and job creation that data needs to be available about entrepreneurship/enterprises or the awareness or motives for venturing into these green economy thematic areas.

Table 2.1 provides data on the green economy activities and efforts that are currently in place in South Africa. The thematic areas focus on the green economy activities per province. However, the reported statistics need to provide information, for instance, on how the job creation data was obtained and the source that facilitated the information on job creation. Even though some South African public entities created green jobs, such as the Expanded Public Work Programme (EPWP), the low wages and the limited career prospects resulting from these initiatives present a challenge in addressing inequality and ensuring fairness (Amis et al., 2018). The green economy ecosystem should not be limited to government programmes and policies to accelerate the sustainable development goals in minimising climate change but requires collective efforts and diverse mechanisms (Nhamo & Mjimba, 2017, 2020; Nhamo & Mukonza, 2020; UNEP, 2018).

Often, enabling a green economy ensures that the tools are enough and shows whether necessary resources in place (Diale et al., 2019). A critical construct in looking at resources is capacity. In most cases, capacity is often overlooked, especially concerning environmental issues (Diale et al., 2019; UNEP, 2018). Enabling a green economy also involves information technology and innovation (Anthony & Majid, 2016; Diale et al., 2022). The researcher believes that once this milestone of capacity building within the green economy is fully implemented, the mechanism may be a change towards green entrepreneurship (Diale et al., 2019; 2021b). Globalisation in the current context can be seen as a contributing factor where a country such as South Africa can benefit from international markets (Diale et al., 2021b). Choudhary and Patil (2015) echo the latter statement by supporting imported goods and services, such as

imported technology for hydropower generation and biomass (Diale et al., 2022a). Some scholars have demonstrated that biomass combustion with coal and heat generates electricity effectively (Diale et al.,2021b). This has further been tested to have saved costs for energy enterprises and provided effective ways of adopting renewable energy (Diale et al., 2021b; Masini & Menichetti, 2012). The focus of the current study is on the prioritised green thematic areas as set by the National Development Plan Agenda 2030, which consists of sustainable energy, agriculture, water, transport and mobility, as well as waste management (Diale et al., 2022).

South Africa is a democratic country where the law regulates the system and triumphs over all undesirable behaviour (Diale et al., 2021b). The energy justice and legal perspective is a short-term solution (Diale et al.,2021b). The legal perspective may facilitate the distributive justice of equal access to resources even for societies that are unable to afford the services (Diale et al., 2021b; Guruswamy, 2010). The different tailored types of funding to promote access to energy or clean water, for example, can be in the form of grants, financing, loans, equity official development assistance and equity financing (Diale et al., 2021b; Loock, 2010; Nunes et al., 2016). The National Youth Development Agency can spearhead the funding process to promote access to energy products, services, consulting, or distribution in the South African context (Diale et al., 2021a; Diale et al., 2021b).

The South African National Youth Development can work with the Green Youth Indaba and the Innovation Hub to ensure the sustainability of entrepreneurship in targeting the youth of South Africa. Green change readiness programmes to manage the fear of the unknown within the green initiatives could be introduced (Diale et al., 2021a; Diale et al., 2021b). The lessons learnt from developed countries and from the neighbouring African countries need to be replicated to share the success factor advances and the technological factors promoting the green economy (Diale et al., 2021b; Haselip et al., 2015). Furthermore, there is a need to manage initiatives such as knowledge dissemination through conferences and workshops to steer the direction of research and to find how best to formulate policies (Diale et al., 2021b; Suurs, 2009). The subsequent sections focus on the literature review after critically explaining the context relevant to the study.

2.2 LITERATURE REVIEW

The section begins with outlining the environmental challenges and proceeds to detail a green economy and solutions to remedy the challenges underpinned by psychological principles. In subsequent sections, generic and green entrepreneurship literature is discussed through the lenses of the key drivers in building an ecosystem to fulfil the research agenda of the current study.

2.2.1. Environmental challenges

Some problems identified during conferences held by the C40 ICLEI UNEP include climate change, a rapid decline in diversity, and land use (Höjer & Wangel, 2015). The source of environmental challenges is human activity. Questions arise on efforts to manage human behaviour within the environmental sphere: Is the management of human behaviour fully integrated into the green economy? Specific resources, skills, and infrastructure can facilitate or inhibit environmental challenges. To add to the argument, the lack of skills and resources threatens the system. The available resources and the infrastructure to strengthen the systems may facilitate and boost the adoption of the green economy. Urbanisation also contributes to the environmental problems. The increased number of individuals who move from rural or semi-rural areas to urban areas pressurises these environments (Höjer & Wangel, 2015). Urbanisation also negatively impacts energy consumption and land and water use. Further challenges within the environmental sphere include the lack of competence and skills, and the inability to utilise innovative solutions within the green economy (Höjer & Wangel, 2015). Another challenge from a global sphere is that the economic, cultural, and political spheres should be more noticeabe, specifically regarding designing solutions to environmental challenges (Brand, 2012; Starchenko et al., 2021). Efforts to transition to a green economy have failed because of a lack of contextualisation and the lack of cultural, economic and political sphere incorporation (Bernstein & Cashore, 2012; Brand, 2012; Starchenko et al., 2021).

The green paper formulated by the Department of Environmental Affairs emphasised that South Africa faces challenges such as environmental degradation, power, unemployment, socioeconomic factors, and inequality, needing intermittent attention

(Department of Environmental Affairs, n.d). The failed environmental policies resulted from the need for change management programmes (Brand, 2012; Starchenko et al., 2021). In giving effect and suggestions to change dynamics, the change management principles that industrial psychologists often champion need to be introduced more explicitly by looking at the behaviours within the green economy and green entrepreneurship. The green economy is one of the interventions that can assist in minimising the environmental challenges. Another intervention is adopting green entrepreneurship to facilitate the transition to a green economy. The latter interventions are discussed in later sections.

2.2.2. Global green economy initiatives

The green economy is one mechanism to remedy environmental challenges (Nhamo & Mjimba, 2020; Nhamo & Mukonza, 2020). The green economy includes eight thematic areas: sustainable energy, water, transport (mini car/cycles), agriculture, waste management, green buildings, responsible consumption, and resource conservation and management (Diale et al., 2021b; UNEP, 2018). A green economy is a solution to curb carbon emissions, reduce pollution, carefully use water resources, and regulate elevated energy use. This is conducted to ensure resource efficiency and maintain ecosystem services, including the biodiversity that addresses the economy through employment (Greent project, n.d; Nhamo, 2013; UNEP, 2018). The green economy, through the sustainable development goals framework, can be used to minimise poverty and inequality, and to promote the development goals (Greent project, n.d; Leal-Filho, 2019; Nhamo, 2013). The green economy's mandate is to introduce innovative ways to redress the inequalities and the lack of access to energy, water, or food security (sustainable agriculture)] (Diale et al., 2021b; Lonergan, 2018; Lu, 2017; Mugambiwa & Tirivangasi, 2017; Diale et al., 2022; Nhamo & Mjimba, 2020).

The green economy, the sustainable development goals and green entrepreneurship form part of the innovation and advancement tools. With the idea of innovation, information technology is used as an innovative tool to disseminate and communicate the transition to a green economy. The introduction of information technology resulted

in an initiative titled Townsend (Diale et al., 2022; Höjer & Wangel, 2015). The idea was that the introduction of Townsend would assist in transitioning and producing green products, and it would eliminate time in converting the product to finished goods, thereby contributing to the intelligent cities initiative (Höjer & Wangel, 2015). The ideas of energy efficiency and clean technology are also enablers of the green economy (Barbier, 2020).

Introducing funding schemes contributes to enabling a green economy. Barbier (2020) proposes different funding mechanisms, such as a global environmental financing facility to finance all the green economy thematic areas, which is perceived as multi-donor funding. Additional green funding mechanisms include an international payment for the ecosystem, reduced emissions from deforestation and the forest degradation scheme, global carbon tax, financial transaction taxes, currency transition taxes, international finance facility, taxes on airline travel or fuel; and lastly, the taxes on the global arms trade (Barbier, 2020). Although funding mechanisms are in place, these still need to be implemented primarily in the South African context. These funding mechanisms work if emissions happen or if trade happens. Barbier (2020) argues that funding poses challenges in transitioning to the green economy or attaining sustainable development goals. The challenges concerning funding were revealed by various institutions needing to be improved by bureaucracy and the reluctance to pay more for a green product or service (Bosma, 2020).

Curbing environmental challenges or pursuing action to implement solutions involves costs, and it causes strain on the economy. Furthermore, the challenge of inaction also needs to be considered when focusing on challenges to avoid threats posed in the environmental, economic, and social spheres. The latter argument opens a call for professionals from diverse fields, such as psychologists, economists, scientists, engineers, and environmentalists, and from the society at large, such as the politicians, the community members, and the youth, to engage in a collective effort to minimise environmental challenges. A contribution from the current study is to capitalise on appraisal and positive reinforcement to reward and encourage behaviour change. To echo the contribution, funding for individuals saving the planet while embarking on entrepreneurship is a contribution.

A green economy is a tool to ensure that natural resources are preserved for future generations and that mitigation programmes to minimise carbon emissions and pollution are in place. Furthermore, the mandate of the green economy is to ensure that resources are maintained and used efficiently to benefit the environment, society, and economy, as well as the promotion of sustainable development goals (Kasztelan, 2017; Nhamo & Mjimba, 2017, 2020; Nilsson, 2016; Sachs et al., 2019).

Current global green economy models, including the success factors and the challenges, may guide the adoption and management of green economy activities and initiatives in South Africa. Some global initiatives include the introduction of smart cities or sustainable cities. According to Hojer and Wangel (2015, p. 335), innovative, sustainable cities as a social construct can be defined as "the place where information technology is combined with infrastructure, architecture, everyday objects and even our bodies to address social, economic and environmental problems for the future". Several initiatives and programmes such as the C40, the ICLEI (Local Governments for Sustainability), the Clinton Climate Initiative, the cities programmes, the European Commission, the Impact Environment Assessment and the baseline studies to identify the social and the environmental challenges emerged from these conferences to accelerate the adoption of a green economy (Höjer & Wangel, 2015; Scherhaufer et al., 2018). Other green economy programmes and catalytic initiatives, such as the Principle 7 Rio Declaration on the Environment and Development, were formulated. The government and the private sectors adopted sustainable consumption and production patterns to meet the requirements of the environmental declaration (Nhamo & Mjimba, 2017; 2020). During the Global Economic Crisis Conference, the United Nations Environment Programme (UNEP) introduced the Global New Green Deal encouraging various states to support green jobs and to promote the sustainability and growth that was advocated for by the Millennium Development Goals (Amis et al., 2018; Savin, 2022; Sulich & Rutkowska, 2020).

Enabling the green economy needs to be explored by looking at current global green economy models and learning from the success factors and the challenges. There have been several green efforts across the globe, such as introducing smart, sustainable cities (Diale et al., 2022). An initiative enabling the transition to a green

economy would having ambassadors or champions in different sectors, such as the private or public sectors and tertiary schools. However, society is overlooked when formulating policies. To capitalise on collective efficacy in transitioning to a green economy, society and key stakeholders must form part of the movement (Diale et al., 2021a). *Collective efficacy* is a group of people coming together to remedy a challenge (Fritsche et al., 2018). One initiative developed in Sweden is Symbiocity, an initiative to promote eco-friendly businesses (Höjer & Wangel, 2015).

Following the background and the mandate of the green economy, the prioritised green economy thematic areas are discussed in detail in subsequent sections.

2.2.2.1. Sustainable energy

Sustainable energy is a key prioritised green economy thematic area. Energy demand per sub-industry, such as the iron and steel industry, the chemical and petrochemical sector, the non-ferrous metals, and the non-metallic minerals industry, is experienced in South Africa. Electricity is a significant commodity in South Africa. Currently, the country has produced 18 000MW of electricity. By 2030, 39 730MW is planned to be produced. This means that 21 730MW is needed (Department of Energy, n.d). Photovoltaic (PV) or storage from private institutions and municipalities are further accelerators to ensure sustainable energy. Managing energy infrastructure through smaller power plants and gas to power nuclear is pivotal. South Africa can facilitate the sustainable energy thematic area by producing and managing crude oil and petroleum (Department of Energy, n.d).

The researcher paints the picture of what is needed in the market to create opportunities for emerging and current entrepreneurs.

In ensuring green entrepreneurship within the energy sector, efforts within solar, hydro, renewable energy, and other alternative ways of ensuring sustainable energy must be the cornerstone of the green transition process. According to the literature, the support mechanisms implemented worldwide are non-financial and financial (Diale et al., 2021b; Gujba et al., 2012; Loock, 2012; Walsh, 2012). Generic business frameworks such as the utility renewable energy business and the customer renewable energy business model have been developed to facilitate the

manufacturing-to-consumption value chain. The latter mechanism is introduced to support renewable energy enterprises in international markets (Diale et al., 2021b; Yu et al., 2016; Richter, 2012; Richter, 2013). Due to the diffusion of energy supply, support such as investments can accelerate the planning and the implementation of the scarce commodity [energy] (Diale et al.,2021b; Masini & Menichetti, 2012).

2.2.2.1.1. Challenges within the energy sector

The lack of access to energy serves as a challenge in South Africa. Energy is scarce, and millions of people, especially in rural areas, are not connected to the electricity grid due to a lack of affordability (Amankwah-Amoah, 2015; Diale et al., 2021b). Many people use fires and fuel lighting for basic energy needs, particularly in the rural areas (Burma, 2016; Diale et al., 2021b). Success factors or contingency plans were introduced as an alternative mechanism, such as renewable energy (Burma, 2016; Diale et al., 2021b). The latter serves to ensure that everyone can light their houses or businesses. Further challenges include wage or salary disparities, skills shortages, shortage of coal, corruption, the mismanagement of funds and resources, the lack of policy framework, and the limited absorption of solar manufacturing plants, especially when it comes to energy (Amankwah-Amoah, 2015; Diale et al., 2021b).

Figure 2.1 illustrates the rural and electrification growth rates from the 1990s to 2016 (Diale et al., 2021b). The red line demarcates the rural electrification growth rate, and the blue line demarcates the rural electrification rate (percentage of rural population) (Diale et al., 2021b). Rural electrification provides electricity access to the population in rural areas (Amankwah-Amoah, 2015; Diale et al., 2021; Rural Electrification Graph, 2019).

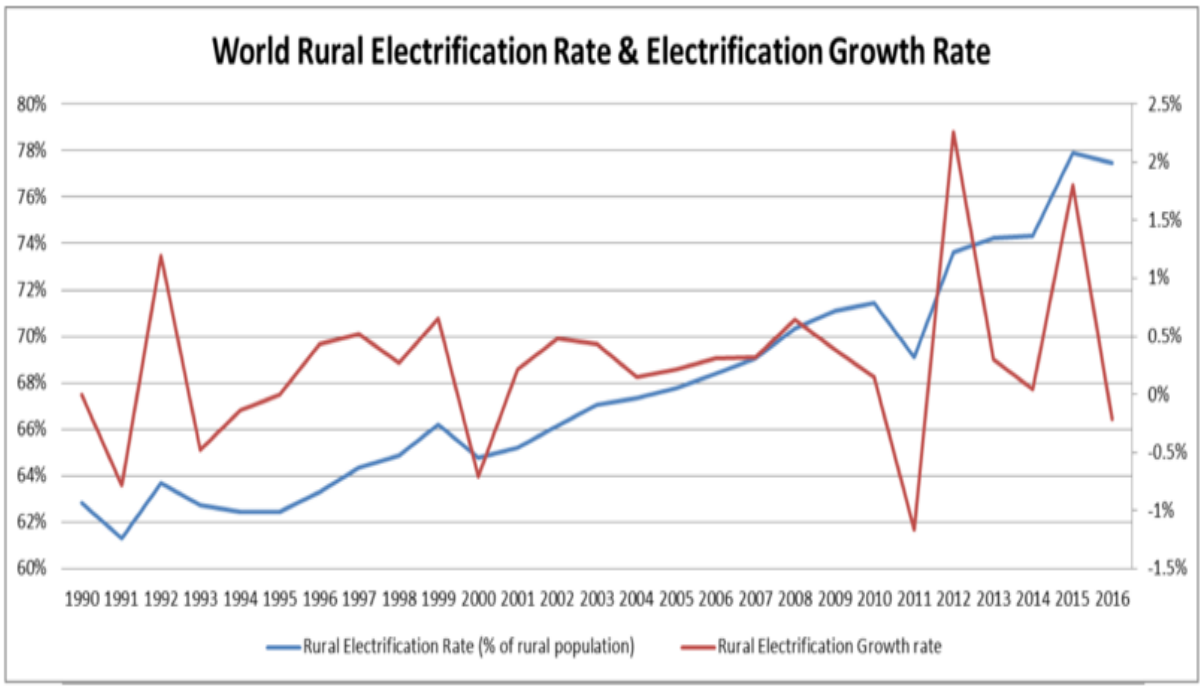


Figure 2.1: World rural electrification rate and electrification growth rate

Source (Wikipedia; Rural electrification graph, 2019).

The population in the rural and the urban areas needs more resources due to load shedding in South Africa. This challenge is experienced by those who can and cannot afford electricity.

Globally, within the energy sector, the challenges ranged from COVID-19 cases, the harsh lockdown, especially in South Africa, looting, and the most significant challenge, cable theft, especially in Gauteng. These challenges then led to businesses closing, increased retrenchments, and a negative impact on wellbeing, which affected the resilience and motivation of individual. High costs, political astuteness, and security issues are documented challenges in South Africa with the support given to the attention of investment, capital, education infrastructure and funding (Andrews & Nwapi, 2018; Brilliantova & Thurner, 2019; de Groot et al., 2017), but with less need of solutions from a multifocal point of psychology, social behaviour and engineering processes. In ensuring green entrepreneurship within the energy sector, efforts within solar, hydro, renewable energy, and other alternative ways of ensuring sustainable energy must be the cornerstone of the process leading to the green transition.

2.2.2.1.2. Management and monitoring challenges within the energy sector

The largest electricity regulator is Eskom, which has introduced loadshedding in stages. The lower the stage, the lower the severity or the number of hours a specific region is scheduled to be without electricity. The stages were formulated to decrease pressure and manage electricity usage; however, this tactic had adverse effects as it resulted in businesses closing and households needing electricity. The country has a solar park in the Northern Cape to minimise the need for most South Africans to access electricity (Amankwah-Amoah, 2015). The solar park is meant to improve the lives of others and to promote sustainable tourism. This strategy was intended to attract tourists and investors, thus contributing to the country's economy (Diale et al., 2021b).

Efforts have been made to introduce energy technologies and policies to reduce poverty and facilitate clean energy (Diale et al., 2021b; Oyedepo, 2012; Hancock, 2015). The need to contribute to the societal need by reducing electricity expenses for the poor serves as a crucial social context (Diale et al., 2021b; Mondal et al., 2010). The Department of Energy has supported plans for individuals with resources to provide alternative energy, such as solar (DOE, n.d). This foster and facilitate an energy business mindset.

A monitoring tool rating system should ensure that the implemented infrastructure is sustainable (Diale et al., 2021b). The proposed monitoring tool is a sustainable infrastructure rating system (Diale et al., 2021; Diaz et al., 2018) that can be used initially when implementing energy technologies, services, or the distribution of renewable energy tools (Diale et al., 2021b). As time progresses, it can be implemented in all the green economy thematic areas. Vat returns, government subsidies, tax incentives for innovation, price control, demand assurance, and venture capital are some of the supporting mechanisms that have been implemented worldwide to support the adoption of the green economy (Diale et al., 2021a; Diale et al., 2021b; Gujba et al., 2012; Loock, 2012; Walsh, 2012).

2.2.2.2. Waste management

Waste and littering are the most significant concerns in the South African context, as waste is one of the contributors to the climate change. Pollution is rampant due to

nonadherence to pro-environmental behaviours (sustainable behaviour). Further pollution is observed from the individual, public spaces, and large manufacturing and chemical industries through chemical waste. Global initiatives such as the Green Chemistry Commitment Programme were implemented from then onwards. Illegal dumping serves as a contributing factor to pollution in South Africa. There have been some efforts to reduce, reuse and recycle waste, including separation at the source (Dube & Nhamo, 2021; Mukonza, 2020; National Waste Management Strategy, 2020; National Environmental Management Act, no. 107 of 1998; Ogando et al., 2017; Waste Act & Municipal Systems Act, 2000; Waste Act National Domestic Waste Collection Standards, 2009).

The separation at source entails the provision of bins demarcated by recyclable materials such as glass, paper or plastics, and by non-recycled labelled bins to various organisations. These separation-at-source efforts are evident in organisations, malls, or shopping complexes but not necessarily in residential households. The latter may infer that the lack of stimuli to promote pro-environmental behaviour at home or in private residences will cause a delay in the transition to a green economy. The waste bins or similar infrastructure provided to organisations is not provided to individual households, as communities-at-large often have one bin for all the types of waste.

One of the waste management tools is the waste collection services by the municipalities. A total of 61% of the households in South Africa have access to domestic waste collection services (DEA, n.d). According to the DEA Report (n.d) on the mitigation and adaptation programmes, opportunities could be in the form of converting waste to energy, in the separation at source, or in the training of informal waste pickers. Further training could be in garden waste and composting at home or in the wastewater treatment baseline assessment, as this training could benefit the economy and society and save the environment. Resources such as the 330 litres of bin per household are needed. By 2030, 30% of the waste needs to be managed at landfill sites, whereby the need to convert waste to energy by 50% is enforced. The

anaerobic digestion or food waste is set to be managed by 70%, including windrow composting or garden waste, by 2030 (DEA, n.d).

Government departments across the country manage various landfill sites. However, the individuals separate and sort their waste. The latter is a good initiative, but it poses hazards to an individual's physical wellbeing. Most of the time, the individuals use their hands and do not wear any protective clothing when going through the waste material. This calls for technology to be used at landfill sites. In general, the waste pickers have low levels of education, with approximately 92% of the waste pickers not having completed formal schooling (Viljoen et al., 2018). It was found that only 25.4% of the street waste pickers and 42.6% of the landfill waste pickers had previously held full-time jobs (Viljoen et al., 2018). The statistics show concern over the level of education and the sustainability of jobs; ultimately, it affects the rights of the individuals due to a lack of education or awareness, lack of skills and protective clothing.

2.2.2.2.1. Maslow's hierarchy of needs simulated onto the waste sector.

In South Africa, we often see individuals pushing trolleys and going through yards or bins to collect recyclable materials to make a living because people see it as an opportunity to grow and turn challenges into opportunities. Maslow's hierarchy of needs can be utilised in trying to articulate this behaviour into a psychological principle and to strengthen human individual attributes.

Maslow differentiated between lower and higher order needs where the physiological, security, status and belongings are seen as survival needs. At the same time, self-actualisation reinforces growth and higher-order needs.

Figure 2.2: Maslow's hierarchy of needs within the waste sector

Source: Own compilation based on Maslow (1943)

One of the frameworks introduced to manage waste and ensure that it can be turned into a fruitful outcome is the integrated national waste management strategy, introduced by the South African government and aligned with its vision in the National Development Plan 2030. Within the waste management strategy, the following frameworks, acts, and guidelines spearhead the strategy (DEA, n.d)

- National Environmental Management Act, 1998 (Act no. 107 of 1998).

- The Waste Act, Municipal Systems Act 2000 (Act no. 32 of 2000).
- The Waste Act National Domestic Waste Collection Standards 2009.
- Industry waste management plans, waste tyre regulations (stockpile abatement plans);
- The regulations regarding the Control of the Import or Export of Waste 2008.
- South Africa's foreign policy; the Strategic Approach to International Chemicals Management (SAICM);
- List of waste management activities that have, or are likely to have, a detrimental effect on the environment 2013;
- Waste classification and management regulations;
- Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal;
- Stockholm Convention on Persistent Organic Pollutants (pops);
- Rotterdam Convention on Prior Informed Consent Procedure for certain Hazardous Chemicals and Pesticides in International Trade;
- Vienna Convention for the Protection of the Ozone Layer; National Waste Management Strategy 2020;
- Norms and the Standards for the Assessment of Waste for Landfill Disposal Norms and Standards for the Disposal of Waste to Landfill 2013;
- National Standards for the Extraction, Flaring or Recovery of Landfill Gas 2013.
- Regulations regarding the exclusion of a waste stream or a portion of a waste stream from the definition of waste regulations for the control of import and export of waste;
- National Waste Information Regulations, 2012;
- Waste Classification and Management Regulations, 2013;
- Regulations Regarding the Planning and Management of Residue;
- Stockpiles and Residue Deposits, 2015;
- Compulsory Specifications for Plastic Carrier Bags and Plastic Flat Bags, 2003;
- Waste Tyre Regulations, 2009;
- National Pricing Strategy for Waste Management, 2016

2.2.2.3. Sustainable water

From a critical point of view, transitioning to a green economy may be hampered by the challenges or the lack of resources in South Africa. To illustrate the lack of resources within the large economic and metropolitan cities, there are 14 911 people without access to running water in Cape Town, which has a population of 1 287 118 people. From a population of 1 213 642 people in Tshwane, 84 377 are without water. The scenario is no different in Johannesburg with 24 476 people without running water within a population of 1 966 084. While in the eThekwini metro, only 53 822 are without water from a population of 1 207 536 (Stats SA, 2016). Millions of people do not have access to clean water, especially in rural and semi-rural areas and some parts of urban areas (Borowski, 2020; Matsiliza & Block, 2017). In the Eastern Cape Province, some people spend days, and in some instances, weeks pass without water. These scenarios demonstrate that the highlighted challenges present green entrepreneurship opportunities in South Africa. More projects and enterprises within the water sector are needed, with diversified financial schemes for those who cannot afford a borehole or water tanks or to pay for transported water.

A sustainable water sector ensures purification, osmosis, and quality of life. Sustainable water does not only include consumption from private households or organisations, but the preservation of water for future generations, the management of the irrigation system for hydropower (type of energy), and a contribution to suitable agriculture (Lonergan, 2018). South Africa has experienced droughts for some time, with the authorities asserting that water does not reach the catchment areas. Questions then arise on the issue of whether this is due to lack of rain or resources or skills or lack of managing the budget. The factors mentioned earlier are similar to the discovery made by Javadinejad (2019) in Iran wherein the implementation of a sustainable water management system, which comprises separating water use into agriculture, energy or personal use by households or organisations. However, the lack of investment and training and technologies exacerbate the challenges.

2.2.2.3.1. Interventions in the water sector

The interventions identified in the context of sustainable water in international markets, which could be added to the ecosystem and serve as a support mechanism, include the price control of irrigation. Further interventions in the sector are infrastructure, greywater reclaimation, collaboration, riparian rights, and the development of water supply (Agathokleous et al., 2017; Alcamo, 2017; Carrera et al., 2018; 2019; Crossman & Pollino, 2018; Grum et al., 2017). The water shortages can spearhead motives for entrepreneurs to develop innovative tools to avoid the challenges of greenwashing awareness in the use of greywater and clean water for drinking and cooking (Diale et al., 2022).

2.2.2.4. Sustainable transport and mobility

Implementing sustainable transport and mobility in reducing carbon emissions and the number of cars on the road can assist in transitioning into a green economy. The need to engage in lift clubs and cycling is also recommended. However, not all regions and provinces have adequate bike trails, and some people have been victims of crime while trying to use bikes for transportation or exercise in South Africa. Riding a bike may be a luxury for some, while the lack of money to buy a car or pay for bus or taxi fare necessitates the use of a bike. The integrated rapid transport initiatives such as *Reavaya*, *Are yeng* and the Gautrain at a large scale, specifically in metropolitan cities are indicative of the technology used in South Africa's sustainable transport strategy to minimise carbon emissions (SACN report, n.d).

Sustainable transport is also observed from a smaller-scale enterprise such as the "Delivery ka speed" (fast delivery transport from township), which can be supported through the financial and non-financial mechanisms and an integration of the principles of industrial psychology such as motivation and reinforcement. Cutting-edge transport and mobility in the form of electric cars is gaining momentum, with the need for charging stations as one of the mechanisms. Furthermore, the charging stations should not that rely heavily on electricity to ensure the system functions even during loadshedding. The security of infrastructure and the protection of individuals using bikes for transport will need to be implemented to encourage sustainable transport

and mobility. The transportation carbon emission from one location to another poses a danger to the planet (Bamwesigye & Hlavackova, 2019; Pamucar et al., 2021; Zhao et al., 2020). Sustainable transport and mobility aim to reduce the carbon footprint and the cars on the road, and encourages individuals to cycle, engage in lift clubs, and use public transit transport such as buses to minimise carbon emissions (Bakker et al., 2018; Venter et al., 2018). One of the contributing factors to the increased number of cars on the roads results from urbanisation, which worsens the environmental challenges (Peprah et al., 2019). The use of cycling initiatives is further reinforced by making bike trails as a means to encourage cycling and to ensure people's wellbeing and to build sustainable communities through cohesion (Kwiatkowski, 2018; Verlinghieri & Schwanen, 2020).

Transport and mobility strategies such as smart mobility and reduced transport costs while protecting the environment are needed (Peprah et al., 2019). Despite decades of efforts to achieve the SDGs, particularly in sustainable transport and mobility, the use of private cars is still leading, with few individuals using public transport, rail, buses or cycles. Gumbo and Moyo (2020) conducted a study on sustainable transport in Johannesburg, South Africa and concluded that there is poor transport transit or connection making it cumbersome for individuals to utilise public transport. This research offered recommendations on categorising transport through integrated bus transit and rail transit as public transport, and it offered recommendations on integrating technology through Geoweb 2.0 (Gumbo & Moyo, 2020). Geoweb 2.0 allows for the digital footprint calculation and assigning carbon footprint metrics (Gumbo & Moyo, 2020). The need to offer support mechanisms, reinforcement, infrastructure through town planning and accessibility initiatives is highly recommended, especially in monitoring different types of travel (Holden et al., 2019; Zhao et al., 2020). The latter may support the social sphere in reducing the number of accidents and reinforcing the sustainable behaviour of using sustainable transport, which contributes to the country’s GDP while saving the environment (Zhao et al., 2020).

Sayyadi and Awasthi (2020) developed a system dynamics model in Canada which looks at the operational factors of sustainable transport and mobility to ensure the

practicalities behind implementing the policies. They simulated the costs of fuel, emissions, congestion, trip rate reduction and car ownership. The operational factors could be used as tactical short-term plans to enforce the implementation of policies that are similar to a study conducted by Holden et al. (2019). However, Sayyadi and Awasthi (2019) utilised a similar methodology as the current study. The difference is that the current study looks at seizing opportunities in pursuit of entrepreneurship within the prioritised thematic areas, such as sustainable transport and the infrastructure at a strategic level.

2.2.2.5. Sustainable agriculture

Another green thematic area is sustainable agriculture. One of the biggest challenges to ensure food security is landlessness. In the 2014/2015, South Africa experienced severe droughts delaying agricultural activities. An innovative approach is needed to maintain sustainable farming and food security (Diale, 2017). Agriculture and farming activities are delayed due to climate change and the lack of water resources (Leal-Filho et al., 2020; Nhamo, 2013). Urban agriculture will not flourish as most shacks are built in backyards, and people occupy land meant for specific innovative development or community upliftment marked by the government (Diale, 2017). The latter statement does not imply that people must be evicted, but it calls for expropriating land to be expanded to entrepreneurial sectors. Sustainable agriculture has been investigated to benefit the inception and implementation of renewable energy through the irrigation system and energy parks (Diale et al., 2021b; UNEP, 2004). Several innovative solutions have been proposed especially regarding food security and productivity. Reports on East African countries, such as Malawi, Tanzania, and Uganda, cited a lack of policies and guidelines for farming productivity (Diale, 2017; Julien et al., 2019). At the same time, other frameworks reported labour challenges with inadequate skills, fertiliser, and machinery (World Bank, 2009; United Nations, n.d).

Furthermore, the reports in Africa show that many populations could benefit from farming by reducing poverty, which enhances a good quality of life (Adenle et al., 2019; Gassner et al., 2019; Waha et al., 2018). Agriculture is one of the key pillars supporting

the economy, and it is a key source of nourishment which minimises hunger as well as malnutrition and ensures food security in Africa (Gassner et al., 2019; Nhamo, 2013; United Nations, n.d; World Bank, 2009). This intervention and commercialisation through the entrepreneurial agenda are needed in South Africa.

As part of the sustainable agriculture strategy and the SDG 2, several plans and frameworks to ensure sustainable agriculture are in place. The National Plan, Agenda 2030, is envisioned to ensure an equitable representation of women, youth and people living with disabilities who are given a fair chance to contribute to sustainable agriculture. The agenda is set to ensure that more support is given to previously disadvantaged individuals by giving access to land financial incentives and strengthening cooperatives between small-scale farmers for commercialisation, especially among the larger-scale farmers. The agenda is supported by a mandate of the Doha Development Round to ensure that monitoring food commodity markets facilitates timely access to market information, particularly concerning price control (Mugambiwa & Tirivangasi, 2017). Food security serves as a critical element, and yet, in South Africa, the resources, skills, technology, and human capital are needed. The agricultural sector is further impacted by the issues in accessing land and the lack of access to water.

Thus, the challenges and the lack of resources call for the need to create an ecosystem. The latter can be effected by turning the challenges into success factors through entrepreneurship in a quest to alert entrepreneurs to identify the opportunities and to come up with alternative technologies. The current study further contributes to the above-mentioned thematic areas within green entrepreneurship in a quest to transition into a green economy. After critically engaging with the literature on green thematic areas, the subsequent section focused on sustainable development goals as well as interventions from the people side.

2.3 SUSTAINABLE DEVELOPMENT GOALS

Upon discussing the crucial element of the green economy and its thematic areas, the sustainable development goals emerge as a tool that can further be used to implement green economy thematic areas. The sustainable development goals can be used as

a yardstick and as part of the performance management tools to monitor the adoption and implementation of the green economy (Miola & Schiltz, 2019). There are 17 sustainable development goals. After reviewing the literature, Kajee et al. (2018) and Lee et al. (2016) reiterated the United Nations' 17 sustainable development goals. Despite efforts made, previous research has not focused on the precise mapping of the sustainable goals within the green entrepreneurship space. The sustainable development goals are depicted in Figure 2.3:

Figure 2.3: United Nations sustainable development goals (United Nations blog, n.d)

The current study covers and addresses some of the emphasised sustainable development goals. The sustainable development goals applicable to this study are Goal 1 – "ending poverty in all its forms everywhere" and Goal 8 – "inclusive and sustainable economic growth, full and productive employment and decent work for all" (Lee et al., 2016). Green entrepreneurship is perceived as a business opportunity to save the earth and generate profit through innovation (Demirel et al., 2019; Jones, 2017; Lotfi et al., 2018). Green entrepreneurs are further seen as individuals managing natural resources (Allen & Malin, 2008). Vaidya and Honagannavar (2017) further add that green entrepreneurship is an environmentally friendly business framework

concerned with generating a profit and contributing to the economy while saving the world. The latter definitions fall within Goals 1 and 8, respectively.

The results show sustainable livelihoods after exploring the green economy from international and South African markets and the sustainable development goals. Sustainable livelihoods can be seen as minimising poverty and inequality by facilitating critical thinking in finding solutions, adherence and implementing policy procedures and priorities for development practices (Serrat & Serrat, 2017).

Figure 2.4, produced by Serrat and Serrat (2017, p 22), summarises sustainable livelihoods:

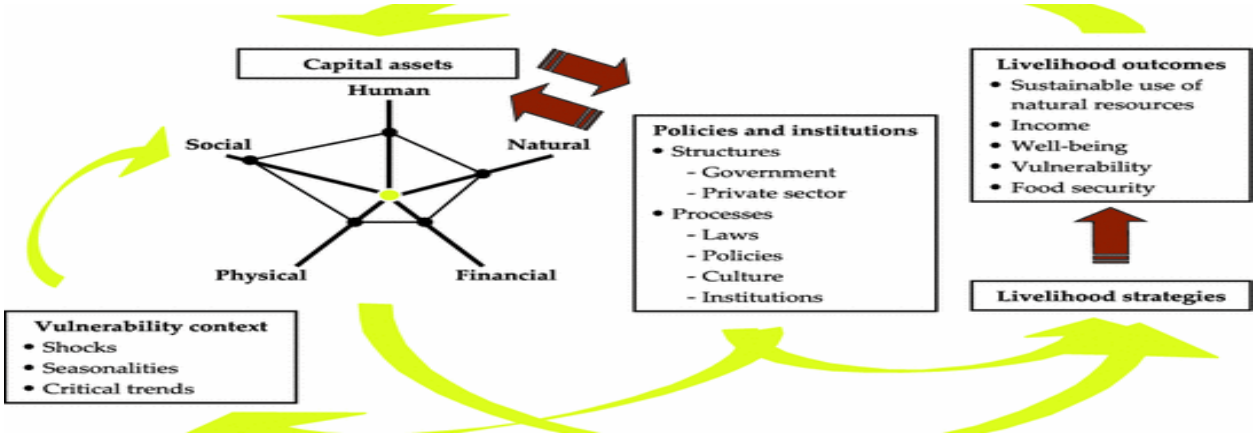


Figure 2.4: Sustainable livelihoods

Figure 2.4 summarises a comprehensive model of integrating the environment, capital assets, policies, institutions, and the livelihood outcomes in terms of well-being and managing human factors and social norms. The highlighted factors could be seen from the lens of industrial and organisational psychology in looking at systems thinking through inputs from the environment, processing, and output, as it is strategic. The evolution of an intelligent city gives emergence to smart connection, a virtual city, a wired city, and urban cybernetics (Thompson, 2016), which give rise to the urban regeneration that was coined by (Choi & Kim, 2017). The revolution of urban regeneration includes spatial planning and sustainable transportation, digital information, autonomous cars, connection, and digital transformation (Choi & Kim,

2017; Diale et al., 2022). It is imperative to discuss sustainable livelihoods when discussing sustainable development goals.

Sections 2.1 to 2.3 responded to the objective: *To conceptualise the green economy and the policies and frameworks adopted by the global markets.*

2.4 INTERVENTIONS TO THE ENVIRONMENTAL CHALLENGES FROM PEOPLE'S PERSPECTIVES

Upon discussing the environmental challenges and probable interventions to the green economy, the current study makes an additional contribution from a people's orientation. Collective efforts and leveraging diverse stakeholders are essential, especially concerning environmental challenges. Society and all the stakeholders need to become involved in capitalising on collective efficacy in transitioning to a green economy (Diale et al., 2021a). Collective efficacy refers to a group of people coming together to remedy challenges, in this case, the environmental challenges and have the confidence and capabilities to embark on the movement (Diale et al., 2021a; Fritsche et al., 2018; Jugert et al., 2016). Additional mechanisms and interventions concerning solutions from a people's side are explained in the latter areas: environmental psychology, efficacy, personality required in a green economy, motivation, psychology of entrepreneurship, and social entrepreneurship.

2.4.1. Environmental psychology

Environmental psychology, as part of the social psychology domain, focuses on behaviour, motivation, and the attitudes domain regarding sustainability and environmental awareness perspectives. Furthermore, the subfield of environmental psychology offers a framework that is inclusive of appraisal, cognition, personality traits, the value system, reinforcement, and pro-environmental behaviour (Busic-Sontic et al., 2017). The green economy, as well as minimising the environmental challenges and climate change, needs to be designed and simplified so that everyone will understand what the phenomena entails (Diale et al., 2021a). Some appraisal tactics need to be highlighted in this process. For instance, informing society about the benefits of complying with policies, the implications of climate change for current and

future generations, and the benefits of gaining knowledge about climate change to capitalise on pro-environmental behaviour (sustainable behaviour). The impact of the green economy mechanism needs to be carefully designed and mapped for current and future generations. The mapping may include benefits of learning more about climate change and how to capitalise on pro-environmental action or behaviour in transitioning to green entrepreneurship within the South African context (Diale et al., 2019).

The rationale for incorporating psychology into environmental aspects is that systems, ecosystems, and processes fail because people and behaviour are overlooked in the green economy and engineering spaces (Diale et al., 2019). Inappropriate behaviour, the lack of motivation and the negative attitudes towards a green economy still pose a threat to societies. Environmental psychology can be demonstrated by the social identity model, as depicted in Figure 2.5.

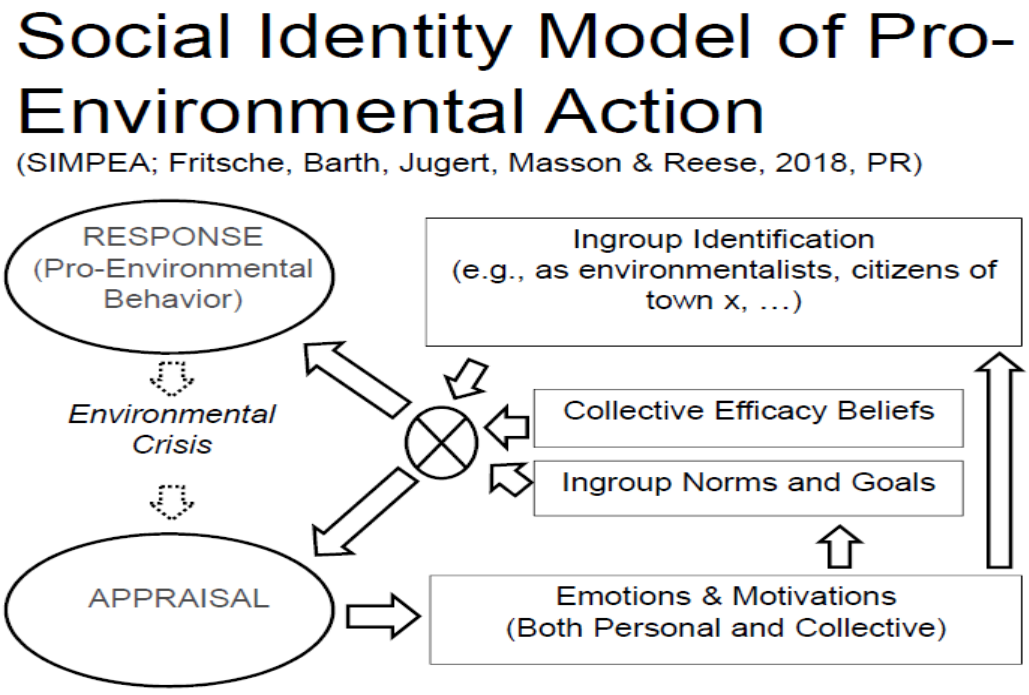


Figure 2.5: Social identity model of pro-environmental action (Fritsche et al., 2018 pp. 246)

Some individual human attributes reflected in Figure 2.5 directly and indirectly affect people's social environment. It should be noted that a person's self-concept consists of both personal and collective/ social identities. Fritsche et al. (2018) hold strong views that people group their action traits collectively and base their confidence on everyone in the same group towards achieving goals. The model further raises an awareness of appraisal. Appraisal encourages desirable behaviour and emphasises some reward or reinforcement to motivate people to do more or achieve a goal. The appraisal can be implemented in the green space by rewarding individuals who adopt pro-social and environmental behaviour which can then turn into a profitable mechanism that benefits society, saves the environment, and contributes to the South African economy.

The three crucial social identity factors (identification, efficacy, and norms) affect the environmental challenges and the pro-environmental action appraisals. The latter states that if people believe that the environmental challenges or climate changes do not exist or fail to adopt pro-environmental behaviour, it leads to undesirable effects and serves as punishment, while the reverse is true (Dunlap & McCright, 2008; McCright & Dunlap, 2011). Ecological theory constructs add to the environmental psychology framework, informing the sections that follow.

2.4.1.1. The ecological theory constructs.

In this section, anthropogenesis, biocentrism and ecologisation form part of the ecological theory constructs, further supporting behaviour and values within the environmental concerns. Literature suggests that the significant constructs underpinning the green economy are anthropogenesis, biocentrism and ecologisation (or the application of ecological methods). The three constructs were chosen by the researcher to fulfil both the green economy and the human individual attributes about environmental concerns. To translate the latter constructs to the current study, there is a need to move from the natural sphere of transitioning to a green economy to a more social policy, which serves as a missing link (Ivlev et al., 2019). The discussion on the human attributes approach in the current study supports the latter argument.

Furthermore, this study contributes to the integration and contextualisation of the sustainable development goals by facilitating the awareness of human attributes strategies in adopting policies, procedures, and a blueprint for environmental awareness. The ecological theory is a theoretical foundation of preservation, reuse, and the adoption of the green economy. The ecological theory focuses on the social economy, ensuring the equitable, fair, and sustainable allocation of resources (Gliedt & Parker, 2007). The next section explains the ecological constructs, thereby strengthening the behaviour and values within the domains.

2.4.1.1.1. Anthropogenic values

The anthropogenic approach focuses on natural or environmental human behaviour (Alade, 2019; Zeng et al., 2020). Anthropogenic values are the guiding principles of someone else's being (de Groot & Thøgersen, 2018). Building on the theoretical construct discussed in the preceding statement, some efforts have been made regarding the environmental values and concerns. Environmental values are perceived as the worth, feelings and perceptions individuals place onto the environment or the sense of importance individuals have for the environment. It has been shown statistically that individuals with high environmental values see the importance of protecting the environment by adopting eco-friendly tactics (Qazi et al., 2020).

Literature contributes to the term anthropogenesis within water use and the management thematic area by avoiding littering and enforcing sanctions for misusing resources and the inability to reuse resources (Kanwal et al., 2021). The core factors form part of the green economy. Furthermore, anthropogenesis emphasises the environmental norms ascribed by the communities (Mou & Azees, 2019). The balance of individual perspectives (self-concept) and collectivism through the community environmental norms is essential in fast-tracking sustainable livelihoods through green accords. The green accords, in the form of petitions, facilitate awareness of environmental factors. The anthropogenesis' emphasis on society is premised on Schumpeter's work, specifically on the social domain, which is integrated into entrepreneurship (Schumpeter, 2004).

When considering entrepreneurship and the green economy, the social domain needs to consider environmental factors. Social entrepreneurship transforms societies by offering goods and services, thereby generating profits while uplifting communities, fostering engagement, and offering empowerment (Chandra, 2017; Schumpeter, 2004). Furthermore, social entrepreneurship fosters a commitment to entrepreneurship by saving the planet and avoiding environmental degradation (Jayaratne et al., 2019). It is believed that entrepreneurship is controlled and enabled by social factors, which are the context and external factors determining its success or failure (Diale et al., 2019). Social entrepreneurship and aligning the community to the core of the business is crucial and may determine any enterprise's existence and life cycle (Acs et al., 2017; Schumpeter, 2004).

Altruism is another related human trait driving pro-environmental behaviour (sustainable behaviour) and ensuring the welfare of others and the environment. The altruism trait is closely linked to the anthropogenesis approach to environmental value (Ye et al., 2020). The key characteristic supporting altruism is social innovation, which has been demonstrated to be the push-and-pull factor concerning green entrepreneurial intentions (Ye et al., 2020).

2.4.1.1.2. Biocentrism values

Biocentrism is the intrinsic value facilitating the behaviour of preserving natural resources and the need to save the planet as guided by ethical principles, environmental ideologies, and global politics (Ivlev et al., 2019). The biocentric approach focuses on governing and protecting vegetation (Taylor, 2021). Political leaders often champion the biocentric approach (Afinegentova, 2018). The biocentrism approach focuses on sustainability, moral obligation, and environmental ethics. Some studies argue that adopting biocentrism is guided by an egalitarian culture (Taylor, 2008), which is the adoption of a different culture or position to one's beliefs.

2.4.1.1.3. Ecologisation values

The concept of ecologisation emerges from the fields of economics and ecology, which are primarily researched in the United Kingdom and Ukraine (Kovtun, 2020; Koziuk et

al., 2018; Marina, 2020; Sabadash, 2020), as there are no publications on ecologisation in the African context. Ecologisation is a tool to accelerate the sustainable development goals while benefitting the economy and society (Leal-Filho, 2019). It serves as a more diversified value, implying a systematic environmental awareness approach (Kovtun, 2020; Koziuk et al., 2018; Marina, 2020; Sabadash, 2020). Ecologisation focuses on nature and human life and avoids using natural resources or environmental harm (Marina, 2020; Sabadash, 2020). Ecologisation is further influenced by self-efficacy and transparency in business according to environmental policies and bylaws.

Ecologisation within green entrepreneurship encourages entrepreneurs to disclose the risks that may impact their business, mainly focusing on the risks posed by climate change (Marina, 2020). Ecologisation as a construct plays a crucial role in ensuring the equality of access to resources and the protection of natural resources while encouraging youth, women, and societies to exploit the market and pursue entrepreneurial intentions. Society members are encouraged to pursue innovative niche businesses such as green entrepreneurship to minimise poverty while becoming socially aware citizens adhering to environmental values (Kovtun, 2020; Marina, 2020).

There needs to be more performance management, ecologisation tools and tracking of the impact globally. Further efforts have, however, been made to manage conflicts between the organisational culture and clans within the ecologisation process in the quest to ensure wellbeing (Koziuk, 2020; Sabadash, 2020). The tools in place to manage these conflicts and role ambiguity are policies, political will and buy-in, the different criteria designed to suit the ecologisation principles, and tariffs and licensing (Sabadash, 2020). These factors are crucial for business or the entrepreneurial intention within the green entrepreneurship spectrum.

The commonalities between anthropogenesis and ecologisation are that these approaches are underpinned by pro-environmental behaviour in the business process. These approaches focus on the human element, the environment, and wellbeing and ensure that the impact of a social, economic, and environmental sphere is maintained.

While biocentrism on the other hand emphasises pro-environmental behaviour inclusive of protecting the living and focus on the environment and vegetation.

2.4.2. Efficacy theory

The pioneer of the self-efficacy theory is Albert Bandura. The self-efficacy theory consists of the internal and external locus of control. The internal locus of control is reassurance from within, whereby an individual believes in their capability. Individuals with an internal locus of control base their successes or failures on their actions whereas the external locus of control argues that a person's success or failure is impacted externally or influenced by the external environment. According to Bandura's (1997) theory, the more people perceive themselves as competent in the business, the more they are ready to take on entrepreneurship. People with high self-efficacy perceive complex tasks and obstacles as challenges in life (Contreras et al., 2017). Bandura then developed a social learning theory or role modelling theory which has expounded on the entrepreneurial lens of modelling an entrepreneurial mindset, and it borrowed from concepts of business mentoring and coaching.

2.4.2.1. Self-efficacy and green entrepreneurship

This section strengthens the association between self-efficacy and entrepreneurship, building on the self-efficacy theory. There are existing theories and empirical research on the social learning theory or the role of the modelling effect on green behaviour (Doanh & Bernat, 2019; Fuller et al., 2018; Hsu et al., 2019; Nowinski et al., 2019). Minimal focus has been put on international markets between self-efficacy and green entrepreneurship. Self-efficacy has been shown to significantly influence green entrepreneurial activities among students in Pakistan through risk aversion (Nowiski et al., 2019) which involves bearing the risk and maintaining momentum in converting an idea into a profit margin. Other international efforts have focused on self-efficacy, a green entrepreneurial mindset, and the need for achievement (Qazi et al.,2020). As one of the personality factors, proactiveness has been shown to impact green entrepreneurial motives amongst students in Pakistan.

2.4.3. Personality and Pro-environmental Behaviour

The need to consider personality as a component of the human individual attributes' framework concerning environmental concerns is a burning issue. Studies have demonstrated that one's personality may influence decisions, especially in entrepreneurship, as well as factors such as religion, culture, and one's upbringing (Akhtar et al., 2018; Raut et al., 2018). Some investigations have been undertaken to understand personalities or traits from the environmental psychology spectrum. It has been shown that the most applicable personality trait is the biospheric trait. Individuals with the biospheric trait have a strong desire and willingness to save the planet (Busic-Sontic et al., 2017; Nguyen et al., 2016).

Five significant personality factors have been investigated concerning pro-environmental behaviour. Conscientiousness, one of the big five personality, is often characterised as having good planning skills. Individuals with a conscientious personality trait ascribe to obligations and set standards. As a second personality trait, extraversion is characterised by finding enjoyment in interacting with others; most extroverts are fulfilled when engaging in outdoor activities. Individuals with an agreeable personality trait like following set rules and often they conform to the rules and regulations. Neuroticism is often seen in individuals who are constantly worried and distressed that the worst can happen and therefore have a negative outlook on life events. The fifth personality trait is openness to change, which is often seen in individuals who are always exploring new, innovative ways of doing and being (Akhtar, 2019; Anglim et al., 2020; Şahin et al., 2019). Honesty and humility were added to the personality types; they were investigated to prove that individuals with high humility and honesty tend to avoid exploiting others for personal gains and are not interested in a lavish life. They feel little temptation to break rules. These factors are implied within green behaviour (Soutter et al., 2020)

Agreeableness was shown to be somewhat associated with pro-environmental behaviour with a correlation of r=.25 and r=.34. Openness to change was shown to be the most strongly associated with pro-environmental behaviour with correlations of r=.35 and r=.46. The facet and interest factor of artistic was shown to contribute

positively to pro-environmental behaviour. Altruism and sympathy were shown to be strongly associated with pro-environmental behaviour, as discovered by Souter (2020). Akhtar (2019) tested the relationship between the five-factor model and the environmental values and found that agreeableness was highly related to environmental concerns ($\beta = 0.32$, $t = 9.42$, $p < 0.01$), followed by openness ($\beta = 0.21$, $t = 3.92$, $p < 0.01$), neuroticism ($\beta = 0.19$, $t = 3.86$, $p < 0.05$) and conscientiousness ($\beta = 0.09$, $t = 4.17$, $p < 0.01$).

2.4.4. Motivation to start a business (Push-and-pull factors)

As part of the continuation of the human attribute's framework, the motivation theory is discussed through the lens of the push-and-pull factors. Previous studies discovered that individuals are pushed into entrepreneurship because they are dissatisfied with their current jobs and drawn into entrepreneurship because of the market opportunities (Monitor, 2015). Furthermore, the start-up triggers are often pushed by factors such as the need for survival, retrenchments, divorce, death in the family, the desire to build an empire and generational wealth. The factors that make it possible or encourage an individual to venture into business are family members, mentors, customers, and potential business partners (Bosma et al., 2016; Karabulut, 2016; Monitor, 2015).

McClelland et al. (2005) identified the potential pull in the market. The pull factors are observed by an individual seeking a job that exposes one to entrepreneurial opportunities, education or capacity building (Diale, 2017). Furthermore, aspiring entrepreneurs are drawn into the market due to being power-hungry. They prefer independence, have a high need for achievement, are innovative, and have the ambition to embark on new challenges and gain social standing and recognition (Bosma et al., 2016; Karabulut, 2016; Monitor, 2015). A person may venture into business due to a job misfit, one's personality, disagreements with management, retrenchments, job dissatisfaction, and the lack of autonomy (McClelland et al., 2005).

2.4.4.1. Motives of green entrepreneurship

Upon reflecting on the motivation construct, the researcher unpacked the motives domain through the lens of green entrepreneurship. While the motives for venturing into green entrepreneurship are underdeveloped globally, some research efforts have

been undertaken to date were by Bergset (2015), Bosma et al. (2016), Gast et al. 92017), Moskwa et al. (2015), Oguonu (2015), Nikolaou et al. (2018), Robinson and Stubberud (2010), Silajdžić et al. (2015), Solaja (2017), and Walley et al. (2015). Previous research found that the motivation to embark on ecological entrepreneurship should be considered at the macro, micro and meso levels (Bergset, 2015; Gast et al., 2017). The macro-level focuses on green entrepreneurship, serving societal needs, generating wealth, and solving economic and environmental challenges at a larger scale. The micro-level involves earning a living to provide for one and their family. The meso-level includes green entrepreneurs developing markets for green products and offering services to small markets or firms (Bergset, 2015; Gast et al., 2017; Moskwa et al., 2015; Oguonu, 2015). The current study focused on modelling the macro dynamic variables in formulating the green entrepreneurship model.

Another green entrepreneurship motive identified from previous studies is that individuals pursue green entrepreneurship because they are committed to sustainable living and they have a strong desire and passion for nature because they need to maintain healthy living (Bosma et al., 2016). Other investigations in the United Kingdom found that entrepreneurs valued the green value system and seized available opportunities (Bosma et al., 2016; Gast et al., 2017). The factors influencing the motives to engage in green entrepreneurship included education, the availability of a green market, best practices learned from different countries, motivation to benefit the economy and environment, and profit generation. Moreover, motives from international markets indicated encouragement and influence from family commitments and support, desire for control and independence, profit from cattle or lifestock, lifestyle, own research within the green economy thematic areas, and the exposure gained from international travel (Walley et al., 2015). In addition, motives discovered in the international market were to reduce the environmental impact, materials and energy costs, earn a living, and educate society (Gast et al., 2017; Robinson & Stubberud, 2010).

Silajdžić et al. (2015), in their exploration of green entrepreneurship in Bosnia and Herzegovina, found that some individuals pursued ecopreneurship to change their attitude toward the environment, especially in the light of climate change, while at the

same time leaving a legacy and raising awareness of the green market. These motives serving as the pull-and-push factors to venture into green entrepreneurship were influenced by failed markets and changes in the natural environment (Nikolaou et al., 2018).

2.4.5. Psychology of entrepreneurship framework

The psychology of entrepreneurship framework emerges after reviewing the literature on the psychological principles that apply to the study. It forms a basis to strengthen the individual human attributes framework and the interventions from the human side. The psychology of the entrepreneurship framework consists of environmental psychology, the efficacy theory, pro-environmental behaviour, values, efficacy, and personality. Furthermore, the psychology of entrepreneurship framework is concerned with the cognitive, behavioural and social factors while also contributing to the scientific field of industrial and organisational psychology in the current study.

2.4.5.1. Cognitive

The level of cognition, the ability to pursue markets, and the ability to adapt to the market form part of alertness or brain functioning (Frese, 2014; Hisrich et al., 2007; Urban, 2020). Brain functioning gives rise to neuro-entrepreneurship, often strengthened by the level of exposure an individual has gained through education. The brain is like plastic; it absorbs everything around it (Leaf, 2013; 2018; Sharma et al., 2021), and then the crystallisation, the sense-making, the application, and the level of education further trim down how one uses the absorbed information. When translating the latter argument in the current study, it gives emergence to neuro-green entrepreneurship, where an individual with specific cognition, values, or push-and-pull factors regarding green entrepreneurship is materialised. The assimilation of the environment develops some alertness, ability, and resilience to exploit the market and pursue entrepreneurship.

2.4.5.2. Behavioural and the social factors within green entrepreneurship

Behavioural and social factors are some pillars of the psychology of entrepreneurship. Behavioural factors are usually what one can see or observe in achieving a goal; they

are usually influenced by the trait activation theory and the behavioural activation response. In addition, behavioural factors are influenced by an individual's motivation, stimulus response, and the need for achievement and action. According to Olson-Buchanan et al. (2013), there are two kinds of entrepreneurship:

- Necessity entrepreneurship – The entrepreneurs have no better option/choice to earn a living.
- High-entrepreneurship – The entrepreneurs expect to employ at least 20 employees in five years.

The contextual factors affect entrepreneurial success as they influence the entrepreneurs' actions. Peripheral to entrepreneurial success is an individual's actions which are essential for entrepreneurship for the following (Olson-Buchanan et al., 2013):

- Acquires the necessary resources for exploiting an opportunity.
- Improves the entrepreneurs' cognitive entrepreneurship model (through feedback) and promotes developing entrepreneurial expertise.

The behavioural element is further influenced by environmental agility, innovation, transformation, motivation, ecopreneurs management, profiling of environmental entrepreneurship, development agencies crowdfunding, environmental policy, legal framework business incubators commitment and the green skills to govern the rights of environmental entrepreneurs (Antolin-Lopez et al., 2019; Domańska et al., 2018; Foster et al., 2010; Hörisch, 2015; Massa-Saluzzo & Toschi, 2018; Nikolaou et al., 2018; Rajan, 2019; Rodgers, 2010; Schaefer et al., 2015; Yakovleva, 2018; Zamfir et al., 2014). Literature suggests that for the desired change to occur, social context plays a huge role, drawing from the work of Schumpeter (2004). Society can considerably praise and support entrepreneurship innovation (Diale et al., 2021a).

The above discussion was in response to the following objective*: To conceptualise the key variables of the psychology of entrepreneurship.*

2.4.6. The role of industrial psychology in a green economy

The individual human attributes such as environmental psychology, efficacy theory, personality, motivation, and the psychology of entrepreneurship framework are subfields within industrial and organisational psychology. Industrial and organisational psychology concentrates on human behaviour and applies knowledge to manage all work-related aspects (Van Vuuren, 2010). It is evident that the precise roles of industrial psychologists, as opposed to human resource practitioners, need to be clarified (Barnard & Fourie, 2007a; Schreuder, 2001; Van Vuuren, 2010). Professionals in the field can begin by agreeing to one definition of industrial and organisational psychology (Barnard & Fourie, 2007b). According to Watkins (2001), industrial and organisational psychology professionals suffer from an identity crisis as their roles are similar to those of human resource practitioners. The matter was confounded by universities in channelling the field under the auspices of management science, which later operated under personnel psychology and then later human resource management (Barnard & Fourie, 2007a).

The need for industrial psychologists to adopt an interdisciplinary approach in finding solutions to the turbulent market emerged (Moalusi, 2001). According to Barkhuizen et al. (2014), industrial and organisational psychology contributes to developing wellness strategies, interventions, leadership, guidance through careers, and developmental programmes. This includes health promotions, psychology development programmes and stress management. For organisations to maintain and ensure that their employees are mentally and physically healthy as well as employee and organisational wellness, fully employed workplace counselling programmes, environment person fit, and entrepreneurial awareness need to be in place. This role is supported by the Health Professions Council of South Africa (HPCSA), as industrial and organisational psychology uses theoretical and scientific knowledge to ensure that organisations flourish with wellness strategies (HPCSA, n.d). Furthermore, industrial and organisational psychologists need to adapt and become resilient to assist individuals, groups, and communities at a larger scale in turbulent environments (Barkhuizen et al., 2014).

Through a review of the literature, efforts have been made concerning green human resources practices such as green compensation, green rewards, green training and development, as well as through green employee relations and green management (Ahmad, 2015; Ahmed et al., 2019; Cheema & Javed, 2017; Obeidat et al., 2020; Yong et al., 2019). The industrial psychologists' role, identity, and applicability have not received much attention, let alone the role of IOPs role in accelerating sustainable development goals and transitioning onto the green economy. The subsequent section focuses on the efforts concerning the sub-fields of green practices.

2.4.6.1. Green human resource practices

Human resources, as one of the subfields of industrial and organisational psychology, has been investigated through the lens of a green economy in international markets (Fawehenmi et al., 2020; Peng et al., 2020), but with minimal focus on the behavioural and scientific perspectives as they relate to green human resource practices within the South African context. The previous research focused on capacity development and skills enhancement in the subfield to assist individuals and organisations in adopting and using sustainable behaviour as part of their business strategy (Ahmad, 2015). The HRM policies are needed to manage and accelerate the resources used to promote environmentalism and boost satisfaction and employee morale (Ahmad, 2015).

2.4.6.2. Ergonomics and green ergonomics

Ergonomics is derived from two Greek words: "ergon," meaning work and "nomos," meaning laws, thereby denoting the science of work (Caplet, 2007; International Ergonomics Association, n.d). Ergonomics (or human factors) is a scientific discipline that is concerned with understanding interactions between humans and other elements of the system. The profession applies theory, principles, data, and methods to design and optimise human wellbeing and the overall system performance (Caplet, 2007). Ergonomics, as a subfield of industrial and organisational psychology and the engineering subfields, is a science concerned with the fit between people and their workstations. Ergonomics aims to ensure that the tasks, the equipment, the information, and the environment fit each worker.

The domains of ergonomics are cognitive, organisational, and physical, as depicted in Figure 2.6.

Figure 2.6: Domains of ergonomics

(International Ergonomics Association, n.d)

The benefits of ergonomics in the workplace are increased productivity, efficiency, output, and quality of work (Amrutha & Geetha, 2019). Furthermore, ergonomic principles improve engagement, morale, and overall health, creating a culture of organisational safety. They prevent turnover, absenteeism, and lawsuits resulting from injuries or illnesses due to the work environment (Huda & Matondang, 2018).

The detrimental effects of poor ergonomics are ergonomic stressors, psychological stress, physical/emotional pain and injury. The ergonomic disorders affect employee morale and productivity and add to organisational costs (Huda & Matondang, 2018). When translating the latter statement into green ergonomics, previous research looked at green human resource safety principles (Amrutha & Geetha, 2019; Huda & Matondang, 2018; Poon et al., 2016; Sarker et al., 2018; Sharan, 2018; Thatcher & Milner, 2014), with minimal focus on the complete translation of green ergonomics

principles. Research on green ergonomics from the soft side (people side) needs to be more present, specifically regarding the behavioural factors and validation, with the lens of industrial and organisational psychology calling for a research agenda. A further inferred translation, which will need to be validated in future, is the design of the workplace, green building principles and its nexus on the wellbeing of a person and machine to benefit the economy and the environment simultaneously.

The following section provides a background to generic and green entrepreneurship. The study's contribution argues that green entrepreneurship is the catalytic solution to enhance the probability of transitioning into a green economy.

This section responded to the objective: *To conceptualise the field of industrial and organisational psychology in the green economy*.

2.5 BASIS OF THE GENERIC ENTREPRENEURSHIP AND THE GREEN ENTREPRENEURSHIP FRAMEWORK

This section discusses the first generic entrepreneurship, followed by the basis of green entrepreneurship.

2.5.1. Reinforcement of generic entrepreneurship

Entrepreneurship is a complex concept, and it is defined in various ways. Although there is no single definition of entrepreneurship, it can be seen as a catalyst contributing to the economy through improved quality of life, profit generation from business ventures and the creation of employment (Bosma et al., 2016; Monitor, 2015). Some authors describe entrepreneurship as identifying markets, taking risks, converting ideas into reality, and formulating innovative products and business models (Schaper, 2016; Schumpeter, 2004).

The theory is widely used, leading to intent and action, and is called the theory of reasoned action, which includes pursuing entrepreneurial intent and optimising the available support structure as coined by Fishbein and Ajzen (1975). Unsurprisingly, South Africa, as a developing country, faces many socio-economic issues such as poverty and unemployment (Diale et al., 2022). The COVID-19 pandemic worsened these socio-economic issues as the unemployment and poverty rates drastically

increased (Diale et al., 2022). As a result, millions of people have lost their jobs, and thousands of businesses were forced to shut down (Maree, 2021). Notably, entrepreneurship is the intervention that can create jobs and revive the hope of the millennial workforce.

Total employment has been a goal of the public sector for decades. However, the unemployment rate is increasing. Therefore, the best alternative that will help to create jobs and poverty alleviation is entrepreneurship (Diale et al., 2022). Entrepreneurship has two essential prosocial functions relevant to economic development and poverty reduction. Entrepreneurship contributes to the creation of new jobs and the productivity growth, with an impacting outcome on both macro and micro levels, i.e., decreasing the unemployment rate, increasing GDP, higher earnings, and increased spending on private consumption. Entrepreneurs convert many technological inventions into innovative products or services to benefit the wider society. Evidence shows that entrepreneurship contributes to knowledge spill over, technological change, and higher intensity and efficiency in introducing innovations than established firms (Olson-Buchanan et al., 2013).

2.5.2. Reinforcement of Green Entrepreneurship

Various terms describe green entrepreneurship, including eco-entrepreneurship, environmental entrepreneurship, ecopreneurship and sustainable entrepreneurship (Hörisch et al., 2017; Muñoz & Cohen, 2018; Santini, 2017; Schaltenger, 2016; Tharindu & Koggalage, 2020; Vasilevska & Rivza, 2018). Vaidya and Honagannavar (2017) define *green entrepreneurship* as commercialising technological and innovative products within a green economy thematic framework. Green entrepreneurship may present a tool for addressing and minimising environmental challenges, generating profits and benefiting the welfare of communities (Ebrahimi & Mirbargkar, 2017; Grinevich et al., 2019).

Green entrepreneurs face multiple jeopardies of creating and formulating sustainable green products and services while meeting social, economic, and environmental objectives (Demirel et al., 2019; Ebrahimi & Mirbargkar, 2017). For sustainable entrepreneurship to flourish, a general awareness of environmental challenges and

how they affect South Africa in the current and future needs to be urgently implemented (Diale et al., 2021a). Green entrepreneurship, sustainable entrepreneurship or ecopreneurship can be looked at from scales of varying degrees in terms of the criteria. More entrepreneurs from small-scale enterprises are environmentally conscious (Diale et al., 2021a). Furthermore, the small scales are often called the “Davids” and the large firms as the “Goliaths” (Bérard & Saleilles, 2016; Poldner & Branzei, 2015). Green entrepreneurship, sustainable entrepreneurship and ecopreneurship need to be assessed, looking at weaknesses and strengths and facilitating sharing of best practices (Diale et al., 2021a).

The difference in Table 2.2. illustrates the small scales (Davids) and the large firms (Goliaths) within the green economy. Table 2.2 denotes the differences and the specific function of the business objectives of green entrepreneurship.

Table 2.1: Differences between the start-up and the established enterprises criteria

Criteria	Davids	Goliaths
Age	Rather new	Old, incumbent
Size	Small	Large
Objective function	The social and environmental objectives are equally important as the economic objectives	The economic objectives are dominating, and the social/environmental objectives are complementary to the green economy

Source: Bérard and Saleilles (2016); Poldner and Branzei (2015)

2.5.2.1. Categories of ecopreneurship

The categories or clusters of ecopreneurship must be established to ensure the implementation and sustainability of green entrepreneurship. Green entrepreneurship or ecopreneurship can further be understood by categorising the behaviour and the motives of the individuals embarking on green entrepreneurship, as presented in Table 2.3. The ecopreneurship concept was coined by Schuyler (1998). Thereafter, various authors used the concept referring to business activity in making a profit while at the

same time saving the environment (Kardos et al., 2019; Kirkwood & Walton, 2010; Kirkwood et al.,2017; Santini, 2017; Schaltenger, 2016). The various green entrepreneurs' categories, those who need to make profits and those who are committed to sustainability and are determined to improve the environment, can be summarised in Table 2.3.

Table 2.2: Categories of ecopreneurship

Types of ecopreneurs	Description
Environmental conscious	Develops innovations that either reduce resources or have an impact in a larger scale or improve costs.
Green entrepreneurs	Aware of environmental issues and have their business in the environmental marketplace.
Innovative opportunist	A financially oriented entrepreneur spots a green niche or business opportunity that happens to be green.
Adhoc or accidental entrepreneur	Accidentally lands on opportunities that are green without a clear motive why they are in the niche market.
Visionary entrepreneur	Builds their business based on the sustainability principles.
Ethical maverick	Sets up alternative style business on the fringes of society.
Self-employer	Advocates for nature-oriented enterprises, e.g., the wildlife habitat perseveration, eco-tourism, or the low desire to change the world.
Opportunist	Involved in environmental technology to help businesses and communities reduce the environmental load on air, soil and water. Has a low desire to change the world but has high financial drive.
Non-profit business	Have a high desire to change the world and a focus on profits.
Successful idealists	Have a high desire to change the world and a high financial drive.
Green business	Did not start the business from scratch but later saw the importance of greening their existing business.
Green, green business	Designs the business to be green starting from its products and the processes.

Eco-dedicated	Consistently adopts environmentally friendly business practices.
Eco-open	Partially adopts an environmentally friendly business.
Eco reluctant	Adopts environmentally friendly business practices only when regulations force them.
Alternative actors	Business exists to support lifestyles.
Bioneers	Investors with a research and development (R&D)] focus in high technology sectors, such as alternative energy sources.

(Nikolaou et al., 2018; O'Neill & Gibbs, 2016; Schaltegger, 2016; Skoglund, 2017; Walley et al., 2015)

Table 2.3 provides a thorough portrayal of the different types of green entrepreneurship. However, it lacks flexibility. For instance, people possess different entrepreneurship skills and do not resort to a single category, which raises the following question: can people possess different types of green entrepreneurship instead of falling into a single category? For instance, can it be channelled to context (O'neil & Gibbs, 2016)? Entrepreneurship is situational, depending on the set dilemma or the opportunity.

2.5.3. Social Entrepreneurship Ecosystem

Social entrepreneurship is another pillar adding to the business incubator or the ecosystem in the current study. The social domain needs to be considered when looking at entrepreneurship and the green economy. Sustainable entrepreneurship evolved from environmental and social entrepreneurship (Bérard & Saleilles, 2016; Poldner & Branzei, 2015). In other words, the social entrepreneurship concept needs to be explored when looking at the environmental practices and the challenges that are inclusive of the orientation to entrepreneurship to save the planet and avoid environmental degradation. York et al. (2016) argue that entrepreneurship can occur outside the business environment, which gives meaning to entrepreneurship resulting from personal growth while investing in social life and the psychological aspect of self-discovery. The evolution of sustainable entrepreneurship can create a positive outcome because societies and communities will perceive the challenges arising from

climate change and will turn the challenges into fruitful outcomes (Klein, 2016; Pauli, 2010; Sharma, 2020).

Entrepreneurship can be viewed from the lens of the ecosystem to complement the broad definition of system dynamics. Stam (2015), however, argues that entrepreneurship is the outcome of systems. For entrepreneurship to be seen as a sense-making tool, it must be understood from the social constructions and the narratives that emerge for society to benefit from the discourse (Roudy, 2016). The social entrepreneur utilises technology, particularly social media, to reach global audiences (Diale, 2017). This initiative fosters a positive mindset that aspiring entrepreneurs can succeed despite the obstacles (Diale, 2017). Usually, the ambassadors who act as the custodians of social entrepreneurship instil innovation, persistence, leadership, and team-building skills required to pioneer a business (Hayhurst, 2014). Social entrepreneurship raises awareness in redressing imbalances and inequality (Diale, 2017). Social entrepreneurship serves as the monitor or the control and discipline tool that can regulate the behaviours of current and aspiring entrepreneurs (Hayhurst, 2014). Green entrepreneurship is a practical spectrum to accelerate the transition into a green economy. When discussing the social sphere in entrepreneurship, the gender dynamics need to be strongly considered, and the researcher contributes that women's representation in entrepreneurship, as a whole, deserves prioritisation.

2.5.3.1. Women entrepreneurs and the broad-based black economic empowerment

Worldwide, minimal research on green entrepreneurship focuses on women (Diale et al., 2019). There needs to be more research on the female identity within environmental entrepreneurship and how to utilise the identity best to transition into a green economy. Sanyang and Huang (2008) strongly believe that developing women in green cooperatives may alleviate poverty and promote sustainable rural development (Diale et al., 2021a). The latter may ultimately contribute to creating green jobs (Drăgoi et al., 2017). Focusing on social dynamics and sustainable development is essential to fully implement green initiatives (Diale et al., 2021a). Studies have shown that women are more likely to venture into environmental

entrepreneurship, and they are also more inclined to uplift communities through social entrepreneurship (Agarwal et al., 2020; Borquist & de Bruin, 2019; Hechavarria, 2012; Irene, 2017; Kearins & Schaefer, 2017; Kimbu, & Ngoasong, 2016; Maziriri et al., 2019).

Women, the youth and people living with disabilities are still underrepresented, especially economically, more so in entrepreneurial journeys. An optimal business and its size could also have an impact and serves as overpowering aspects within which the women function (Bardasi et al.,2007). Culture, history, and legislation further pose as social factors infleuncing business start up or sustainability. These social factors can either serve as obstacles or opportunities for women seeking to explore the entrepreneurial sectors (Bardasi et al., 2007; Chiloane-Tsoka, 2013 Mandipaka, 2014a; Mandipaka, 2014b; Roudy, 2016). Men's motives differ from those of women as they focus on making more money, while women's motives are to have flexibility and security for their families when starting a venture (Herrington et al., 2010). The research on the motivation of women entrepreneurs indicates that women are seen as socially oriented and designed to help the community or the environment (Botha, 2006; McClelland et al., 2005; Monitor, 2015). There are issues of patriarchy and the gendered roles that women experience, as they are expected to be nurturing, offering a helping hand and engaging in entrepreneurial activities to uplift the community and save the environment (Hechavarria, 2012; Irene, 2017; Kearins & Schaefer, 2017; Kimbu, & Ngoasong, 2016; Maziriri et al., 2019). The latter arguments give women an advantage in thriving in environmental and social entrepreneurship (Hechavarria, 2012).

Women, people with disabilities and the youth must be prioritised in receiving support. The South African government promulgated the Broad-Based Black Economic Empowerment (BBBEE) to ensure equality and representation in various economic activities. The empowerment's mandate is to offer a support mechanism for women and black individuals, youth, and people with disabilities (Chiloane-Tsoka, 2013). There is a need for strong coordination and a memorandum of understanding with the countries that have developed these mechanisms to allow exchange programmes within the SMEs in various green economy thematic areas, mainly targeting individuals

from previously disadvantaged backgrounds (Diale et al., 2021b). To broaden the latter perspective, BBBEE will also need to include additional lenses of facilitating green entrepreneurship and points to be allocated respectively in the form of tendering systems within the advances of energy, transport, waste, water, agriculture, technology, green building, sustainable tourism, and sustainable consumption sectors (Diale et al., 2021a; Diale et al., 2021b).

Upon reviewing the literature on the background and the underpinning principles of generic and social entrepreneurship, the key drivers of green entrepreneurship emerge, informing the following sections.

2.6 KEY DRIVERS OF GREEN ENTREPRENEURSHIP

This section discusses the key drivers of financial and non-financial support. The non-financial support in the current study is infrastructure, customers, education and skills.

2.6.1. Financial Support

The Industrial Development Corporation (IDC) is the national development finance institution that was formulated to promote and enhance economic growth, which plays a considerable role in the petrochemical, manufacturing, textiles, agriculture, mining, and telecommunications sectors in South Africa (Diale & Carrim, 2022; IDC, n.d). The South African Micro-Finance Apex Fund (SAMAF) is an initiative by the Department of Trade and Industry (DTI) whose mandate is to develop sustainable financial stability and facilitate training and capacity building for micro-entrepreneurs and financial intermediaries (Diale, 2017; DTI, n.d). The National Empowerment Fund (NEF) is a government agency under the DTI umbrella to provide capital for black economic empowerment transactions (DTI, nd). The NEF promotes and facilitates black economic participation by providing financial and non-financial backing to black-empowered businesses and fostering an investment culture (Diale, 2017).

The NEF Rural and Community Development Fund provides an investment of R1 million to R50 million with commercially viable ventures that seek to economically benefit communities in the rural and peri-urban areas (DTI, n.d). Primarily, the fund focuses on investing in agriculture, agro-processing, manufacturing, tourism,

agroforestry, retail property development, aqua and marine culture, small-scale mining and renewable energy (DTI, n.d).

2.6.2. Green Finance Mechanisms

Several green financing mechanisms exist worldwide. From a South African point of view, the Development Bank of Southern Africa (DBSA) serves as a cornerstone of green funding initiatives in energy, transport, waste management and sustainable water projects. Zambia, for one, has introduced a climate financing framework with a clear mandate of reinforcing green initiatives and plans and strategies to adopt sustainable behaviour and reduce pollution (Casado-Asensio et al., 2014; Elsner et al., 2021). The Cop 27, held in 2022, pledges billions of rands to support green initiatives in combating the challenges resulting from climate change. A large portion of finance is set aside for renewable energy, primarily to support South Africa with the energy crises.

Furthermore, an additional framework, the Rio Declaration Framework, is in place to focus on green projects and initiatives (Porras, 1992). The Rio 7 Framework gave foundation to the Rio+20 with the agenda of looking merely at the financial mechanisms within the green economy (Abdelkafi & Täuscher, 2016). The Rio Framework offers a finance mechanism through the creditor reporting system, focusing on the following pillars: climate change mitigation, adaptation and biodiversity, and later establishing the United Nations Framework Conventions on Climate Change (UNFCCC). The UNFCCC is the global framework spearheading the green finance mechanisms ranging from green loans, green capital, investment capital and any financing concerning green projects (Kuyper et al., 2018). The overarching pillars underpinning the UNFCCC target the mitigation and adaptation of green projects. The mitigation programmes include projects to minimise carbon footprint: sustainable transport and mobility, waste management, energy, and sustainable water. The adaptation programmes focus on social cohesion, sustainable cities and communities, and vulnerable cities (Anabaraonye, 2019; Kuyper et al., 2018; Wamsler et al., 2020).

2.6.3. Non-financial Support

The non-financial support consists of any non-monetary support mechanism ranging from training on environmental agility, innovation, transformation, motivation, profiling of environmental entrepreneurship, development agencies, environmental policies, the legal framework of business incubators, as well as the commitment to govern the rights of the environmental entrepreneurs (Antolin-Lopez et al., 2019; de Bruin & Lewins, 2010; Diale et al., 2021a; Domanka et al., 2018; Foster et al., 2010; Hall et al., 2010; Hörisch, 2015; Markman et al., 2016; Massa-Saluzzo & Toschi, 2019; Nikolaou et al., 2018; Rajan, 2019; Rodgers, 2011; Schaefer et al., 2015; Scott & Thompson, 2012; Thompson et al., 2011; Thompson & Scott, 2010; Thompson, 2012; Yakovleva, 2018; Zamfir, 2014). The infrastructure resources call for the public and private sector stakeholders to collaborate and facilitate growth within entrepreneurship through infrastructure and finances (Saeidi Aghdam et al., 2020). The additional non-financial support is discussed in the subsequent sections.

Section 2.4 explained the key drivers from a people's perspectives, while Section 2.6 conceptualised the process perspectives of the key drivers in response to the objective of '*To develop conceptualised key drivers of green entrepreneurship'.*

2.6.3.1. Green infrastructure

There are several green infrastructures in place to aid and support green projects. The researcher focused on the green infrastructure within prioritised sectors such as water, waste, agriculture infrastructure, transport, and mobility (bicycles, land, mainly busses and electric vehicles). The prioritised green thematic areas served as criteria for the variables explained in this thesis. There are further initiatives which support the forecast and the projection of the green infrastructure through system dynamics, such as the AnyLogic simulation software, Vensim, Stella Architect, as well as the EN-ROADS (Kapmeier et al., 2021; Sovilj et al., 2021; Zake et al., 2021; Zhang et al., 2021). The latter-mentioned simulation shows the behaviour of a commodity over time. The researcher, however, chose the Vensim modelling software because it allows for a variety of projections, ratios, percentages, and mathematical equations. Further discussions on the system dynamics modelling are discussed in Chapter 3 and

Chapter 4. The subsequent section discusses the infrastructure within the key prioritised green thematic area: the infrastructure with sustainable transport, energy, waste management, sustainable water and agriculture.

2.6.3.1.1. Sustainable transport and mobility infrastructure

In the current study, sustainable transport and mobility are simulated based on the data on bicycles, electric cars and buses (see Chapter 4). The rationale for focusing on bicycles, electric cars and buses within the transport sector is that these means of transport and mobility are regarded as eco-friendly transport (Booysen, 2022; Ghosh, 2020; Holmberg & Erdemir, 2019; Machedon-Pisu & Borza, 2019). The critical sections of the transport infrastructure (including roads, rail, and bridges) are threatened by climate change, and improved modelling of the potential economic and social impacts calls for a research agenda. Upgrading transportation technology, which does not produce emissions, biofuels, alternative fuels, and public transport, is a short-term mechanism to create jobs and reduce poverty. The use of bicycles promotes healthy living and social cohesion through the ride for fun activity, usually hosted by significant metropolitans such as the City of Tshwane, the City of Johannesburg, and the City of Cape Town.

2.6.3.1.2. Sustainable energy infrastructure

Energy infrastructure comprises oil production technology, nuclear power stations, gas, renewable, electricity, waste-to-energy facilities, and hydro-powered stations (DOE, n.d). Crime and corruption need to be considered when it comes to the budget allocation of green infrastructure. Detailed literature on sustainable energy is explained in earlier sections.

2.6.3.1.3. Sustainable water in infrastructure

The need to install water tanks, boreholes, and alternative irrigation systems to cope with the challenges is explained in subsection 2.2.2.3. These mechanism serves as the infrastructure to ensure sustainable water. There is additional infrastructure, such as the wastewater treatment plants (DEA, n.d). The call for digital infrastructure of the water management system emerges given the current operating environment

disrupted by technology. Examples of digital water management systems include smart irrigation systems, the Internet of Things in water management, fabricated capacitive turbidity, and soil moisture sensors. Fabricated sensors use energy transmission, while the turbidity and the capacitive sensors are the measurement tools to detect the water level. The soil moisture acts as an infrastructure to measure the level of humidity after a separation of the soil from the water (Yasin et al., 2021). Some authors added and suggested hydraulic redistribution, groundwater storage, and sustainable aquifer management resources to sustain water fully (Marshally & Fernald, 2020). However, in South Africa, the most common way and infrastructure that has picked up momentum is wastewater treatment works (DEA, n.d).

2.6.3.1.4. Sustainable agriculture infrastructure

The agricultural infrastructure includes rooftop farms (Cilliers, 2019; Venter et al., 2020). Land is the most prominent infrastructure in South Africa (Diale, 2017; Nhemachena et al., 2020). The need for a rooftop farm, commonly known as hydroponics, which consists of an integrated system of agriculture, energy, and water management in one setting, is needed to bypass the challenges of wastage and to promote access to land (Fanadzo & Ncube, 2018; UNEP, 2018). In first-world countries, investment in infrastructure, such as the digital agriculture system to promote nutritious food security through satellite devices, robots, and technological monitoring devices, is still in its infancy (Bernhardt et al., 2020). In some neighbouring countries, there is a commitment to invest in innovative and intelligent agricultural tools. However, there are some challenges regarding the availability of financial resources, inequalities, and the skills needed to implement the agricultural technology tool (Makate et al., 2020).

2.6.3.1.5. Waste management infrastructure

The initiatives discussed in sub-section 2.2.2. require the infrastructure to manage and implement the green economy successfully. Some waste management infrastructure bins for recyclable materials such as glasses, paper or plastics, and non-recycled labelled bins exist. More fleets of trucks and training for personnel sorting waste are

still needed, especially in Africa (Godfrey et al., 2021). When going through the waste material, personal protective equipment (PPE) is required (Kirkman & Vouvoulins, 2021). Biowaste is another type of infrastructure needed in developing countries, and it is defined as a garden or park where waste is sorted to feed into energy and agriculture through composting, compressing and managing the food waste (Zabaleta & Rodic, 2015). The concept of e-waste is a growing trend in Africa that is achieved by sorting discarded electronic waste using the appropriate technology. Investing in electrical and electronics can support the e-waste mechanism for effective and efficient sorting. The e-waste infrastructure is yet to be fully adopted in Africa due to economic and political influences or the lack of support from political leaders and decision-makers (Maphosa & Maphosa, 2020).

2.6.3.2. Green customers or clientele

The clientele or customers serve as the cornerstone and hub of every business incubator (Diale et al., 2021a). Some crucial factors determining a business's success or failure are the customers and customer attitudes, which are often overlooked. That said, some research has been done on customer attitudes within green enterprises (Solaja, 2017). It was discovered that customer attitudes need to be viewed from a perception point of view (Diale et al., 2019). The assessment of perceptions and the potential green customers in support of a green product or service has been proven to aid previous research in the adoption and support of friendly products as well as the willingness to pay more for a green product (Aslani & Mohaghar, 2013; González et al., 2017; Helms, 2016; Liu et al., 2020; Skordoulis et al., 2017; Solaja, 2017). Conversely, efforts have been made concerning the customers' attitude towards green entrepreneurship (Hall et al., 2010; Lennox & York, 2010).

Mapping, tracing, and maintaining clientele in existing literature has often received less attention. However, from a green entrepreneurship perspective, a monitoring tool concerning customers has explicitly focused on renewable energy. The monitoring tools use specialised assistive programmes, stakeholder liaison mechanisms, and checklists (Bryant et al., 2018; Gsodam et al., 2015; Loock, 2012; Richter, 2012; Richter, 2013; Walsh, 2010).

Customers should be willing to buy or support green products and services (Xu & Liu, 2019). The uncertainty of the economy may influence the selling and buying of a product or service. More customers will buy or procure services if the economy is doing well. The economy can be viewed from a demand and supply of green products and services. Conducting market research on whether the price of goods and services is fair and reasonable is recommended. The willingness to support green products and examine the timing of introducing the product into the market reinforces the pillar of market research, which serves as a viable and monitoring tool (Diale et al., 2019; Paco et al., 2019; Kardos et al.,2019; Li et al., 2018; Lotfi et al., 2018; Masocha, 2021; Mukonza, 2020).

If the price is within the customers' affordability bracket, this may increase the willingness to buy a green product or service (Arli et al., 2018; Diale et al., 2019). The customers and their attitudes play an essential role in the success of a business (Diale et al., 2021a). From a green entrepreneurship perspective, efforts have been made to the customer attitude (Paco et al., 2019). Previous studies assert that consumer attitudes and perceptions about a particular green product or service should be considered. Their preference for environmentally friendly products and willingness to pay more for green products should also be explored (Diale et al., 2019; Gilal et al., 2020; White et al., 2019).

Creating market funding or any support for green entrepreneurship appears taboo and is an unheard-of practice (Diale et al., 2021a). Thus, it needs to start with creating awareness and unpacking human behaviour through consumer psychology principles as a short-term solution. The process needs to be simplified for communities to understand the green economy phenomenon, and it must be gradually improved by investigating whether there is a capability to optimise resources and to check if there are opportunities for business gain, profit generation and saving the planet for future generations (Diale et al., 2021a). This argument may contribute to transformative consumer research (Jayaratne et al., 2019).

Market segmentation and differentiation can be achieved by diversifying environmental practices within green entrepreneurship and strengthening the green

consumer variables (Tatoglu et al., 2020). The consumer or the market is the cornerstone of the success of green entrepreneurship. Environmental practices need to be unpacked from the business value chain and the tailored services and products to influence transformation or the change of norms through green products and services. Strengthening the relationship with the stakeholders is fundamental in ensuring that the organisations practice a customer-centric approach and provide the company with a competitive advantage (Tatoglu et al., 2020).

2.6.3.3. Green education and skills development

Green education, curriculum and capacity building is another form of non-financial support to ensure the viability of green entrepreneurship. The need for curriculum review and the inclusion of green entrepreneurship in the South African essential and higher education sectors must be considered to ensure the sustainability of green entrepreneurship (Diale et al., 2021a). Foster et al. (2010) echo the idea of including green entrepreneurship in the schools' curriculum. The green skills documentation and the lessons learnt could be drawn from some parts of Europe in regulating the economic factor of green skills for the country's economy (OECD, 2014). The Sustainable Employment and Economic Development (SEED) programme is another support mechanism to ensure sustainability entrepreneurship (Creech et al., 2014; Diale et al., 2021b; Silajdžić et al., 2015).

2.7 BARRIERS TO GREEN ENTREPRENEURSHIP

Although the green economy and green entrepreneurship are perceived as favourable and desirable outcomes, there are some challenges within the key drivers of green entrepreneurship. The barriers can be clustered into internal and external barriers. The internal barriers are the lack of resources, adequate knowledge, the poor implementation of policies and strategies, negative attitudes, and an organisational culture that is far from the adoption of environmental management (Brustbauer, 2016; Diale et al., 2021a; Jayaratne et al., 2019; Yakovleva, 2018). The identified external barriers are difficulties in obtaining certification for environmental practices and systems, economic uncertainty, the lack of legal and institutional frameworks, the lack of specialised support and networks among small businesses, the lack of skills, the

minimal number of green jobs, and the non-compliance with policies (Fonseca & Chiappetta-Jabbour, 2012; Jayaratne et al., 2019).

Mukonza (2020) investigated green entrepreneurship in South Africa using a qualitative methodology and interviewed 103 green entrepreneurs. It was found that the obstacles to green entrepreneurship are education, competencies, and support from private and public entities. The need for more investors poses challenges and threats to the green entrepreneurship system. Investors in environmental entrepreneurship are cautious investors, where scepticism and reluctance arise when investing in the green entrepreneurial markets (Diale et al., 2021a; Hörisch, 2015).

2.8 SUSTAINABLE CONSUMPTION

Sustainable consumption focuses on the initiatives that focus on reducing, recycling, and reusing materials to minimise the carbon footprint and to encourage the adoption of pro-environmental behaviours in promoting public awareness (Rodriguez-Anton et al., 2019; Wang et al., 2019; Yıldırım, 2018). Furthermore, sustainable consumption involves the green economy thematic areas explained in Section 2.2.2. A further contribution of the current study is through the sustainable development goals, environmental psychology, green psychology of entrepreneurship and the key drivers of green entrepreneurship in formulating the ecosystem.

A reviewing of the literature shows that green entrepreneurship is a complex system requiring multiple lenses and approaches. The researcher contributes to the current study by integrating the system dynamics approach to understand and formulate solutions by looking at multiple constituencies within the generic and green entrepreneurship, the green economy, and the industrial and organisational psychology fields. The system dynamics approach is discussed in the following section.

2.9 SYSTEM DYNAMICS

System dynamics is premised on systems thinking, and it is a concept that is studied in industrial and organisational psychology. Systems thinking considers an individual's

interaction underpinned by inputs from environment, action, and output (Cummings & Worley, 2015; Cummings & Cummings, 2020). The system dynamics approach takes the process further by using software and technology to add to the principles of systems thinking. The system dynamics approach allows deriving and proposing a solution to complex challenges by simultaneously looking at different avenues. A detailed system dynamics research methodology and design is discussed in Chapter 3. The current study is based on a study conducted by Diale et al., (2019). The study formulated a causal loop model, modelling the theoretical global macro variables within green entrepreneurship by utilising a systematic qualitative review. The current research project uses empirics to test and analyse the applicable variables within the South African context. Other studies using system dynamics focused on modelling environmental entrepreneurship, specifically on the focus of the behavioural and the social factors (Diale et al., 2021a). This study by Diale et al., (2021a) is another research output from the current study.

Other studies on the system dynamics methodology have focused on energy development (Laimon et al., 2019), renewable energy, efficiency and performance in response to sustainable development (Laimon et al., 2022). Recent research has focused on agriculture (Wang et al., 2022). Other studies, using the causal loop modelling, have focused on fields other than green entrepreneurship and the technical level of the wetlands systems (Colleta et al., 2021), creative problem solving (Delgado-Maciel,2018), and the use of Twitter and the biogas technology (Comrie et al., 2019; Roubík et al., 2020).

Musango et al., (2014) focused on system dynamics within the green economy but paid less attention on the key drivers for green entrepreneurship. Another study on system dynamics on energy and environmental education, particularly in the United Kingdom (UK), focused on accessibility and usage (Strapasson et al., 2022). Castaño-Barreto et al., (2020) explored fishing, which may support food security, using system dynamics. They used the causal loop, the stocks and the flow but focused on one element at a time, such as the population size and the payment of services. A study conducted in Ghana focused on the system dynamics within the agricultural and water sector; its findings had implications for policy formulation. This study used the pattern

and the structural behaviour or testing (Kotir et al., 2016). Previous research has focused on closed causal loop modelling, environmental challenges, sustainable market transformation and the assessment of sustainable development goals (Colleta et al., 2021; Downing, 2022; Nijhof et al., 2021).

These studies were conducted in international markets, focusing on one element at a time, such as energy agriculture or water and with no focus on the multiple elements or factors, nor green entrepreneurship using a causal loop and mathematical equations. There was also no integrated modelling, consisting of the causal loop, stocks, flows, dynamic variables and parameters. The current study is a breakthrough in incorporating the system dynamics model into green entrepreneurship using the integrated system. Based on the principles of system dynamics, pillars such as science, the economy, environment, and efficiency are used as a yardstick in the current study (Diale et al., 2022). The system dynamics model focuses on innovation by capitalising on technological advances to ensure complexity and longevity: flexibility, adaptability, and problem-solving support using system dynamics technology (Diale et al., 2022).

This section addressed to the objective, '*To conceptualise green economy thematic areas using system dynamics modelling'*.

System thinking and system dynamics often need differentiation as they are somewhat similar. However, Table 2.4 illustrates the differences between the two.

Table 2.3

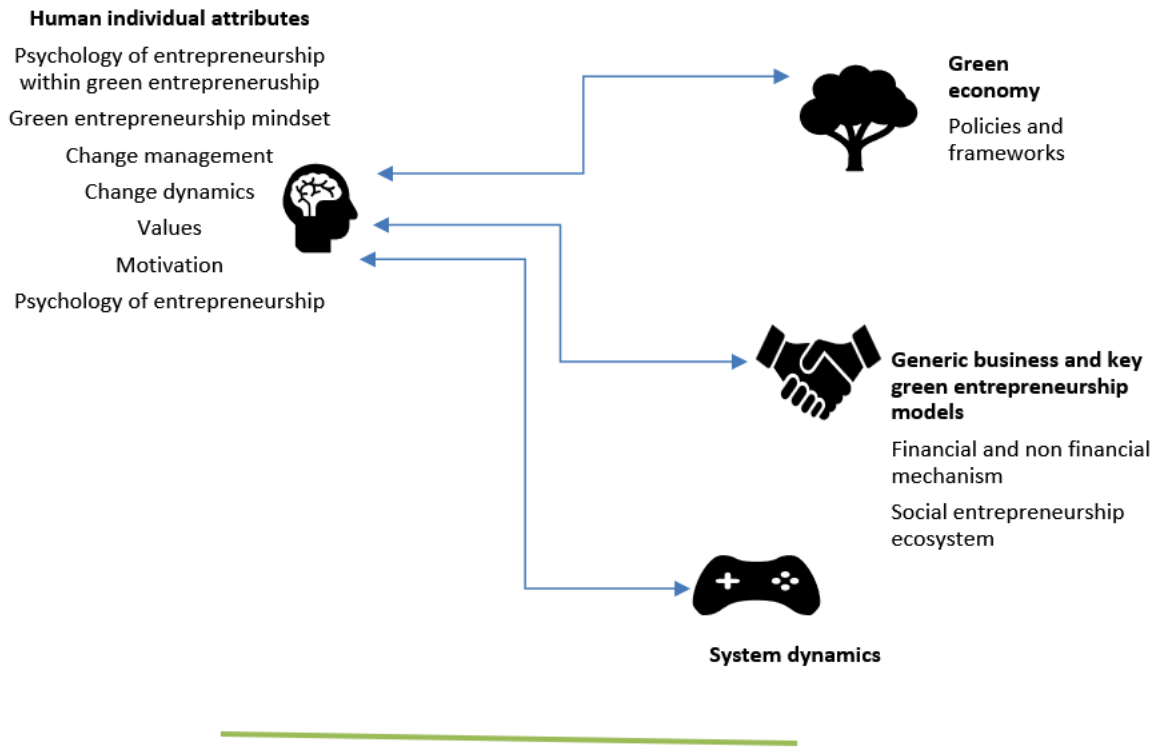
Comparisons between system thinking and system dynamics.

System thinking	System dynamics
Focuses on process (qualitative in nature).	Focuses on a whole product (use of computer software).
Consideration of issues, with less need to formulate solutions.	Solves complex issues ranging from technical to high level strategic problems.
Appraisal of diverse factors and influences.	Develops tangible system solutions.
Presence of patterns, relationships, and shared understanding.	The emphasis is to meet the requirements, to measure the outcomes, and to solve the problems.

Own compilation

2.10 CHAPTER SUMMARY

To summarise the earlier discussions presented in this chapter, the following green entrepreneurship ecosystem incubator is formulated as depicted in Figure 2.7. The double arrows show that the relationship is reciprocal, with the analogy that a human perspective is crucial and needs to be considered when implementing policies and utilising the physical and engineering processes. Figure 2.7 demonstrates how best to optimise or adopt pro-environmental behaviour **(**sustainable behaviour**)** and ensure that the green environment is optimised or altered to suit an individual.



Own compilation

Figure 2.7: Green entrepreneurship ecosystem incubator

CHAPTER 3: RESEARCH METHODOLOGY AND DESIGN

This chapter focuses on the research methodology and design, the research paradigm and philosophy, the data collection procedures, the units of analysis, and the ethical considerations.

3.1. SYSTEM DYNAMICS RESEARCH METHODOLOGY AND DESIGN

The system dynamics approach is illustrated in modelling the key drivers and factors affecting green entrepreneurship in South Africa. System dynamics combines theory, method, philosophy, and computerised modelling in analysing the system's behaviour (Teplov et al., 2016). Furthermore, system dynamics focuses on a feedback loop and nonlinear relationships (Forrester, 2009). System dynamics is viewed as the process or the feedback relationship between the different parts to understand complexity and behaviour throughout the lifespan or the process of the system (Abdelkafi & Täuscher, 2016; Diale et al., 2021b). Systems can be seen as the interrelationship of tangible or intangible parts forming whole systems (Sterman, 2018). The tangible components may consist of parts of a machine or an object, while the intangible ones include relationships, cohesion, feelings, beliefs, and values (Abdelkafi & Täuscher, 2016). System dynamics conceptualises the causal loop relationships, or the stock and flow, to identify the variables that affect the ecosystem by feeding into the whole system (Teplov et al., 2016). The system dynamics approach provides a platform to formulate and simulate mental models using software.

Modelling in system dynamics can take place through a qualitative or quantitative perspective. In this study, the research focused on quantifying the contents of the framework. Therefore, quantitative modelling was used in the current study. Existing case studies, frameworks and reports are available on the internet. Public organisations are quantified through ratios, the rate, percentages, and the growth rate to feed on the theoretically built abstract system dynamics model (see Appendix B).

Furthermore, the Euler equations were used. The Euler method is based on the mathematical equation theory, mostly the differentiation theory (Qian et al., 2020; Sterman, 2018). The Euler mathematical principles were developed to give researchers or scientists leeway to focus on the different parts of making a whole. The focus on the different parts of the system is deliberate to ensure that the solution and the models are looked at with deeper understanding, as guided by the imagination. More so, the focus is on the lower part of the iceberg analogy. The Euler equation history is premised within quantum physics, chemistry, and mathematics – later adopted by French representatives and system dynamics modellers.

The researcher's knowledge, interests and passion for system dynamics were further reinforced by the training that was offered by Eskom in August 2019, as well as the training offered by AnyLogic South African Liaison in August 2020. Upon reading the material on the Euler equation and prior learning and training on the system dynamics, the researcher deduced the following: What are the elements making a whole system? What will happen to the next subsystem if the researcher increases or decreases a subsystem variable? Furthermore, the addition sign is used for the increase, while a multiple sign is used for compounds and relationships with more than two subsystem variables. A subtraction sign is suggested for a decrease, and the division sign shows the decrease between more than two variables. For example, when translating the statement to the system dynamics model, a positive or additional sign is used if the two dynamic variables have the same direction or equally weighed. The multiplication sign is used to compound the relationship of the two dynamic variables, with the same direction and at the same time, that are related to another parameter. The reverse is true for the use of subtraction and for division to elicit the relationship between the variable's principles (Qian et al., 2020; Schiehlen, 2007; Sterman, 2018).

The Euler principles are often used by calculating the input (what feeds into the system) and the output equations in validating a researcher's or scientist's intuition or imagination (Kübler & Schiehlen, 2000; Ta et al., 2022). The Euler principles consist of the modular process in assisting with analysing the physical model descriptors or

the scenarios governed by the controls, followed by the behaviour of a model depicted by the graph equations (see example Figures 3.5, 3.6 & 3.7). Zimmermann et al. (2016; 2022) echo the latter statement and further assert that the system dynamics uses basic mathematical equations. The system dynamics elements, the stocks, the flows, the dynamic variables, the boundaries, the connectors, the polarities, the causal loop, and the delays are discussed in sub-sections 3.3.1-3.3.7. The application of the latter to the model formulation is illustrated in Chapter 4.

This study aimed to generate new knowledge by applying the system dynamics within green entrepreneurship in South Africa. The current study looked at system dynamics from high-level strategic perspectives of the key drivers for green entrepreneurship from a policy development level. There are different types of systems, namely the physical or the natural systems and the social system. The system underpinning the current study is the integration of the social, the physical and the natural system due to the multi-disciplinary nature of the study. System dynamics focuses on the 'how' and the "why" but primarily on the "why" more than the "how" part.

The Vensim Modelling Software is used to simulate the key drivers of green entrepreneurship to assist in transitioning to a green economy, given that the green economy is an iterative complex problem requiring multiple facets of developing solutions. System dynamics can be used to analyse policies and frameworks and formulate the solutions (Roth, 2019; Rousseau et al., 2016; Sterman et al., 2012; Sterman, 2018). The modelling in the current study was through causal loops, stocks and flows. Detailed modelling of the current study is discussed in chapter 4.

3.1.1. Ethical consideration

The project received ethical clearance from Unisa. The researcher conceptualised and formulated the project on green entrepreneurship and presented it to the College of Science Engineering and Technology (CSET) in pursuit of a supervisor. Thereafter, the researcher decided to apply for ethical clearance – ethical clearance number

2019/CSET/SOE/MGK/001 – to publish a peer-reviewed paper. This ethics clearance is valid for five years (See Appendix A). The current study's literature and theoretical constructs were published as conference proceedings, which is an accredited conference as per the DHET guidelines. The review process and publishing enabled the researcher to assess the feasibility of the study. As a result, three more outputs ensued as the study continued.

As a subsequent step, the researcher reviewed the policies and the green economy frameworks to further support the current study. These frameworks are readily available online, and the exact source is provided (see Appendix B). Further ethical approval was not required as the frameworks and policies were part of the data collection available in the public domain. The researcher contacted the ethics administrator, who confirmed that ethical clearance is not require if the data source is available in the public domain or on the internet. These data collection mechanisms are suitable for system dynamics as the methodology uses reports, frameworks, and simulations of mental scenarios (Forrester, 2009).

3.2. SYSTEM DYNAMICS RESEARCH PARADIGM AND PHILOSOPHY

The system dynamics approach provides a unique way to view and mentally frame people's observations. This perspective originated from the general systems theory, a rigorous scientific discipline developed in 1954 (Roth, 2019; Rousseau, 2015; Rousseau et al., 2016). The current system dynamics study took an interdisciplinary approach, which extended to engineering, mathematics, computer science and economics. The central premise of the systems theory is that ordinary laws governing systems provide a conceptual framework for understanding the relationships within a given system and handling any problems or changes in that system (Roth, 2019). This highlights the value of viewing a system (individual, group, or organisation) as a whole and gaining a perspective on how the parts play their role. The systems perspective was instrumental in the current research because of its potential for understanding and exploring the interactions among the variables and the parameters (Sterman, 2018). In unpacking the philosophy and the paradigm of system dynamics, the

researcher deemed it relevant to unpack the history of system dynamics, informing the following section.

3.2.1. Historical trends of ecology and system dynamics

It is very important to examine and analyse the history of environmentalism underpinned by the Club of Rome ideology. The Club of Rome evolution theory, founded in the 1970s, teaches the integration of social, technological, and economic factors into the main area of protecting the environment. The Club of Rome emerged due to the ecological challenges often clustered under Western problems (Schmelzer, 2017). The Club of Rome was founded to help government and society cope with environmental challenges and promote environmentalism. The evolution of the Club of Rome gave emergence to the consciousness and the awareness of promoting sustainable or ecologically desirable behaviour. One can deduce that the green constructs of ecologisation and biocentrism, as discussed in Chapter 2 of the current study, are premised on the Club of Rome's historical trend. The trend was witnessed in hosting a chain of conferences to debate ecological factors and how best to remedy the challenges (Schmelzer, 2017).

Thereafter, the Club of Rome partnered with MIT, specifically Jay W. Forrester, a computer engineer. The system dynamics perspective evolved and was housed under the Sloan management at MIT (Forrester, 2009; Lane, 2007; Schmelzer, 2017). It emerged to support initiatives in minimising environmental degradation, bringing possible ways to remedy the misuse of technology and resources. The emergence of system dynamics does not focus on business or staffing issues, but instead regulates and monitors population growth in urban areas. Then it was later found that the tool could be used to learn more about ecological challenges. The history of the Club of Rome reflects attempts to find solutions to ecological problems by looking at the ecological challenges from an exponential growth perspective (Schmelzer, 2017). Exponential growth is one of the key characteristics of system dynamics, which is illustrated in Figure 3.6

The system dynamics approach led to initiatives titled the Bellagio Declaration on Planning, where scientists across the globe held brainstorming sessions and added that ecological problems need not be looked at in isolation but as a whole. Furthermore, solving ecological problems needs to integrate scientific, technological, and political perspectives (Schmelzer, 2017). The current study further contributes to the discourse by integrating behavioural and social perspectives, as explained in Chapter 2.

3.3. ABOUT SYSTEM DYNAMICS

Coined by J. W. Forrester, system dynamics is a simulation model using methodological and computer-based simulation to design and simulate the behaviour of a system. The latter is conducted to understand social, economic, environmental, and organisational structures (Forrester, 2009; Sterman, 2001;2018). System dynamics is underpinned by theories of organisational studies, history and engineering contributing to a theory and empirical studies of solving complex challenges. A system theory takes foundation from the underpinnings of Aristotle that a whole is preferred to its parts, thereby focusing on a system's connectedness and interrelationship.

Barry Richmond later reinforced critical thinking and Peter Senge's five disciplines of *system thinking, achieving personal mastery, shifting mental models, building shared vision, and team learning* (Forrester, 2018). The system dynamics model looks at different solutions simultaneously as a complex system. System dynamics is heavily premised on simulation and the gamification of mental scenarios and theories (Forrester, 2018). The system dynamics model encompasses stocks, levels, flows, rate delays, connectors, feedback causal loop, boundaries or parameters, and polarities (Forrester, 2009; Nabavi et al., 2017). These elements of a system dynamics are discussed next:

3.3.1. Stocks and levels

Stocks function as an accumulation over time, and they can be identified by a box in a system dynamic modelling software. For instance, the bank is a stock when taking money to the bank. The levels are denoted with a box similar to a stock (Forrester, 2009;2018; Meadows, 1977; Sterman, 2001).

3.3.2. Flow and rate

A flow acts as an accelerator, resource, or game-changer, facilitating a change in a given scenario (Forrester, 2009;2018; Sterman, 2001). The inflow and the outflow further characterise the flows. Sterman (2001) makes an example of the inflow that is characterised by water running to a sink at a certain rate, while the outflow can be characterised as water going through a drain. The rate is denoted by a valve or a regulator with the shape of an hourglass, thereby implying the need to act in changing behaviour within that specific flow (Meadows, 1977). An example of a flow can be the growth or loss of money influenced by how the economy performs. Figure 3.1 is an example of the stock and the flow into and out of the system.

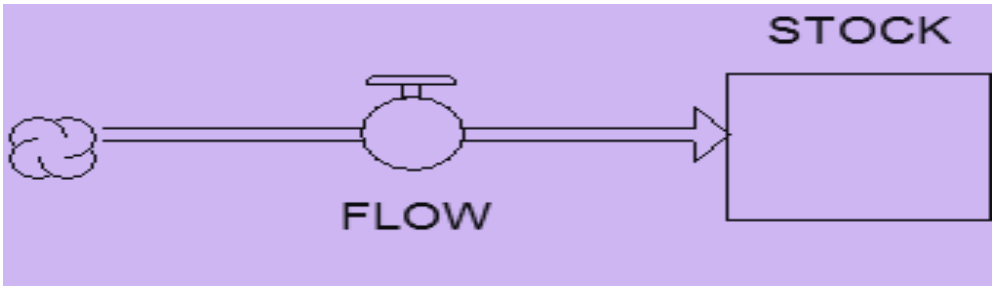


Figure 3.1: Stocks and flows example (Forrester, 2009, 2018; Sterman, 2018)

3.3.3. Boundaries

Boundaries denote how far a system can go, as influenced by the capability, the environment or the criteria set by the researcher. Setting boundaries comes with challenges and is usually underpinned by personal judgment (Nabavi et al., 2017).

However, at the same time, this is an advantage as the researcher experiences some flexibility. The parameters illustrate the boundaries in the current study.

The boundary or the parameter is depicted by a cloud as per the diagram (see Figures 3.1 and 3.2); some software uses a round shape with an arrow inside.

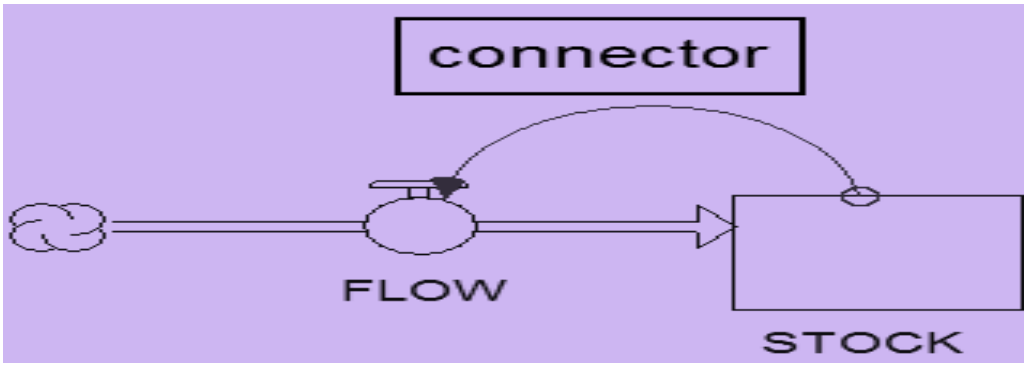


Figure 3.2: Stocks and flows with a connector and boundary example (Forrester, 2009, 2018; Sterman, 2018)

3.3.4. Connectors

The connectors are arrows indicating a direction or movement from one variable to the other. Other system dynamics models make use of word links, which can be seen in Figure 3.2.

3.3.5. Polarities, feedback causal loops and dynamic variables

Polarities are signs such as “–” or “+”, opposite (o), and same (s), and they are used in a causal loop to define the relationship between variables. A causal loop is an iterative cycle used to determine why policy adoption is lacking (Sterman, 2001). The “+” means that if Variable A increases, then Variable B increases. The “–” sign denotes that if one variable decreases, the opposite is true for the second variable. A causal loop can either reinforce or balance. The feedback loop reinforces if a system is favourable with a positive effect denoted by “R” inside the causal loop or it balances if

it has a negative relationship in its loop denoted by “B” (Forrester, 2009, 2018; Sterman, 2018; Teplov et al., 2016). The feedback causal loops are based on the dynamic variables. The dynamic variables set a direction for the study. A variable denotes the dynamic variable in the Vensim Modelling Software without a box around it. The causal loop of the study was simulated using Vensim. The causal loop of the study is shown in Chapter 4.

3.3.6 Delays

The delays in the system are influenced by time or information. In most instances, the delays are influenced by time, causing a feedback loop to not reach a desired goal on time and effectiveness (Sterman, 2001). The delays are often denoted by two strokes or lines within a causal loop. An important aspect to consider with the system dynamics approach is to avoid many variables in one causal loop and rather have subsystems if the research has more variables to simulate (Teplov et al.,2016). The delays can be seen in Figure 3.3.

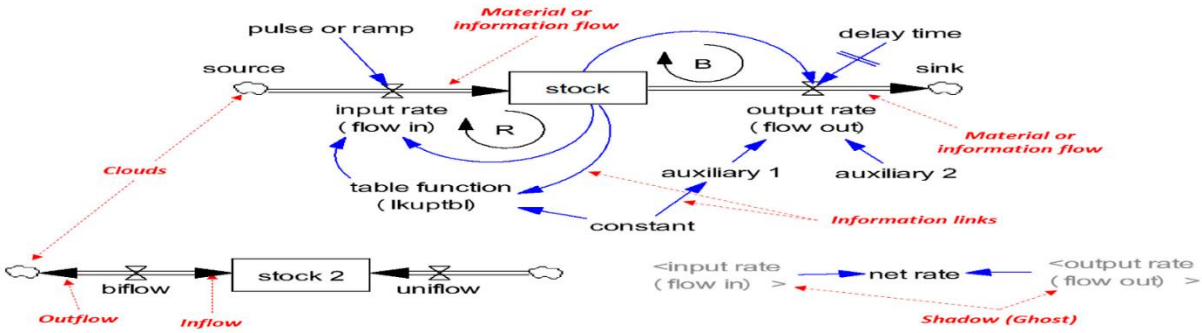


Figure 3.3: Integrated stock, flows, boundaries, reinforcing, balancing and the delay example (Sterman, 2001; Sterman, 2018)

3.4 BASIS OF COMPUTER SIMULATION SOFTWARE

The simulation is based on the game theory pioneered by John Von Neumann in 1928. Game theory is used interchangeably with the system dynamics computer simulation as it offers a platform for users to make decisions in the most interactive and fun manner (Macrae, 2019).

Famous computer simulations underpinning system dynamics are the AnyLogic Modelling Software, the Vensim Stella Architect and the En Roads computer simulations. Table 3.1 shows a summary of the computer simulation software that is used to date. The uptake is still slow as system dynamics is still in its infancy, especially in South Africa. The model and the methodology need to be adequately understood, and only a few people understand. Two sources emerged from a keyword Google Scholar search of sources using system dynamics in South Africa from 2017 to 2022. In addition, a critical search of system dynamics and green entrepreneurship did not yield a single source within the South African context. The only available source was a review paper written by the researcher on green entrepreneurship as part of the current study. The article on empirics and the methodology forms part of the subsequent publication.

Table 3.1: Comparison of system dynamics modelling software capabilities.

AnyLogic Modelling Software	**Vensim Modelling Software**	**Stella Architect Modelling Software**	**En Roads Modelling Software**
System dynamics, discrete, bass diffusion, agent-based capabilities	System dynamics capability only	System dynamics capability only	System dynamics capability only
Stocks, flows, dynamic variables, parameters and levels	Stocks, flows, dynamic variables, parameters and levels	Stocks, flows, dynamic variables, parameters and levels	Stocks, flows, dynamic variables, parameters and without levels
Uses round dots to show dynamic variables	Has causal loop capabilities	Has causal loop capabilities	Does not have causal loop capabilities
Open access for students and learning purposes only	Open access for students, academic use and learning purposes	Does not have open access and costly	Does not have open access and costly
Easy to use	Easy to use	Somewhat easy but uses words such as source and sink	Time consuming. Recommendation of 18 months to learn how to use the tool (Kapmeier et al., 2021)
Few uses of software due to the need to purchase the license	Widely used globally	Used by Eskom in South Africa	Never been used in South Africa

(Own compilation)

The selection of Vensim was informed by the researcher's prior experience gained in open access for academic use and its convenience.

3.5. STEPS IN SYSTEM DYNAMICS MODELLING

The system dynamics model consists of identifying a problem, formulating a dynamic hypothesis, creating scenarios and mental models, and framing the model. The elements are explained below by applying them to the current research. The steps are adapted from Gokhan et al (2019).

3.5.1. Step 1 of the system dynamic approach is identifying a problem.

The main problem relevant to the current study was transitioning into a green economy, which is a complex challenge with pressures. The transition into a green economy using a green entrepreneurship lens serves as the missing link. Furthermore, solutions to the integration of green entrepreneurship need not focus on one scenario but on the multiple and dynamic ways of recommending solutions, which are underpinned by systems thinking and dynamics theories. Therefore, the capabilities of system dynamics were deemed a relevant tool to utilise in the current study. Green entrepreneurship incorporating system dynamics and seeking multiple ways of finding a solution has yet to be noticed. Research or publications need to be more focused on green entrepreneurship and its interrelatedness or linkages with the lens of system dynamics in the South African context. Entrepreneurial ecosystems can serve as a business incubator consisting of environmental, social, and economic structures in the current study. It is envisaged that the community will benefit from the business incubator and the ecosystem model. The ecosystem acts as an accelerator to alleviate poverty, contribute to the country's overall economy, and save the environment.

The study further opens avenues in utilising the system dynamics model to expand the scope of consulting within the industrial and organisational psychology through green entrepreneurship in South Africa**.** This study contributes by creating awareness of the pro-environmental behaviour [sustainable behaviour] as part of environmental

psychology and the key drivers of green entrepreneurship using the system dynamics approach.

3.5.2. Step 2 of the system dynamic approach is identifying the dynamic hypotheses.

The dynamic hypotheses of the study are:

- The key drivers of green entrepreneurship consist of policies, finance mechanisms, green infrastructure, green companies, entrepreneurial mindsets, green customers, and the GDP.
- The key drivers of green entrepreneurship can be simulated through dynamic variables, stocks and the flows in a system dynamic model.
- The key drivers of green entrepreneurship positively influence each other in an iterative simulation through a causal loop in a system dynamic model.
- Sustainable behaviour and green entrepreneurship serve as tools to assist in the full transition to a green economy in South Africa.

After formulating a dynamic hypothesis, it is recommended to create scenarios, mental models, and model formulations. The model is depicted in Chapter 4.

3.5.3. Data collection procedure

Data collection was through a review of policies, frameworks, and industry reports that were readily available online. System dynamics allows for the psychological factors referred to in Chapter 2 to be treated as discrete and exogenous variables that may not be quantifiable but play a significant role in the system. An exogenous variable is one that can impact the system positively or negatively. In this study, the psychological and social variables discussed in Chapter 2 positively influenced the system. The adoption of sustainable behaviour motivation and the education or skills serve as contributions, and they were beneficial to the study. The data was sourced from the

internet platforms such as the United Nations, Department of Environmental Affairs, Department of Energy (DOE), Department of Water and Sanitation, Department of Transport, SEDA, and Statistics South Africa (Stats SA) on recycling activities and land reserved for commercial agriculture; *Tread Media* Magazine, *Business Live*, *Mail and Guardian* (green jobs), and *Business Tech*; South African government Eco Schools Programme, the Global Entrepreneurship Monitor (GEM), eco schools, and technical and vocational education and training (TVET) institutions and the promotion of innovation for climate and environment-related employment; SA facts, AgriOrbit, Plastics SA, New Horizon, Yokogawa South Africa (Pty) Ltd, Anaergia Technology Waste, and water treatment companies and suppliers; the Skills for Green Jobs (S4GJ), Bikemap, the DBSA Green Fund, the Greencape, the Open Book UCT, Mastercard (green market data), Economic Status, *Statista*, and the World Bank.

3.5.3.1. Inclusion and exclusion criteria

The researcher reviewed the archives of the National Development Agenda 2030 – the data from 2020-2030. The National Development Plan Agenda 2030 is a parameter/delineation in the current study. The researcher focused on leading metropolitans concerning green economy initiatives in South Africa. The country has set the prioritised green economy thematic areas. From the eight thematic areas, only five are prioritised: sustainable agriculture, water, energy, transport, and waste management. This study focuses on the entrepreneurial key drivers within the above-mentioned green economy thematic areas.

3.5.4. System dynamics units of analysis

The units of analysis explain how the researcher analysed the data (Creswell & Creswell, 2018). The system dynamics equations use mathematical models to develop the causal models, stocks, and flows to analyse the data. In this instance, there is data from the reports and the framework, as discussed earlier (see Section 3.5.3). The

current study utilised Vensim for the causal loop model. It also used the integrated model consisting of the dynamic variables, the stocks, and the flows as the parameters. The researcher chose the Vensim modelling software because it allows for various analyses such as projections, ratios, percentages, stocks, flows, time series and behavioural graphs. Figure 3.4 illustrate the interphase of the Vensim modelling software.

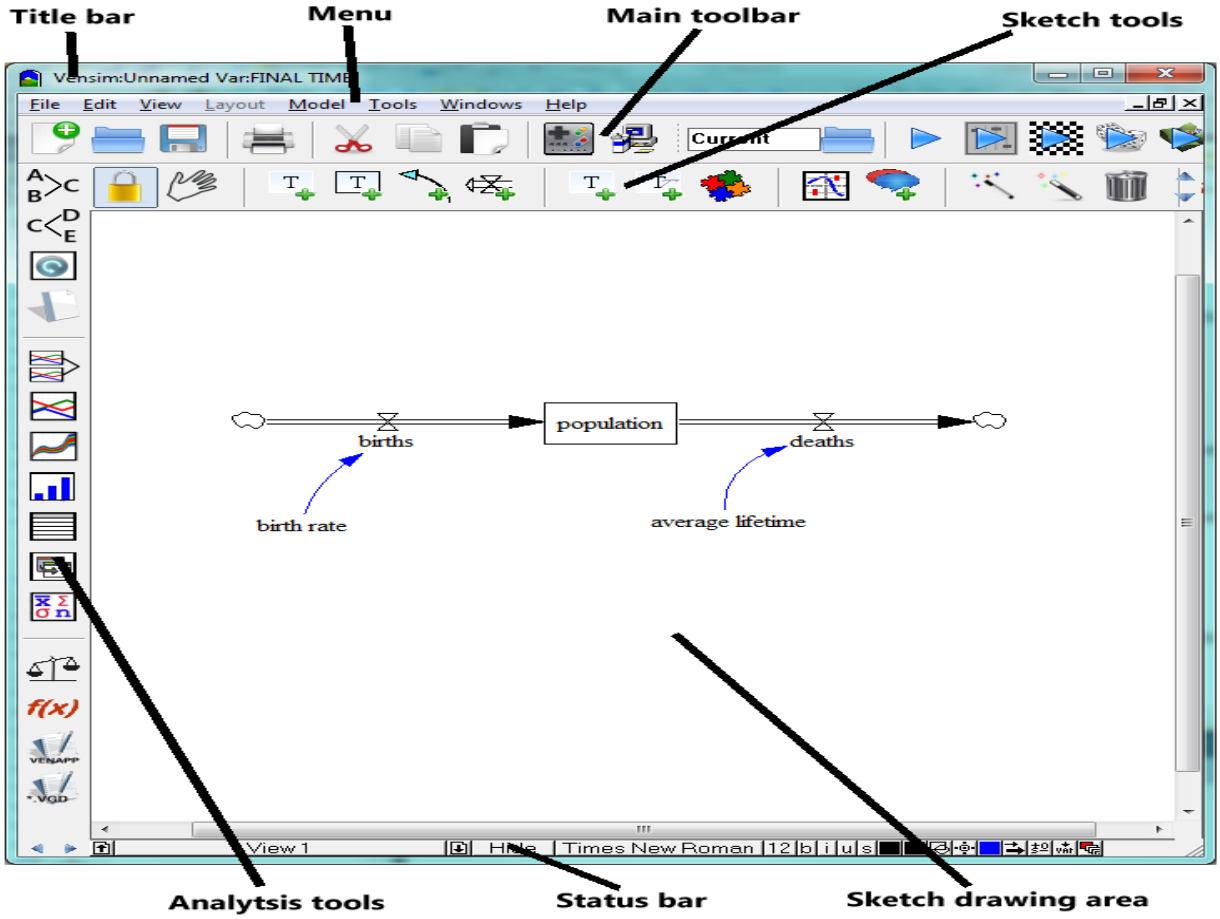


Figure 3.4: Preface of Vensim: System dynamics icons

As previously mentioned, system dynamics is a complex tool requiring multifaceted ways to find a solution. Once the elements and the sub-elements are explained and formulated into the model, the analysis takes place in assessing how a system behaves or changes over time, divided into the static or the dynamic model using

graphs or time series (Forrester, 2001; 2009; 2018; Meadows, 1977; Sterman, 2001; 2018).

An analysis can be in the form of one or more ways that are depicted in understanding the system's behaviour (see Figures 3.5, 3.6 and 3.7).

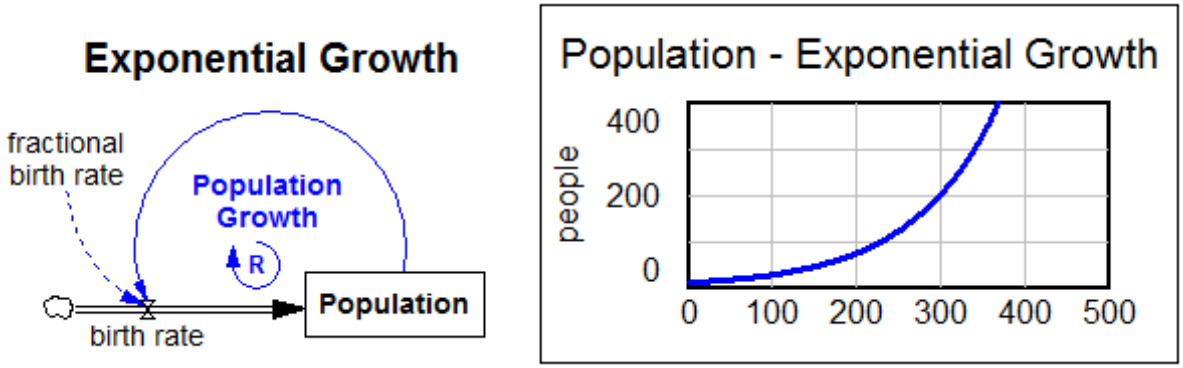


Figure 3.5: Linear growth graph example (Sterman 2000, p.108)

Linear growth is the apparent growth showing a clear, straightforward direction, usually showing whether the variable is reinforcing. For example, if Variable A increases, Variable B increases, or R denotes it. If the relationship is balancing, it demonstrates a threat to the system. It is usually depicted by the “B” or “–“ sign or an “O” meaning the opposite. The balancing relationship is a threat to the system as it changes the direction of the model. For instance, if initially a variable was going clockwise, the balancing variables can be demonstrated by the variables moving anticlockwise. Furthermore, to identify the balancing relationship, count the number of polarities or the negative and the positive sign. If the number of negative signs outweighs the positive signs, then the relationship is balancing, denoted by the sign “B”. The balancing relationship is illustrated in Figure 3.6

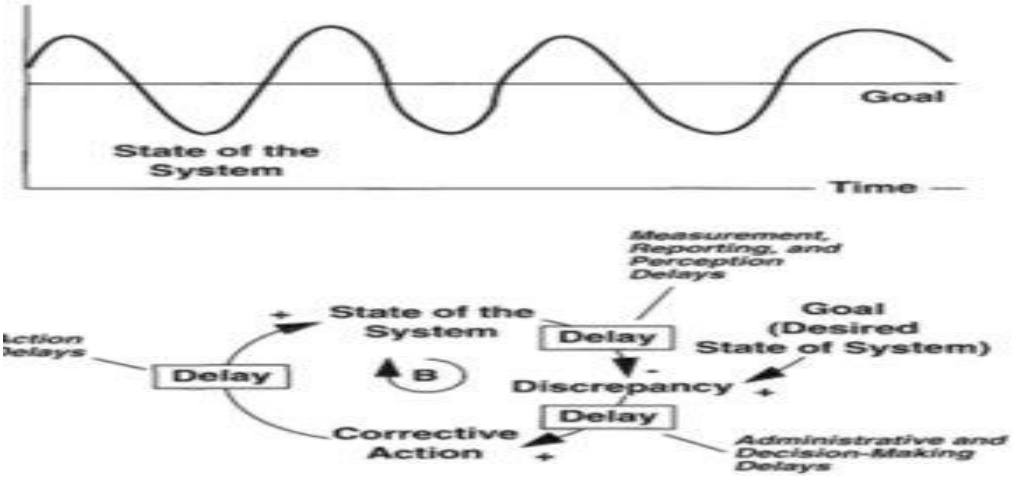


Figure 3.6: Stasis or equilibrium graph example (Sterman, 2000 p. 114)

Stasis or equilibrium implies that everything is even, equal or linear. The stasis or equilibrium graph may be experienced. Figure 3.7 shows a graphical spike going up and down before it reaches a goal affected by either internal or external factors.

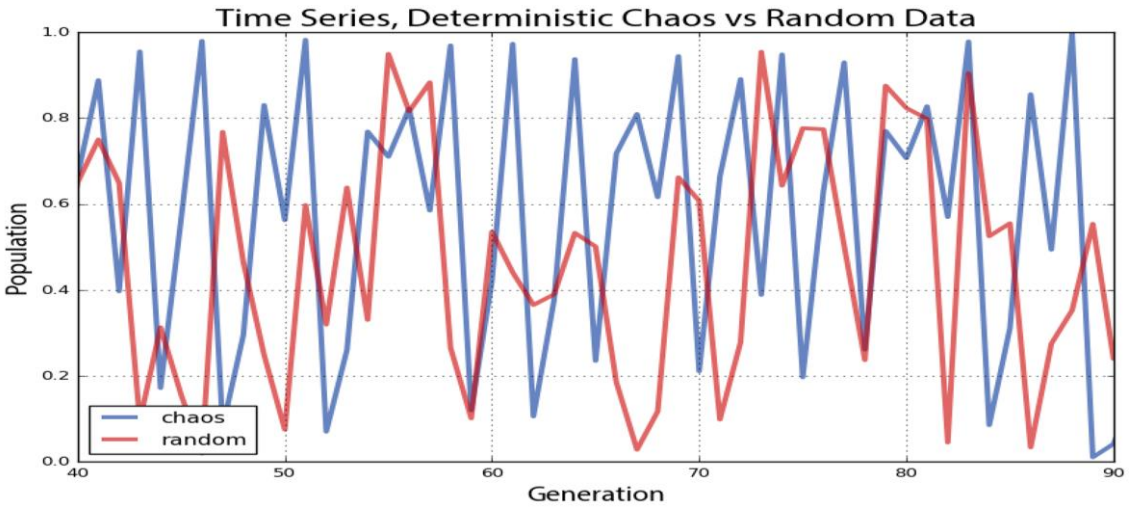


Figure 3.7: Randomness and chaos graph Boeing (2016 p.11)

There is no clear pattern; the relationship is non-linear, and the direction can take any path. The types of the system dynamics analysis are summarised in Figure 3.8.

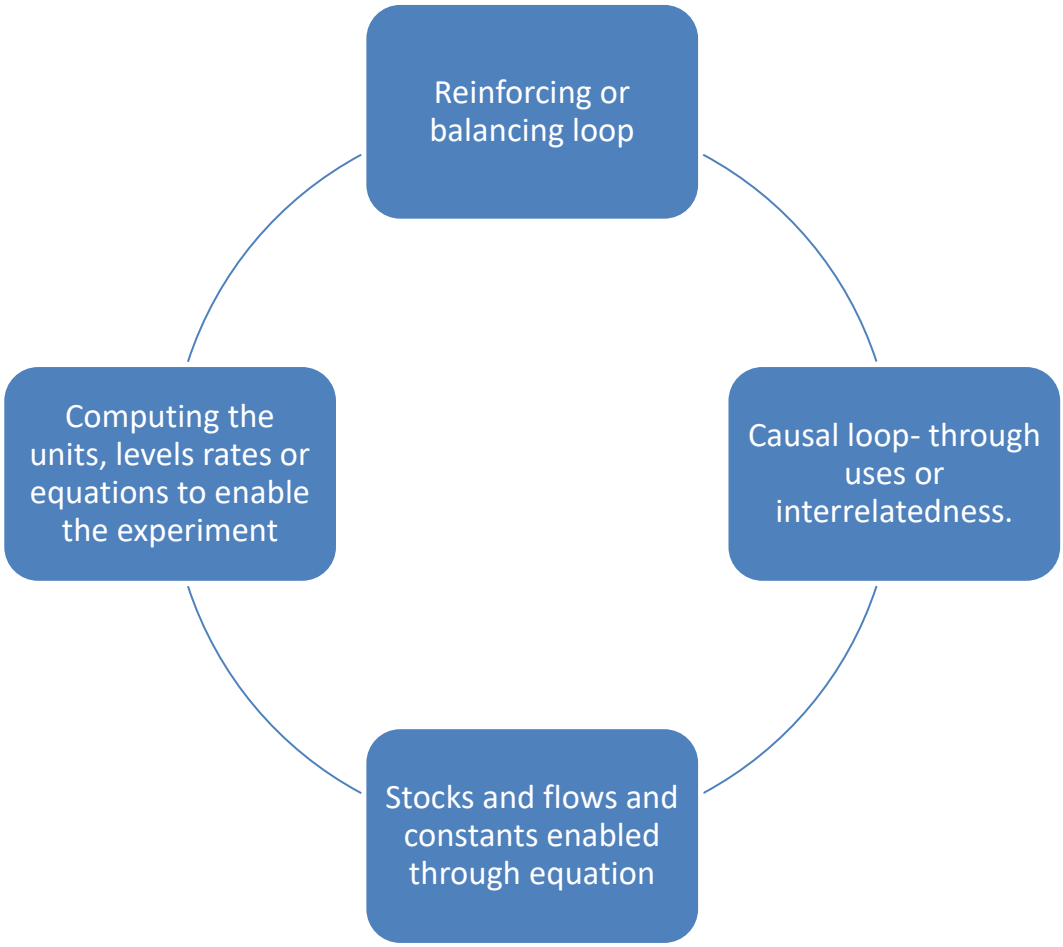


Figure 3.8: Types of system dynamics analysis

(Own compilation based on Forrester, 2018; Sterman, 2018)

To summarise the analysis section, the study utilised the stocks, flows, causal loops, and constants. The constants are one of the inputs, an analysis tool within system dynamics. It is defined as the initial values or the raw data and is not necessarily illustrated with equations (Sterman, 2018). The causal loop, stocks, flows, equations and graphs are illustrated in Chapter 4.

3.6. VALIDATION PROCESS OF SYSTEM DYNAMICS

Upon articulating the problem setting the hypothesis and the dynamic variables, the subsequent and final stage is to engage in a validation process. There are various

ways to validate the model in system dynamics. The researcher must first assess the real world and gather frameworks, policies, and literature to aid the formation of mental models. They must then set the strategies, the structure, and the rules in adding parameters or boundaries on how far a system can go or offer solutions, as depicted in Figure 3.9. The process is implemented in Chapters 1, 2, 3 and 4 of the study.

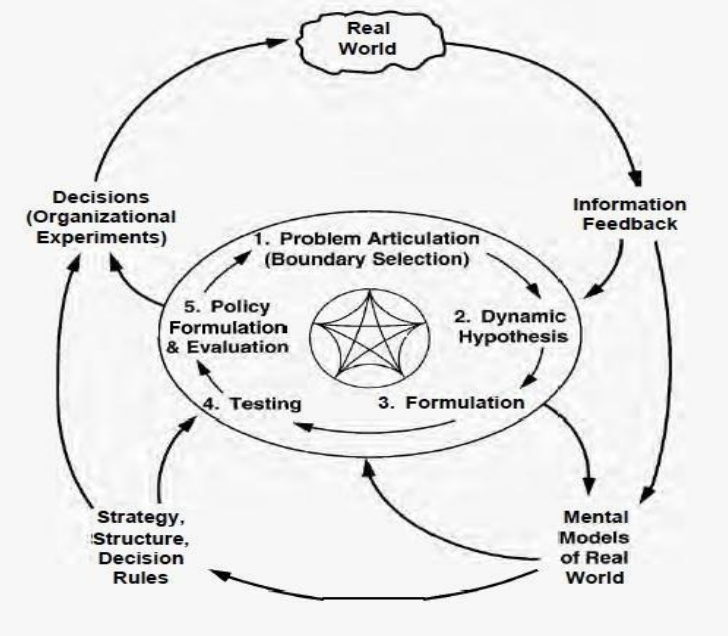


Figure 3.9: Validation process in system dynamics modelling (Gokhan et al., (2019: 688)

The other validation process can be done using case studies or observations based on the dynamic hypothesis (Forrester, 2018; Roth, 2019; Sterman, 2018). The validation that applies to the model in the current study was done using the case studies and the frameworks, as well as through the steps discussed in Section 3.5.3. As explained by Zimmermann et al. (2016; 2022), the validation process occurs in various iterative processes. The case studies and the framework are available on the internet and public organisations. The case studies are further used in the current study through the mentioned platforms. The case studies can either be qualitative or quantitative, but to match the current study, the results of the case studies were quantified (see Section 3.4.3). The case studies, together with the reports and the frameworks, are readily available on the internet. The percentages and ratios were

extracted from the reports and frameworks simulated in Chapter 4; the links are also provided (see Appendix B).

3.7. CHAPTER SUMMARY

The chapter discussed in depth the research methodology and the design that applies to system dynamics, which is inclusive of the sources of data, the research philosophy and paradigm; the ethical consideration that applies to the system dynamics, the history, the methodology; the simulation process as well as the characteristic of the system dynamics model and validation. The following chapter illustrates the results, the actual simulation of the system dynamics model consisting of the causal loop, stocks and flows in modelling the key drivers of green entrepreneurship to serve as an accelerator in transitioning into the green economy. The results and the model formulation serve as continuing steps, yet they are part of the conclusion of the system dynamics model.

CHAPTER 4: RESULTS

Chapter 4 illustrates the simulation of the key drivers through the causal loop model using the Vensim modelling software (see Figure 3.3) and the integrated model consisting of the dynamic variables, stocks and flows (see Figure 3.4). The results are illustrated in Appendix B of the study. The data illustrates the results and the sources of the data. The model formulation and the validation process serve as a continuation of the steps from the previous chapters. The information in the table in Appendix B was used to feed onto the simulation using the Vensim modelling software.

4.1. SYSTEM DYNAMIC SCENARIOS AND EQUATIONS

A high-level macro variable defines the study, that is, looking at the variables from a policy and strategic level. The variables are modelled in years with parameters of from the South African National Development Plan Agenda 2030. Using the Euler equation based on the differentiation theory provides a solid basis for the simulation and the modelling of the results (see Section 3.1). The Vensim modelling software is programmed using Java Script. Therefore, when inputting the variables on the model, the researcher did not leave space and did not use ‘’&’’ as the Vensim modelling software would treat these factors as errors. The multiplication sign is denoted as *, while the division sign is /, as the Vensim does not recognise the common sign of X for multiplication and ÷ for division.

The systematisation and the actual path taken to conduct the simulation are premised on the steps outlined in Chapter 3 as well as building from the history and the definition explained in the chapter. The results were crystallised through the study's stocks and flows, followed by its equations and the behavioural graph. It then moved to the study's dynamic variables, followed by dynamic equations and graphs. The systematisation was further supported by the model conceptualisation, which included assumptions and an explanation of simulation. The testing was done using the equations and

simulations, and the validation by matching the results and discussions with the research questions, the data from the reports, and the literature.

The causal loop and the integrated model in Figures 3.4 and 3.5, was used to simulate and conceptualise the results based on the literature, and the data that was used can be found in Appendix B. Zimmermann et al. (2016; 2022) assert that the system dynamic simulation and the validation occurs in every stage of the research, starting from the conceptualisation to the simulation of the results.

4.1.1. Green entrepreneurship stocks and flows

Six stocks and flows have emerged through the simulation process (see Figures 4.1, 4.2, 4.6, and .4.12). The rationale for having three stocks and flows is that the variables that serve as the input (inflow) to the system should be in congruence with the output (outflow) in the model (Vensim, n.d).

4.1.1.1. Green economy policy and the SA green business

This study's stocks and flows were: the potential adopters of the green economy (input), the flow of the adoption rate of SA green framework policies, and the enterprises adopted green policies behaviour (stock). As illustrated in Figure 4.1, potential SA green businesses are all the enterprises in the basket; the flow, represented by the arrow, facilitates and narrows down the criteria to green enterprises influenced by entrepreneurial mindset, as seen through education and activities such as mentoring and coaching modelled, results in active SA green business .

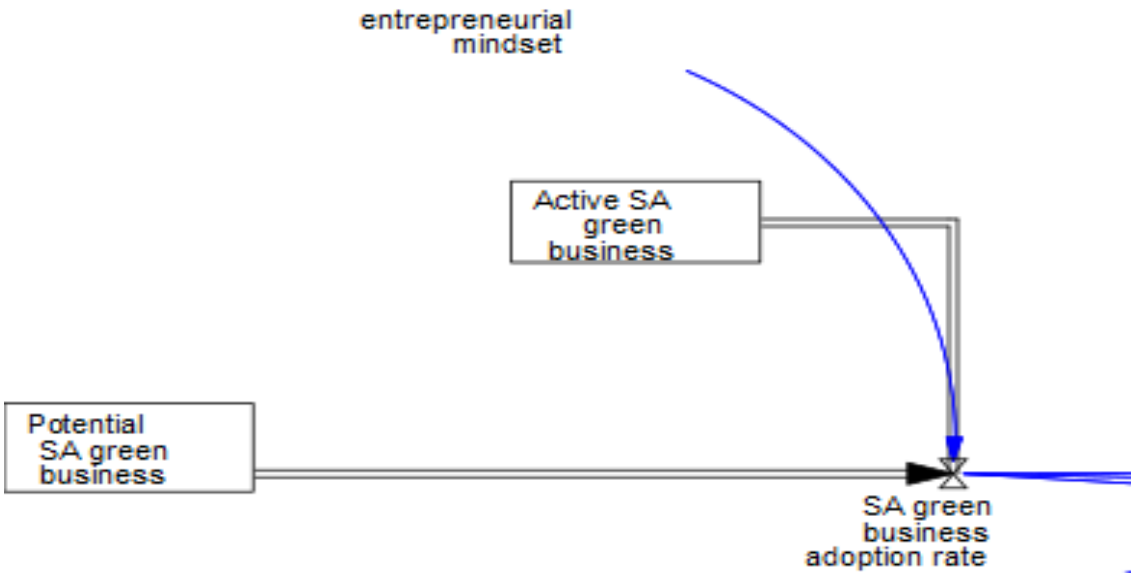


Figure 4.1: Green economy adoption rate and SA green business stocks and flows (Own compilation)

Upon completing the mental modelling and visibly illustrating the stocks and flow, the following process involves feeding the equations onto the model. The equations are based on the Euler principles, as explained in Equation 1. All equations in Chapter 4 were developed by the researcher.

A flow of SA's green policies:

SA green policies rate = SA green business adoption rate * SA Entrepreneurial Mindset (1)

The type of data that was used and simulated for the variables on the stocks and the flow in Figure 4.1 was:

South African green economy activities = 60%.

The population that adopted green behaviour through the green business – the number of green companies in green prioritised areas – consisted of:

Number of bicycle retailers = 200.

Number of bus enterprises = 41 (environmentally friendly buses).

Electric car companies = 29.9%.

Number of enterprises in the water sector=2.1%.

Number of energy companies = 24%.

Number of commercial sustainable agriculture = 5%.

Number of recycling companies' enterprise = 300.

Number of wastewater treatment companies = 155.

Number of waste-to-energy companies = one large-scale waste-to-energy company.

One medium scale incorporated from the Netherlands operating in SA.

One small scale specialising in converting organic waste to energy.

Total three waste-to-energy enterprises in SA

The current study simulated the number of sub-green enterprises and active green businesses. Further information and specific data used in the study is placed under Appendix B.

The entrepreneurial mindset is calculated by the sub-variables as:

Total early-stage entrepreneurial activity (11%); female-male opportunity ratio (0.80); entrepreneurial intentions (11.7%); necessity or motive (1.5); perceived opportunities (42%).

The mathematical model used to test the conceptualisation and explanation from Figure 4.1. continues in Figure 4.2 to fulfil the testing phase as:

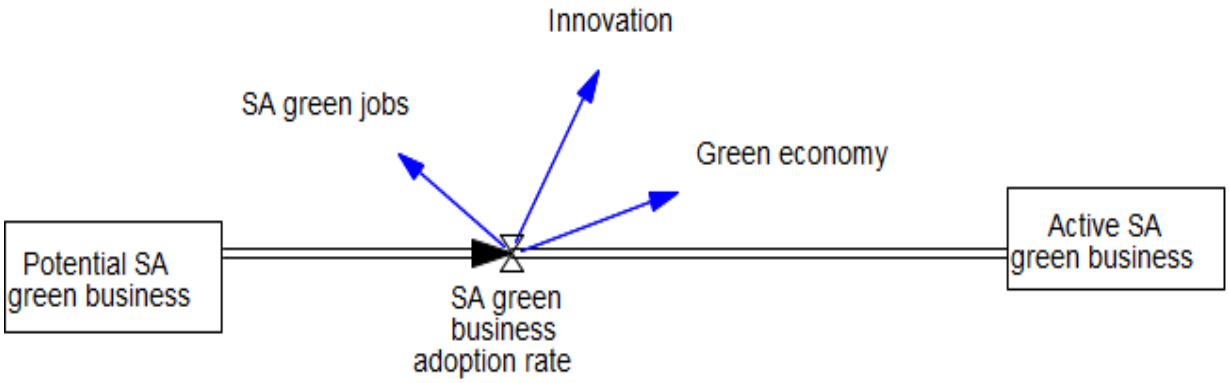


Figure 4.2: Active SA green business stocks and flows (Own compilation)

The data used to feed into Figure 4.2 supported by equation 1 is under green companies.

Stock active SA green business was calculated as part of equation 2 as:

Active SA Green Business stock = Potential SA Green Business/ SA Green Business rate (Green Economy + SA Green Jobs + Innovation) (2)

Potential SA green companies are calculated under sub-section 4.1.1.1. To continue with model building, testing and validation, the data for the green economy used was 60%, the level of innovation was 29.7%, and the green jobs accounted for 2 280 800. The data for the green jobs was the number of people employed within the green sectors, specifically waste, as there is no documented data in other prioritised green economy thematic areas.

Once the mental model conceptualisation, formulation of the equation, and testing phase were completed, the next step was to analyse the data using behavioural graphs and time series guided by the steps in Chapter 3.

The SA green business starts growing from year six and remains stagnant towards year eight.

Figure 4.3. SA green business behavioural graph (Own compilation)

Figure 4.4 shows an increase. By 2030, which is in the eighth year, the adoption rate of the green business would be 31.748.

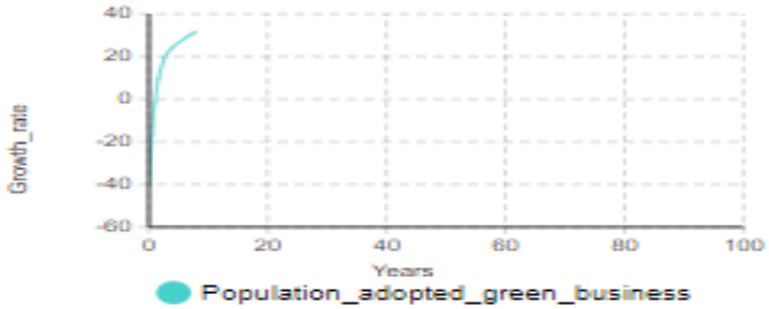


Figure 4.4: Population adopted green business behavioural graph (Own compilation)

4.1.1.2. Green entrepreneurship and green economy

In conceptualising and explaining Figure 4.5, in a quest to transition into a green economy green entrepreneurship has been overlooked, and the current study provides evidence that green entrepreneurship serves as the missing link by utilising the system

dynamics approach. Green entrepreneurship is simulated using the SA green business variable in the current study.

Figure 4.5 illustrates a linear relationship: the SA green business increases over time as influenced by the green economy moving at the same rate. The black and the yellow lines on the curve increase at the same rate, with one on top of the other.

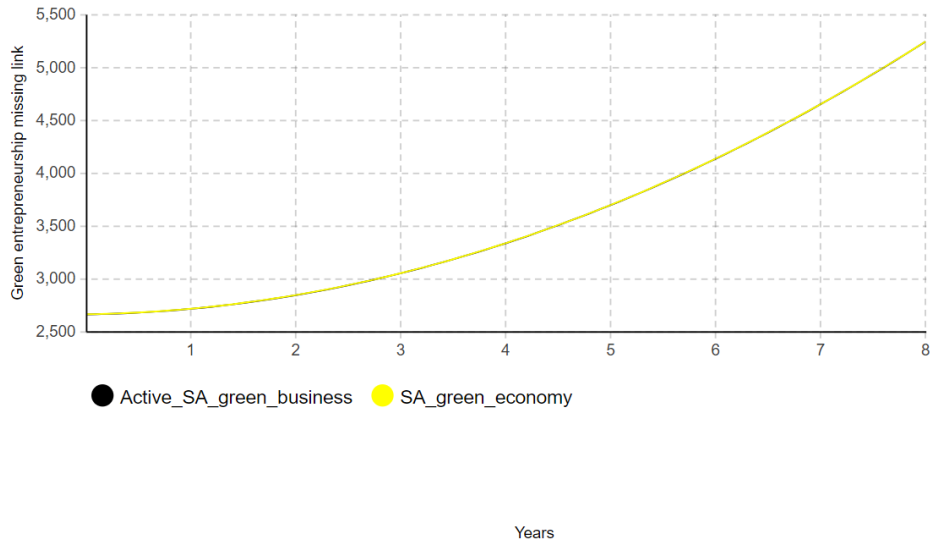


Figure 4.5: Green entrepreneurship as a missing link to green economy behavioural graph (Own compilation)

Figure 4.5 shows growth at the same rate between the SA green business and green economy. By the eighth year, the growth would increase by 5 200.

4.1.1.3. SA customers and green customers

A variable customer is another key driver for green entrepreneurship, also simulated in this study. The researcher took the variable's total customers as potential customers, and as the scenario continued, the result was to calculate the green customers. In illustrating the stocks and flows, potential SA green customers (input), the green customers' adoption rate as a flow and the total SA green customers (output) simulated as shown in Figure 4.6.

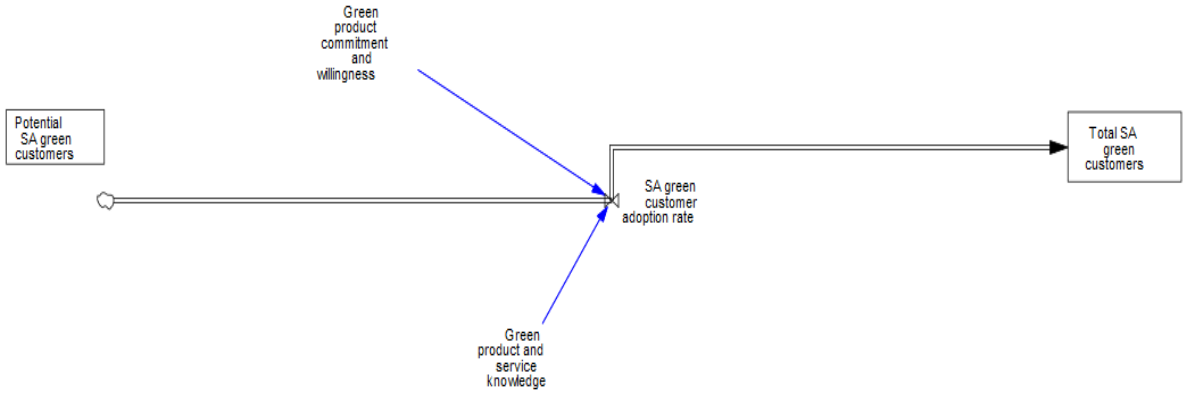


Figure 4.6: Potential SA green customers and the total SA green customers stocks and a flow (Own compilation)

The total SA customers are individuals who can afford to buy products and services (18 million) – the first stock under Figure 4.6. At the beginning of the equation, Figure 4.6 treats all 18 million customers as potential customers until the basket is narrowed down to the green customers, as depicted on the last stock in Figure 4.6. The data on the green product and the knowledge is used to calculate the green customer as depicted in Figure 4.6 and the behavioural graph in Figure 4.7. The growth rate for the green customer by year eight, which is 2030 is projected to be 127 000. The total number of individuals committed to buying a green product is 68%, and those who know the green product is 52% in South Africa.

Equation 3 for Figure 4.6 is:

Green Customers = Total SA Customers * Green Product and Service Knowledge * Green product and services willingness and commitment (3)

Figure 4.7 illustrates the increase in green customers over time (eight years between 2022 and 2030). As explained in previous chapters, the National Development Plan set the 2030 goal. The model and all the behavioural graphs are simulated for an eight year.

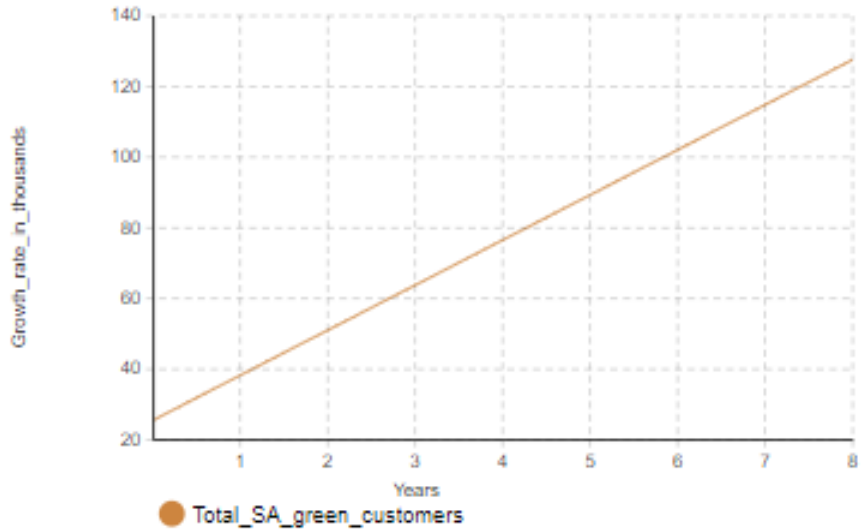


Figure 4.7: Green customers' behavioural graph (Own compilation)

The green customers are expected to grow to 127 000 by the eighth year, as depicted in Figure 4.7.

The ensuing section focuses on simulating the study's dynamic variables and parameters.

4.1.2. Green entrepreneurship dynamic variables

The dynamic variables are simulated as the macro variables denoted by a box around them. Then, the parameter serving as the boundaries (how far a model can go) is denoted by the arrows or the links in the Vensim model simulation software. The application stems from Chapter 3.

4.1.2.1. Green companies' dynamic variable

The prioritised green projects in South Africa as per the green thematic framework are:

- Sustainable agriculture;
- Sustainable water;

- Sustainable energy;
- Sustainable transport;
- Waste management.

The current study focused on green entrepreneurship based on the prioritised green thematic areas set out by the National Development Plan Agenda 2030. Therefore, the parameters use wording such as enterprise, commercialisation or business and they are treated synonymously so not to lose the meaning of the entrepreneurial focus of the study (see Figure 4.8). The behaviour of the enterprises within the latter-mentioned green thematic areas is modelled as depicted in Figure 4.8.

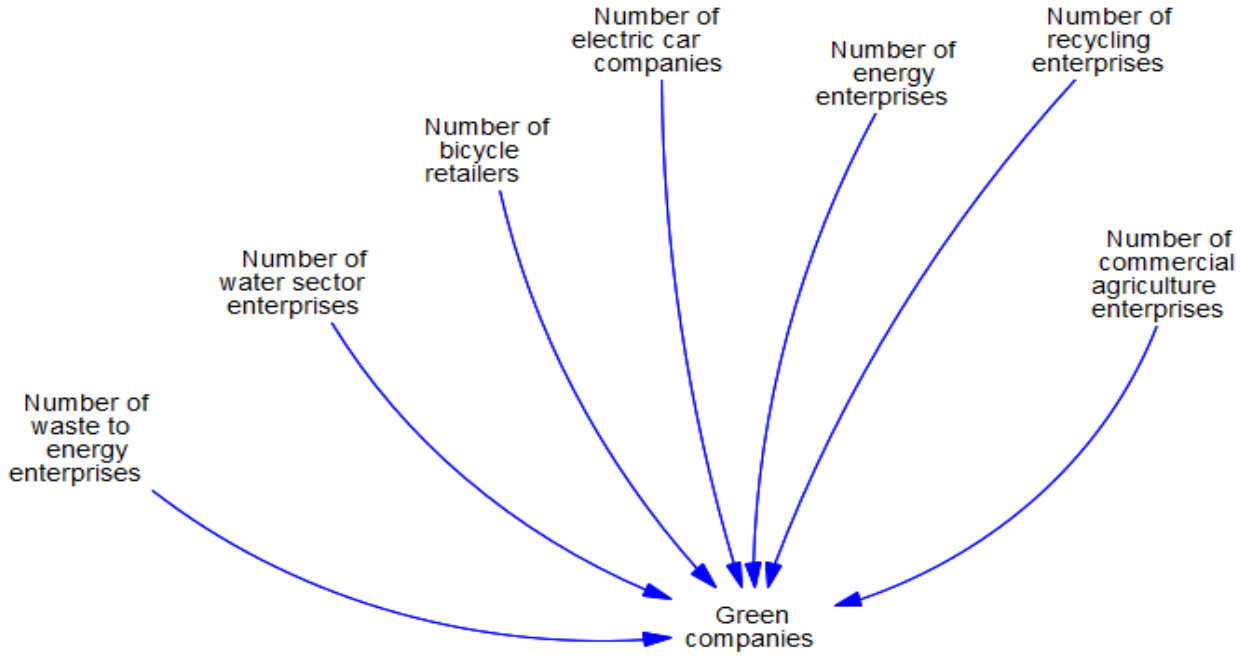


Figure 4.8: Green companies dynamic variable with parameters (Own compilation)

The researcher has modelled sustainable transport focusing on electric cars, buses and bicycles as the latter means of sustainable transport are considered environmentally friendly. Thus, fulfilling the “green” criteria.

The SA green policies and framework must include the element of green sustainable enterprises to transition to a green economy. It serves as a missing link, ultimately influencing the adoption rate. South Africa has policies in all the green economy thematic areas. This refers to green policies from the community or the social perspectives (DEA, n.d). However, there needs to be an awareness of the behaviour of the green companies integrated into the policies.

The dynamic variable in Figure 4.8 illustrates the green companies as formulated and tested via equation 4:

> *Green companies*= number of electric bus enterprises + number of water sector enterprises + number of bicycle retailers+ number of energy enterprises + number of commercial agriculture + number of electric cars companies + number of recycling enterprises+ number of energy companies+ number of wastewater treatment companies (4)

The behaviour of the green companies and their growing capability can be observed in Table 4.1. The data used in this dynamic variable is the same for when the researcher calculated the stocks and the flows (see data under Figures 4.1, 4.7, 4.8, and Appendix B). The researcher used the prioritised green thematic areas that were set by the National Development Plan Agenda 2030 and searched for data within the prioritised green thematic areas. Table 6 is modelled as a dynamic variable to see the strengths or capabilities of earlier mentioned enterprises.

Table 4.1

Green companies' capability

Dynamic variable name	Current data	Ratio conversion of current data	Capability of growing by the following percentage in 2030
Number of energy enterprises	42%	4.2	1%
Number of bicycle retailers	200	2.00	4%
Number of commercial agriculture enterprises	5%	0.5	84%
Number of electric car companies	29.9%	2.9	1%
Number of recycling enterprises	300	3.00	6%
Number of waste to energy enterprises	3	0.3	0
Number of water sector enterprises	2.1%	0.21	0

Table 4.1 shows the strength and capability within the agricultural sector and the wastewater treatment enterprises, with a decline in the water sector and waste-to-energy capabilities.

4.1.2.2. Entrepreneurial mindset dynamic variable

The entrepreneurial mindset was treated as a dynamic variable and a key driver for green entrepreneurship.

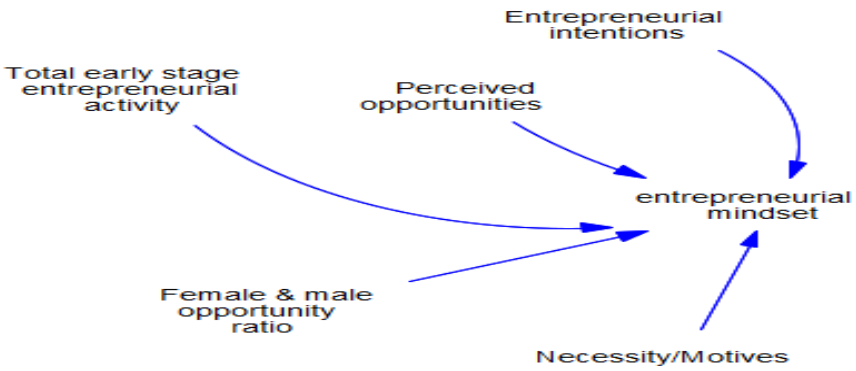


Figure 4.9: SA entrepreneurial mindset dynamic variable with parameters

(Own compilation)

The dynamic variable equation for the SA *entrepreneurial mindset* (equation 5) based on Figure 4.9 is specified and tested as:

> SA entrepreneurial mindset = gender representation + total early-stage entrepreneurial activity + green education entrepreneurial intentions + values and norms (5)

The entrepreneurial mindset was simulated with the following mental model: An individual needs first to ascertain that there is a need to adopt an entrepreneurial mindset by looking at the entrepreneurial activity, success factors, intentions and whether opportunities exist to seize the market. Table 4.2 and Figure 4.10 show the capability and behavioural graph with an additional element of green education to raise awareness and an entrepreneurial mindset.

Table 4.2

Entrepreneurial mindset capability

Dynamic variable name	Current data	Ratio conversion of current data	Capability of growing by the following percentage in 2030
Gender representation	0.8	0.8	7%
Total early-stage entrepreneurial activity	11%	1.1	1%
Values and norms	44%	4.4	4%

Entrepreneurial intentions	11.7%	1.2	1%
Number of green education and skills programme	10 258	10.26	87%

The data was retrieved from the GEM consortium and is available online. The following link https://www.gemconsortium.org/file/open?fileId=50411 was used to obtain data on gender representation, the total early-stage entrepreneurial activity, entrepreneurial intentions, green entrepreneurship education, values and norms (Gem consortium, n.d). The variables are not clustered under the entrepreneurial mindset category in the report. However, the researcher defined the dynamic variable of the entrepreneurial mindset by looking at the following sub-variables and by retrieving data from the mentioned report using the following variables:

- Gender representation;
- Total early-stage entrepreneurial activity;
- Entrepreneurial intentions;
- Green entrepreneurship education;
- Values and norms.

The entrepreneurial mindset behaviour graph is illustrated in Figure 4.10. The graph is chaotic, with spikes going up and down before reaching a goal. There is no clear pattern, and the direction takes any form.

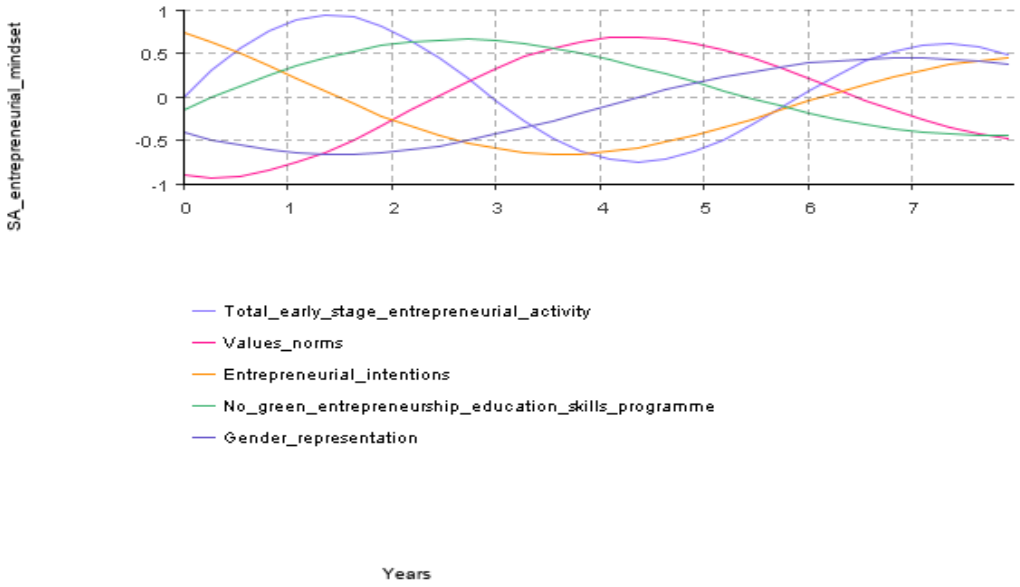


Figure 4.10: South African entrepreneurial mindset behavioural chaotic and random graph (Own compilation)

When grouped together, the behavioural graph of entrepreneurial mindset shows a decline rate of -12.042 by year eight.

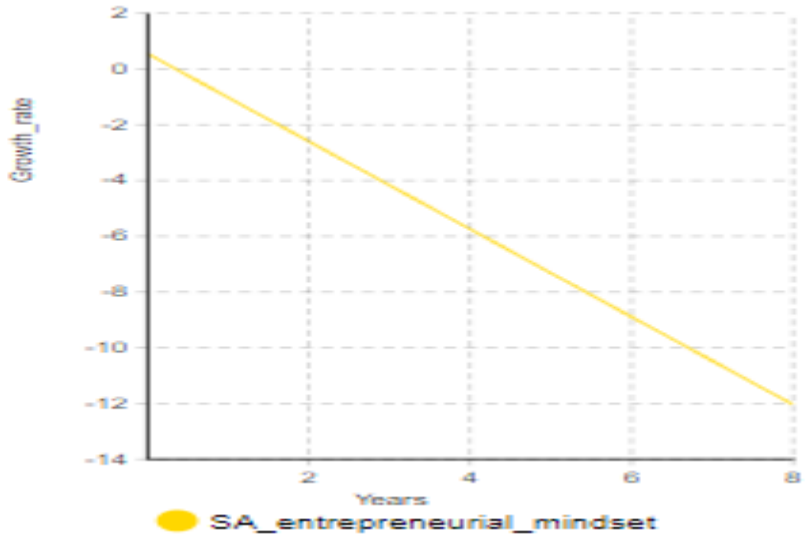


Figure 4.11: Grouped determinants of entrepreneurial mindset behavioural graph (Own compilation)

4.1.2.3. SA green funding

Finance through investment is another dynamic variable that was simulated, as depicted in Figure 4.12. The green finance dynamic variable influences green businesses and green infrastructure. If there is finance, the businesses should survive, and the infrastructure should increase. This scenario is simulated and modelled in Figures 4.12 and 4.13.

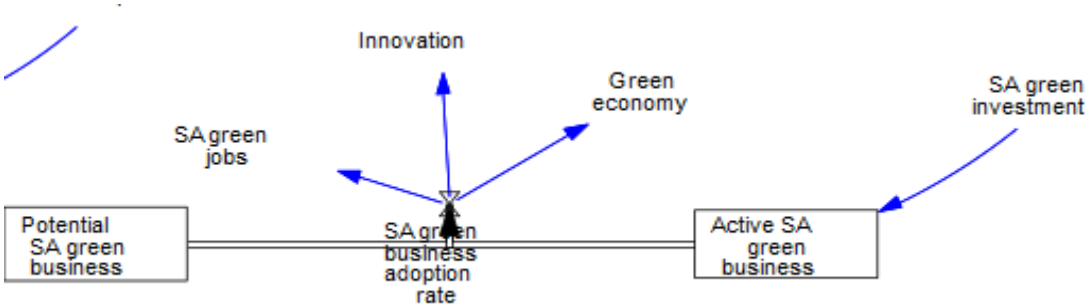


Figure 4.12: SA finance dynamic variable linkage to the stock active business (Own compilation)

The data simulated for green finance was 2.6 billion (see Appendix B). Finance is treated as a constant. The units of analysis, including the constant, are explained under sub-section 3.5.

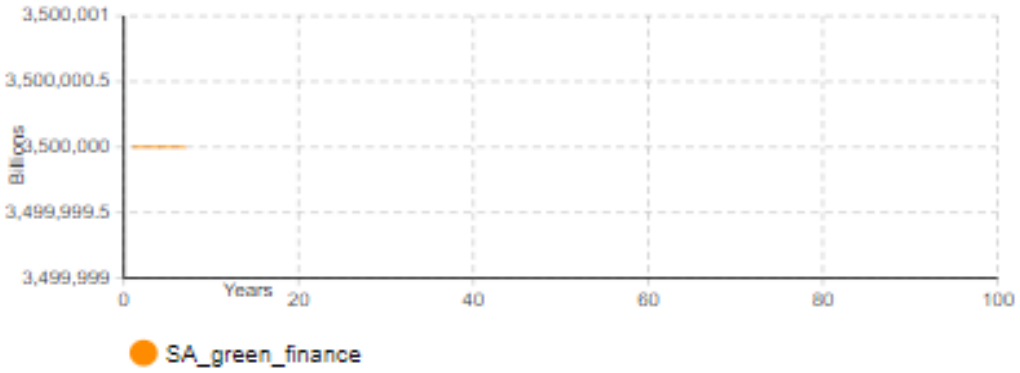


Figure 4.13: Green finance behavioural graph (Own compilation)

Figure 4.13 shows a growth rate for green finance in the first eight to ten years. However, as time moves, there is yet to be an indication of whether the finance is growing.

4.1.2.4. Green infrastructure

The green infrastructure variable was also simulated as a dynamic variable. The green infrastructure comprises bicycle lanes, landfill sites, business incubators, economic development zones, land reserved for commercial agriculture, and wastewater treatment plants (see Figure 4.14). The data is retrieved from various hosts in the public domain (see Appendix B).

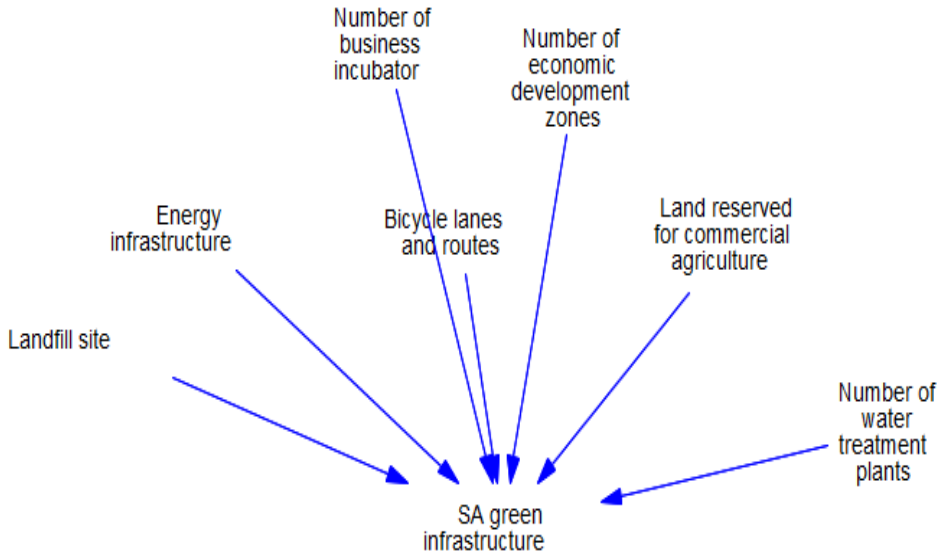


Figure 4.14: SA green infrastructure dynamic variable with parameters (Own compilation)

The data used to simulate the green infrastructure is illustrated in Table 4.3. under the green infrastructure capability. Then, for model testing, the following resulted.

The dynamic variable – equation 6 – for the green infrastructure that is depicted in Figure 4.14 was tested as:

Green infrastructure = bicycle lanes and routes + landfill sites + accumulated energy infrastructure capability + land reserved for commercial agriculture + SA green finance + number of water treatment plants + number of economic development zones + number of SA business incubators (6)

The capability of the South African green infrastructure captured in Table 4.3:

Table 4.3

SA green infrastructure capability

Dynamic variable name	Current data	Ratio conversion of current data	Capability of growing by the following percentage in 2030
Number of business incubators	58%	5.8	40%
Number of water treatment plants	824	8.24	6%
Land reserved for commercial agriculture	37.9%	3.79	3%
Energy infrastructure	12.79%	1.28	9%
Landfill sites	826	8.26	6%
Bicycle lanes and routes	4376	4.376	30
Number of economic development zones	11	1.1	8%

4.1.2.5. Additional parameters

The additional parameters or boundaries supporting the dynamic variables were simulated based on the National Development Plan Agenda 2030, and the time was set in years. A further supporting parameter was accumulated as the green GDP. The background to the parameters or the boundaries was explained in Chapter 3. The parameter green GDP was simulated based on the accumulated GDP concerning the prioritised green thematic areas using the data under Appendix B.

The prioritised green economy thematic areas are:

Green GDP = energy GDP + water GDP + transport GDP + waste management + agriculture GDP. (7)

Aggregated total green GDP is 11.93, derived as follows: energy and water 0, transport 6.5%, waste management 2.9%, agriculture 2.53%

The accumulated green GDP, which consists of the aggregated GDP was 11.93. The contribution made by energy and water was 0%, followed by transport (6.5%), waste management (2.9%), and agriculture (2.53%). The failure rate is simulated to be influenced by the lack of support in the current study. According to the Global Entrepreneurship Monitor (2017), the life span of most businesses in South Africa is a maximum of five years.

The dynamic green business variable influenced the green GDP. The green business contributes to the green GDP, as depicted in the behavioural graph (Figure 4.15). As the SA green business increases, the GDP increases over the years.

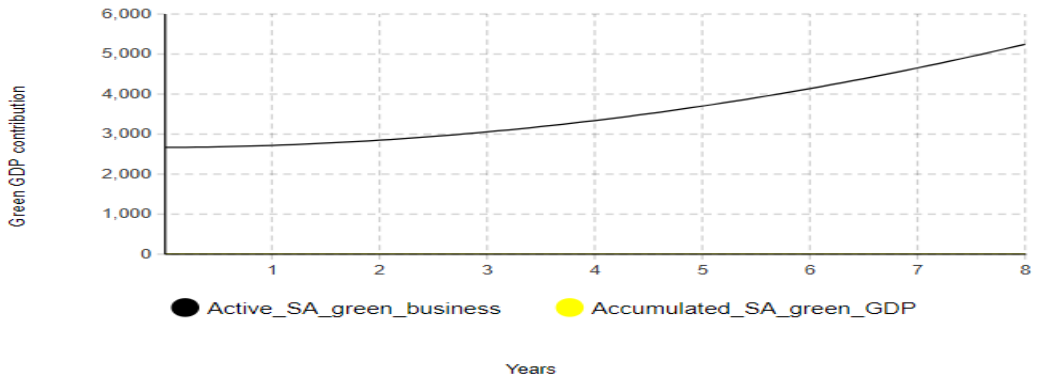


Figure 4.15: Green GDP graph (Own compilation)

4.2. GREEN ENTREPRENEURSHIP CAUSAL LOOP DYNAMIC MODELLING WITH POLARITIES AND DELAYS

The stocks and flows, the dynamic variables, and the boundaries with their equations are discussed in previous sections and Chapter 3. The researcher followed the process of modelling the dynamic variable using the causal loop model on Vensim. The causal loop of the study was (see Figure 4.16):

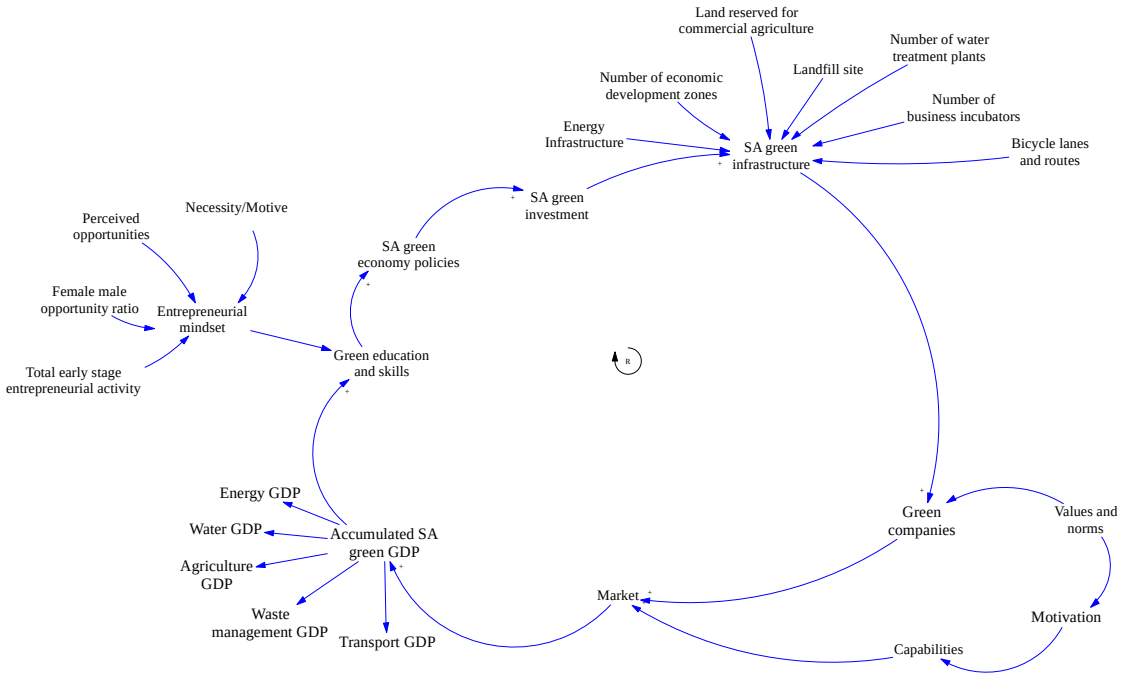


Figure 4.16: South African integrated green entrepreneurship system dynamics model (Own compilation)

The causal loop illustrates the modelling of the variables reinforcing one another as denoted by the “+” sign. There are three sub-loops, and the main causal loop simulates the strategic vital drivers. If funding increases, the infrastructure will increase; the green companies and the green market will increase with the support and the opportunities from the latter macro variables.

Some sub-variables influenced the green companies, from loop 2, on the right, to the main loop. The values, motivation and capabilities influenced green companies. The capabilities sub-variable influenced the green market, where if individuals had capabilities, they could seize the market and create opportunities. The capabilities, motivation and values, as well as the attitudes, add to the theoretical constructs of the psychology of entrepreneurship where the current study contributes through the green psychology of the entrepreneurship framework discussed in Chapter 5. Once the green market is in place, there will be more customers, thereby contributing to the green GDP and policies as per the main loop, which continues on the left side. In the middle of the integrated causal loop, the green customers will result in a change of behaviour through more green champions, more awareness and education to steer the entrepreneurial mindset. Ultimately, the standard of living will increase as more people can be self-sufficient, create opportunities, and contribute to the economy. They will also influence policy formulation and implementation regarding green entrepreneurship. The current study makes further contributions through policy (See Appendix C).

The integrated green entrepreneurship model utilising the system dynamics approach, which includes the dynamic variables, the stocks and flows, the parameters and reinforcing, and the balancing relationship illustrating the testing and validation process, is simulated in Figure 4.17.

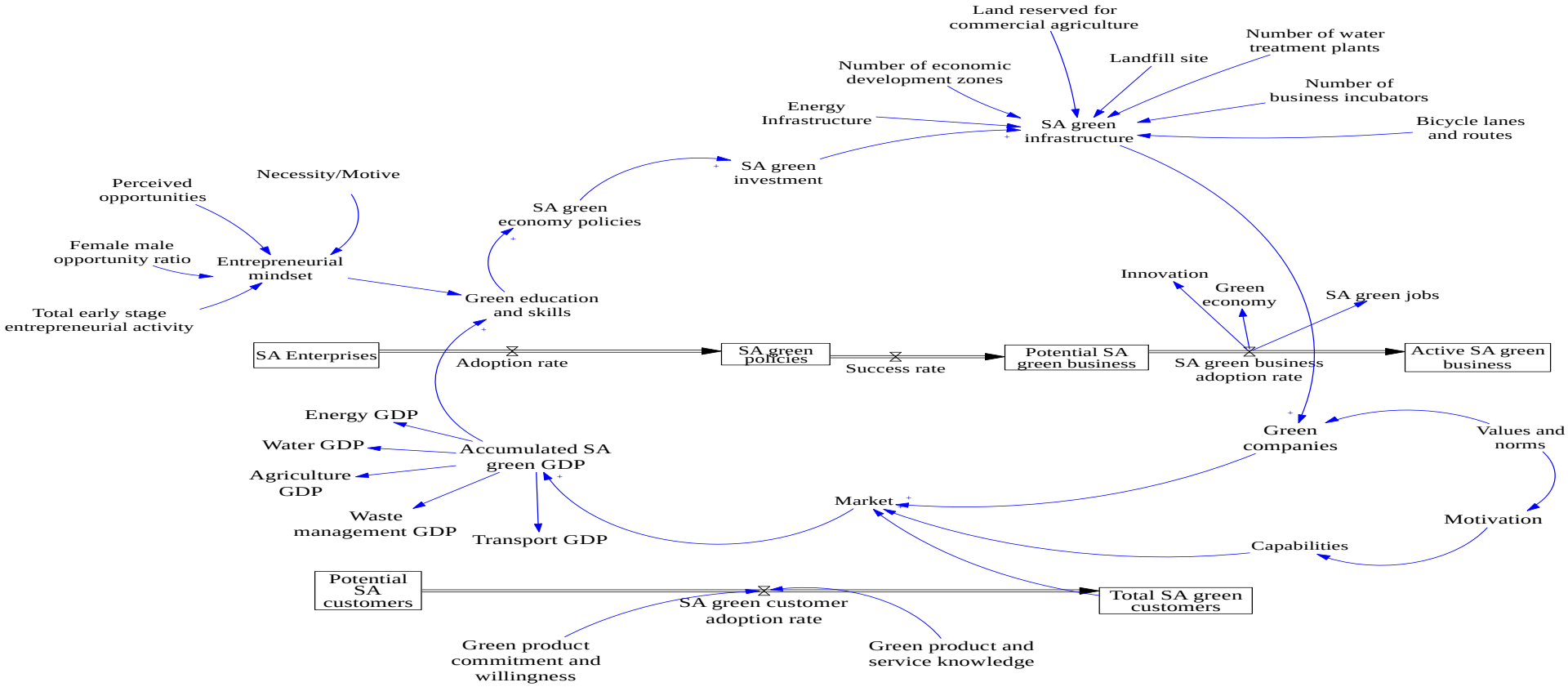


Figure 4.17: South African integrated green entrepreneurship system dynamics model (Own compilation)

Table 4.1

Summary of equations outputs and conditions

Variable	Summarised equation/values	Conditions
SA green policies	Population adopted green business * SA entrepreneurial mindset.	If sustainable behaviour and influence of entrepreneurial mindset are kept together and included in policies
SA green finance	Sustainable energy finance + sustainable waste management finance + sustainable water finance + sustainable agriculture finance + sustainable transport finance	If more benefits and reinforcement such as the influence of green business to the green economy is maintained then the likelihood of the budget increasing is favourable. The investment may also need political buy-in.
Green customers	SA customers * green knowledge * willingness & commit.	
Green companies	No electric bus companies, + No of water companies + No of bike retailers+ energy companies + No of agriculture companies + No of electric vehicles companies + No of recycling companies+ No of waste to energy companies+ No of wastewater treatment companies.	If accumulation and behaviour or pro environmental behaviour happens within the prioritised sectors
SA entrepreneurial mindset	Gender representation + TEA+ EI + Green education + values & norms	
Green infrastructure	Bike lanes + landfill sites + accumulated energy infrastructure + land reserved for commercial. Agric. + SA green fin. + No of water treatments plants + No of economic development zones + No of SA business incubators.	In the condition that a business hub or integrated system of sustainable transport, agriculture, water, energy, and waste management is established
Green GDP	Energy GDP+ water GDP+ sustainable transport GDP+ waste	If accumulation happens within the prioritised sectors and grouped together

	management GDP+ sustainable agriculture GDP	
Population adopted green business	31.748	If green economy, and other resources such as finance and infrastructure are integrated onto the simulation
Green customers growth rate	127000	If more awareness, education, ambassadors are set to influence customers
SA green business	5.329	If accumulation and behaviour or pro environmental behaviour influenced by policies happens within the prioritised sectors
SA entrepreneurial mindset growth rate	-12.042 (negative value which resulted to chaotic behavioural graph for entrepreneurial mindset)	If parameters such as perceived opportunity, opportunity ratio and entrepreneurial intentions are increased then the likelihood of nonlinear relation is set to be the outcome instead of chaotic graph
Green infrastructure growth rate	2048.21	
Accumulated green GDP growth rate	11.93	
SA green finance growth rate	R3.5 billion	

4.3. CHAPTER SUMMARY

This chapter illustrated and described the results and the mathematical equations regarding the stock, flows, parameters, dynamic variables, and the causal loop of the study. The model conceptualisation through scenarios, as well as the model testing and validation through simulation, and the data from the

reports were described. The subsequent chapter provides a discussion of the results.

CHAPTER 5: DISCUSSIONS

This chapter explains and discusses the results under the empirical research questions. The study's empirics align with the dynamic hypotheses, which form part of the system dynamics methodology explained in Chapter 3. The researcher explained and provided in-depth discussions and, where necessary, referred to the sections to avoid self-plagiarism.

The research questions about empirics (dynamic variable), as illustrated in Chapter 1, were:

- What are the key drivers for green entrepreneurship in a South African context?
- Can the system dynamics model simulate the South African green entrepreneurship key drivers?
- Do the key drivers forr green entrepreneurship have a positive or negative relationship in an iterative causal loop within a South African context?
- Are sustainable behaviour and green entrepreneurship technology the missing links to transitioning into the green economy within the South African context?

The subsequent sections discuss the key results and answer the research questions concerning the empirics in line with the dynamic variables.

5.1. DISCUSSIONS ON THE SOUTH AFRICAN GREEN ENTREPRENEURSHIP KEY DRIVERS

5.1.1. Research question 1: What are the green entrepreneurship key drivers in a South African context?

The key drivers of green entrepreneurship consist of the policies, the finance mechanisms, the infrastructures, green education and skills, marketing (consisting of knowledge and commitment), green customers, entrepreneurial mindset (consisting of entrepreneurial intentions, total entrepreneurial activity, the motives, the female and male opportunity ratio, and the green education and skills programme, values and norms). These green drivers contribute to the existing theoretical constructs.

The Department of Environmental Affairs and the National Development Plan Agenda 2030 advocate and formulate green policies, thereby regulating the waste, energy, water, transport, and agricultural sectors, similar to what is discussed in Chapter 2 (see sub-section 2.1 and 2.2). Upon reviewing the green policies and the framework, the policies and the framework need to mention or focus on green entrepreneurship. Therefore, this study contributes to the awareness and adoption of green entrepreneurship through system dynamics modelling. The current study formulated the green entrepreneurship policy as a further contribution (see Appendix C). Only one study focused on green entrepreneurship in South Africa, using a qualitative methodology (Mukonza, 2020).

Another related area – which is synonymous with green entrepreneurship – is the concept of ecopreneurship, which has been investigated in international markets (Hörisch et al., 2017; Muñoz & Cohen, 2018; Nikolaou et al., 2018; Santini, 2017; Schaltenger, 2016; Silajdžić et al., 2015; Tharindu & Koggalage, 2020; Vasilevska & Rivza, 2018). At the same time, other studies focused on environmental entrepreneurship and renewable energy enterprises (Diale et al., 2021a; Diale et al., 2021b; Kardos et al., 2019; Kirkwood et al., 2017; Santini, 2017; Schaltenger, 2016). There is a notable difference between green entrepreneurship, ecopreneurship, and environmental entrepreneurship. Green entrepreneurship or ecopreneurship is an action that contributes to preserving natural resources while making a profit out of the process and ensuring the

welfare of societies (Demirel et al., 2019; Ebrahimi & Mirbargkar, 2017; Grinevich et al., 2019). Moreover, environmental entrepreneurship focuses mainly on saving the environment and creating awareness of the environmental challenges and economic gains (Kardos et al., 2019; Kirkwood & Walton, 2010; Kirkwood et al.,2017; Santini, 2017; Schaltenger, 2016).

A further explanation and categorisation between green entrepreneurs/ ecopreneurship and environmental entrepreneurship is given in Section 2.5.2.1. The categories of ecopreneurship are illustrated in Table 2.3 in Chapter 2. The key drivers are similar to what has been discovered by previous researchers (Anabaraonye, 2019; Antolin-Lopez et al., 2019; Booysen, 2022; Domanka et al., 2018; Elsner et al., 2021; Ghosh, 2020; Hernández & Carrà, 2016; Kuyper et al., 2018; Machedon-Pisu & Borza, 2019; Massa-Saluzzo & Toschi, 2019; Nikolaou et al., 2018; Rajan, 2019; Schaltegger, 2016; Wamsler et al., 2020; Yakovleva, 2018). However, these discoveries did not focus on the psychology of entrepreneurship or sustainable behaviour and the entrepreneurial mindset as the key drivers for green entrepreneurship. The difference is within the methodology adopted by previous researchers, focusing on a qualitative or a systematic review. In addtiion, the current study adds to the literature with the variables mentioned earlier. The methodological contributions of the study through system dynamics are explained in Subsection 2.9, and Chapters 3 and 4. Previous research has focused on sustainable or pro-environmental behaviour within the community or the societal sphere (Busic-Sontic et al., 2017; Fritsche et al., 2018) but with less focus on sustainable behaviour in the entrepreneurial or enterprise sectors, contributing to the current literature.

The system dynamics methodology contributes to the field of industrial psychology by opening avenues of consulting. The multi-discipline of integrating the psychology of entrepreneurship and interventions from individual human attributes concerning sustainable or pro-environmental behaviour are modelled. The actual simulation of results is discussed in research question 2.

5.2. DISCUSSIONS ON THE SIMULATION OF THE SOUTH AFRICAN GREEN ENTREPRENEURSHIP KEY DRIVERS

5.2.1. Research question 2: Can the system dynamics model simulate the South African green entrepreneurship key drivers?

The key drivers can be simulated through the stocks and flows (see Figures 4.1, 4.2, 4.7 and 4.13), the dynamic variables (see Figures 4.19,4.10 and 4.15), and the causal loop (see Figure 4.17). The equations used to simulate the stocks and flows as well as dynamic variables are marked equation 1-6 in Chapter 4. The simulation of stocks and flows has never been used, thus contributing to the body of knowledge. The integrated model consisting of a dynamic variable, the stocks and flows, is depicted in Figure 4.18. A discussion of the key drivers of green entrepreneurship are detailed in sections 5.2.1-5.2.5.

For ease of reference, the graphs are repeated in this chapter to aid in an in-depth discussion that addresses the research questions.

5.2.2. Discussion on the potential green economy policies and the active SA green business stocks and flows as part of the green entrepreneurship key drivers.

Before the modelling formulation could take place, the imaginations assumptions needed to be tested and formulated, as discussed in subsections 1.8.1 and 3.1. The first mental model, which is the assumption or imagination, was achieved by thinking about the key drivers that will spearhead the adoption of green entrepreneurship and the transition into a green economy. The researcher treated all the enterprises as the adopters at the start of the equation, illustrated in sub-section 4.1.1. The focus is on the sustainable behaviour of the enterprises and generating a profit from the adopted sustainable behaviour. The assumption at the start of the equation is illustrated on the first stock, with the potential adopters of the green economy. All businesses are potential adopters, whereby at the end of the equation or the outflow, only the SA green businesses

are calculated based on the success rate. The success rate depends on the customers and the enterprises that have adopted green behaviour, and it minimises the lack of support. The researcher took all the businesses in a basket but reduced or sifted the criteria to only those that adopted green behaviour by illustrating the second last stock (see Figure 5.1). The equation is illustrated in Chapter 4. Based on this assumption, Figure 5.1 was formulated; its equation tested and validated the imagination and the mental model, which has never been explored before.

The discussion on the potential SA green customers and the total SA green customers is supported by Figure 5.1.

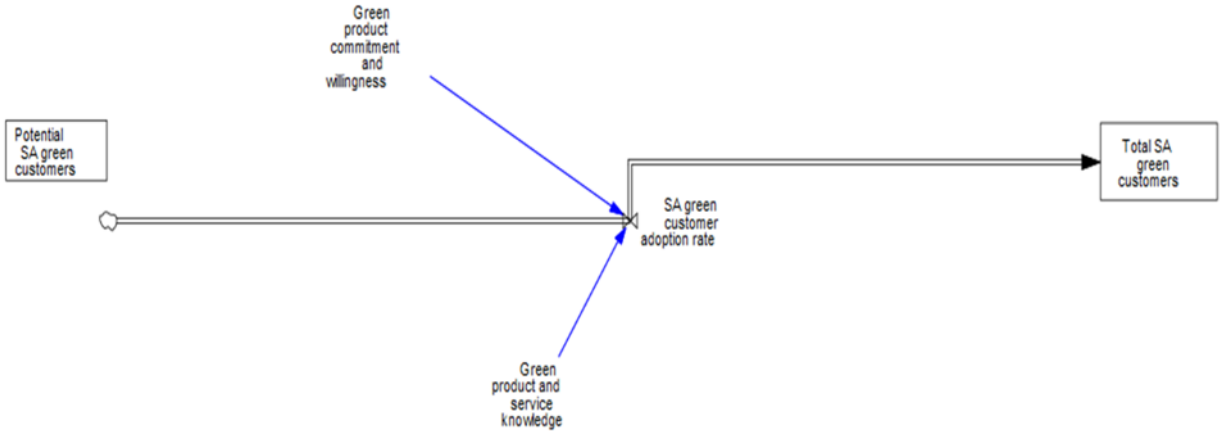


Figure 5.1: Potential SA green customers and total SA green customers stocks and flow

Few studies use system dynamics within the green economy (Colleta et al., 2021; Downing, 2022; Nijhof et al., 2021). However, there is yet to be a match concerning Figure 4.1 of the potential adopters' inflow and the green businesses' outflow. Therefore, the earlier assumption regarding testing and validation contributes to the body of knowledge.

5.2.3. Discussion on the psychology of the entrepreneurship framework as part of green entrepreneurship key drivers

In the current study, the psychology of the entrepreneurship framework supports variable entrepreneurial mindset. The entrepreneurial mindset variable is simulated in Figure 5.2, corresponding with equation 5.

The psychology of entrepreneurship framework is reinforced by the guidelines (Frese, 2014; Urban, 2020). Frese (2014) and suggests that entrepreneurial alertness can be enabled by teaching and training individuals to pursue entrepreneurial markets in instances of adversity or uncertainty. The alertness is achieved through cognitive and behavioural change, as explained in sub-sections 2.4.5.1 and 2.4.5.2, as well as through trait activation, the motivation to act, and acquiring the necessary resources to exploit the market.

The following characteristics support the entrepreneurial alertness that is advocated by Frese (2014), which is knowing how to draft a business profile, plan, create a website, conduct market analysis, and gain financial aid, thereby basically balancing both the financial and the non-financial support as discussed under sub-section 2.6.3 (Anabaraonye, 2019; DTI, n.d; Elsner et al., 2021; Hörisch, 2015; Kuyper et al., 2018; Markam et al., 2016; Massa-Saluzzo & Toschi, 2019; Kapmeier et al., 2021; Sovilj et al., 2021). A discussion on the psychology of entrepreneurship supports the variable entrepreneurial (see section 5.2.3) follows.

5.2.4. Discussion on the South African entrepreneurial mindset as part of the key drivers for green entrepreneurship

The entrepreneurial mindset as a contribution is another key driver, and it is simulated using the dynamic variables with parameters in defining and asserting how far a model can go (see Figure 5.2). Equation 5 was used to depict Figure

5.2 . The discussion on the SA entrepreneurial mindset dynamic variable with parameters is supported by Figure 5.2.

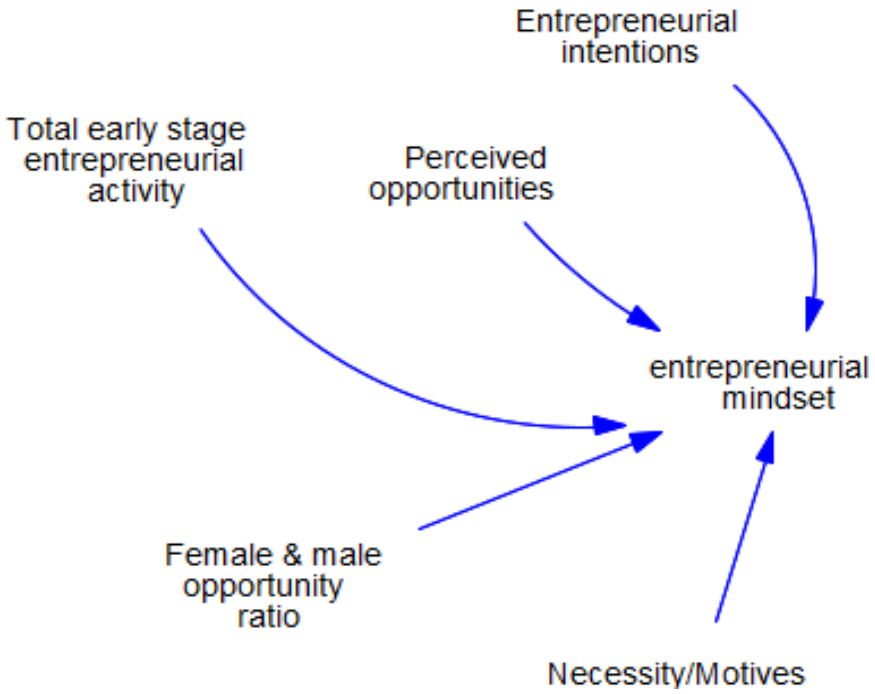


Figure 5.2: SA entrepreneurial mindset dynamic variable with parameters

Although the variable within the entrepreneurial mindset is not clustered under the mindset category, the researcher simulated the dynamic entrepreneurial mindset variable by looking at the sub-variables. Figure 5.2 shows the perceived opportunities, the necessity or motive, the female and male opportunities, the entrepreneurial intentions, and the total early-stage entrepreneurial activity. The perceived opportunities include the individuals' perceptions and whether they can identify the entrepreneurial opportunities. The necessity or motive derived from the principle of motivation is part of the entrepreneurial mindset.

The female and male opportunity ratio shows the gender differences and whether individuals can identify opportunities in the entrepreneurial market. The results show that more men can seize entrepreneurial markets than women, and men are the ones that act when it comes to generating profits (Global Entrepreneurship Monitor, 2017). However, more women than men have a strong need to protect the environment.

The study has formulated a policy (see Appendix C), which should be implemented through diversified support to ensure gender representation in the green entrepreneurial era. The above-mentioned collective agenda is similar to the collective efficacy within societies advocated by Fritsche et al. (2011;2018), but the context of entrepreneurship differs in this study. The support needs to be categorised under the financial and non-financial sphere. The recommendation could be that the strength, capability and years of simulation or the agenda could be extended to 2063 to simulate the variables mentioned earlier as future research recommendations.

Figure 5.3 shows the randomness or chaos of the entrepreneurial mindset in the behavioural graph. The randomness and chaotic graphs demonstrate the spikes, and overshooting, as termed by Meadows (1977), Boeing (2016) and Forrester (2009; 2018). The spikes and overshooting are demonstrated in Figure 5.3, thereby showing the behaviour of the entrepreneurial mindset with no apparent pattern, causing some delays before reaching a goal. Viljoen et al. (2018) assert that waste management individuals have low education levels. The researcher deduces that the level of skills drainage may contribute to the delay and the unsmooth journey as defined by the spikes before reaching a goal, as per Figure 5.3.

The total early-stage entrepreneurial activity line denotes the actual action according to Figure 5.3. The intention is lower than the motivation, meaning that people may have intentions or thoughts about starting a business, but the actual action or motivation is lower (see Figure 5.3). The discovery of low motivation or inaction is similar to the motivation literature discussed in sub-section 2.4.4 (Bosma et al., 2016; Karabulut, 2016; McClelland et al., 2005; Monitor, 2015).

The perceived capabilities focus on the values and norms as well as how individuals perceive themselves within the entrepreneurial journey and whether the norms or business support are in place. The researcher believes that inequalities within a green economy – as suggested by previous research (Guruswamy, 2010; Nhamo, 2013; Nunes et al., 2016; OECD, 2021; Venter et

al., 2020) – influence its capabilities and social norms. Similar to other studies (Sanyang & Huang, 2008; Agarwal et al., 2020; Borquist & de Bruin, 2019; Hechavarria, 2012; Irene, 2017; Kearins & Schaefer, 2017; Kimbu & Ngoasong, 2016; Maziriri et al., 2019), the results reflect inequality due to gender representation.

According to the Global Entrepreneurship Monitor (2017), most South Africans do not necessarily support small and emerging companies. Diale and Carrim (2022) found that women did not necessarily receive enough social support due to patriarchy and their questioned abilities within entrepreneurial markets. The representation of women in the pursuit of entrepreneurship still needs to improve. However, more women than men are inclined to save the environment; notwithstanding, the representation tells a different story as more men still dominate the entrepreneurial sector (Global et al., 2017). In pursuing entrepreneurship within the environmental or green sectors, female representation is outweighed by their male counterparts (Global et al., 2017). The data also shows a strong orientation towards starting a business from males than females (Global Entrepreneurship Monitor, 2017). The data does not provide a full representation of people living with disabilities and youth. The policies, framework, political will, and stakeholders from the community need to form a collective agenda in formulating and implementing the policies concerning the entrepreneurial mindset. The values and norms sub-variable slowly increased from years one to four and started to drop from years five to seven. These high and low spikes may be a result of society not believing in climate change, failing to see the importance of transitioning into a green economy or starting a business within green markets. As indicated in Figure 5.3, gender representation starts low in years one to four and gradually increases from year five with intentions to start an enterprise and the activity or action denoted by the entrepreneurial activity.

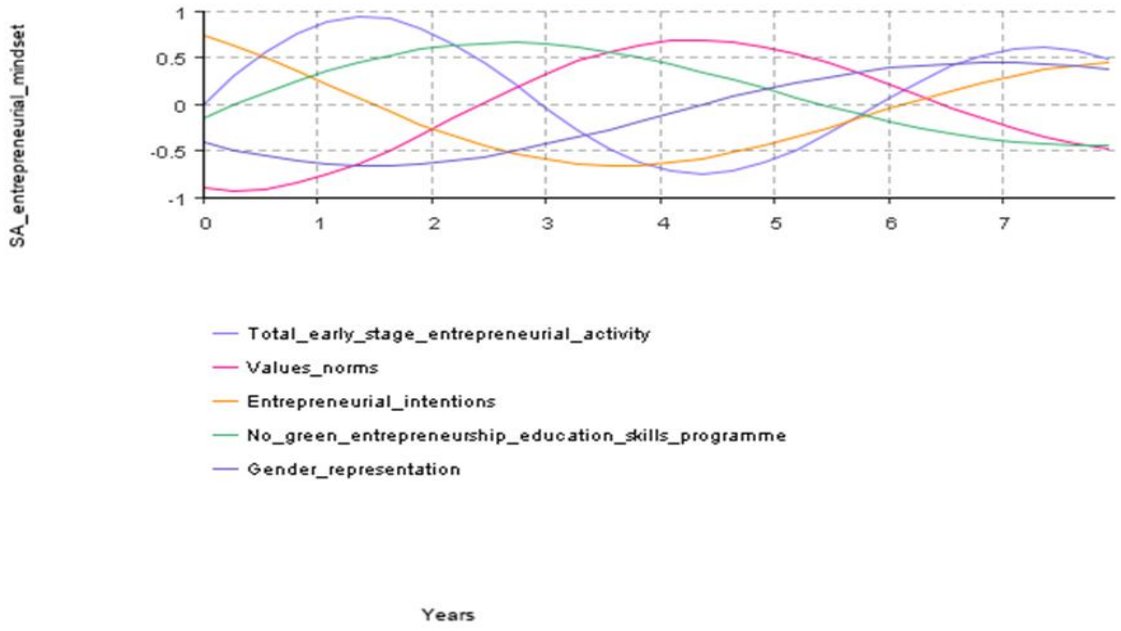


Figure **5.3**: SA entrepreneurial mindset chaotic and random path

5.2.5. Discussions on the South African green customers as part of the key drivers for green entrepreneurship

Figure 5.4 demonstrates that the knowledge and willingness supporting factor contributes favourably to the green market as the behaviour of the graphs shows a sharp increase from the start to year eight, as formulated using equation 3. A study is yet to show the behaviour of green customers within the system dynamics model. However, efforts have been made to highlight customer attitudes and willingness to contribute to green customers (Aslani & Mohaghar, 2013; Paco et al., 2019; González et al., 2017; Helms, 2016; Kardos et al.,2019; Liu et al., 2020; Li et al., 2018; Lotfi et al., 2018; Masocha, 2021; Skordoulis et al., 2017; Solaja, 2017; Xu & Liu, 2019). These studies used different methods and analyses ranging from surveys to statistical software, with similarities that focus on willingness, attitudes, and knowledge. The studies were also conducted in international markets with less focus on investigating the South African context. The green customers give emergence to the green consumer psychology. Consumer psychology focuses on the behavioural patterns, consumption, or an innate process guiding a person's behaviour to buy or not to

buy a particular product. Studies have suggested that the preference for environmentally friendly products and the willingness to pay more for green products needs to form part of the process (Paco et al., 2019), which can ultimately strengthen the commitment and the survival of the entrepreneurial ventures specialising in green products and services (Jayaratne et al., 2019).

Environmental practices need to unpack the business value chain and tailor the services and the products to the customer needs. A value chain is created based on environmental practices, thereby contributing to the concept of green consumer psychology. The argument impacts the transformation or the change of norms through green products and services. Regarding market differentiation and segmentation, strengthening the relationship with stakeholders is fundamental in ensuring that organisations practice a customer-centric approach and may provide the company with a competitive advantage (Tatoglu et al., 2020). Transformation or consumer psychology is an embedded concept in the construct of social entrepreneurship, which was coined by Schumpeter (2004) in considering entrepreneurship and the green economy, the social domain needs to be kept in mind.

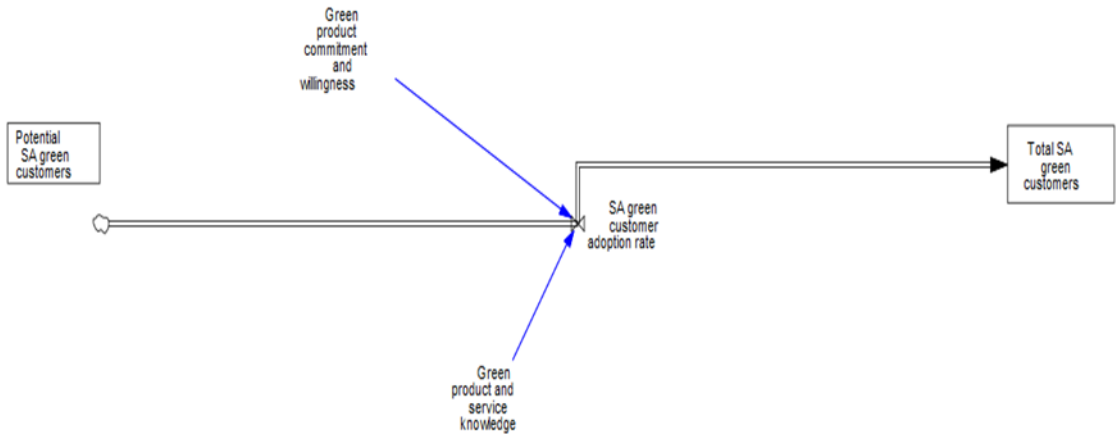
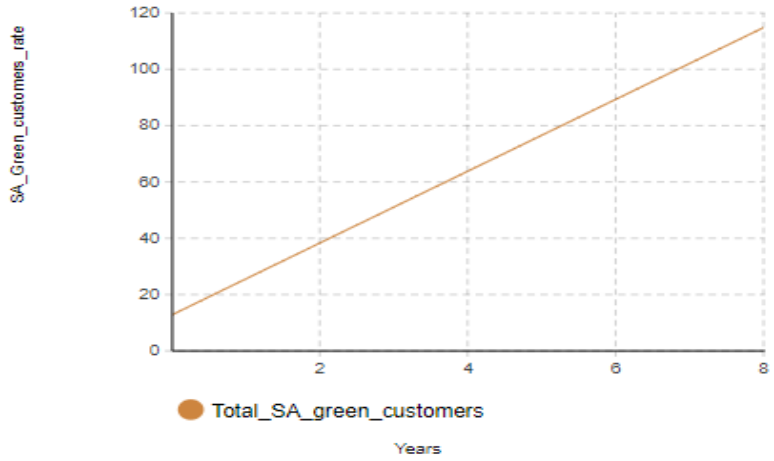


Figure 5.4: SA green customers and total SA green customers stocks and flow

The influences or contributors to the green customers are the willingness to support the product or services and to create awareness about the green products or services.

Figure 5.5: SA green customer's behavioural graph



5.2.6. Discussions on SA green finance and infrastructure

Green finance and infrastructure are additional high-level resources in determining the success or failure of any entity. The infrastructure capability is influenced by finance. If more investment is put aside for the green project, South Africa can implement and expand on green infrastructure. A Google Scholar search indicated that only a few studies from 2015 to date have focused on generic entrepreneurship, and the stocks and flow from international markets. This study contributes to the simulation of various infrastructures such as wastewater treatment infrastructure, business incubator water treatment plants, land reserved for commercial agriculture, energy infrastructure, landfill sites, bicycle lanes and routes and economic development zones in South Africa.

Teplov et al. (2016) modelled the stocks and flows from international markets and focused on the demand and supply, the GDP, and entrepreneurial activity. At the same time, Xia et al. (2018) focused on modelling academic entrepreneurship utilising system dynamics. Other studies, although dated,

were conducted on corporate entrepreneurship, the growth rate in entrepreneurship, entrepreneurial technology incubators, crowdfunding, and the support of start-ups using system dynamics in the international market (Bloodgood et al., 2015; Cosenz, 2017; Jamshidi et al., 2021; Saeidi- Aghdam et al., 2020). The call for public and private sectors to collaborate in reserving infrastructure and finances to support the viability of green businesses is suggested (Saeidi Aghdam et al., 2020).

Abdelkafi and Täuscher (2016) conducted a case study system dynamic modelling of the stocks and flows but did not utilise mathematical equations as their study focused on qualitative methodology. This study contributes to the macro-level green entrepreneurship ecosystem, the mathematical equations, and the integrated system dynamics utilising the stocks and flows, the dynamic variables, the causal loops, and the parameters. The study is the first to utilise the system dynamics methodology within green entrepreneurship in the South African context.

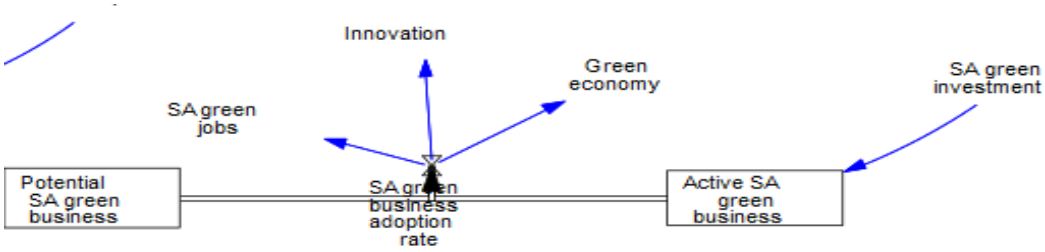


Figure 5.6: Potential SA green business and active SA green business

Figure 5.6 is then expanded to illustrate the impacting factors that may ensure the viability and sustainability of the business, as depicted in Figure 5.7.

Equation 2 was used in depicting the results in Figure 5.6.

Figure 5.7: SA business viability factors graph

A closely related business factor in support of the viability of entrepreneurship is finance, which moves with the same growth rate as the green GDP, and it somewhat supports the SA green business in one year and couple of months. From year two, there is a detachment. This detachment could be because the rate of investment remains the same, which requires more support from the government and private institutions in terms of ringfencing a green finance budget to continue supporting green businesses in South Africa. The relevant green funding institution is the DBSA, as explained in Chapter 2 (see sub-section 2.6.2)

Table 5.1 shows the capability of the green infrastructure and projections adding to the body of knowledge. By 2030, the land reserved for agriculture is expected to increase by 3%, while landfill sites and wastewater treatment plants increase by 6%, and the accumulated energy infrastructure by 9%. The accumulated green infrastructure for energy consists of wind, water, pumped storage, gas, nuclear and coal (see Appendix B). The energy sub-sectors are not robust in isolation; however, the capability is somewhat strongly supported when grouped. This may call for the urgency of different types of energy to be regulated and monitored in one environment or regulator. An example of the

solar park implemented in the Northern Cape can be used as a yardstick to see how best to regulate the types of green infrastructure in determining what resources and how various tools and ways of looking at the process can be maintained. The solar park was implemented to improve the economy through investor and tourist attraction and to ensure access to electricity, as explained in section 2.2.2. The latter intervention is similar to the work of Amankwah-Amoah (2015).

Further infrastructure discovered in the current context includes wastewater treatment plants, bicycle lanes or routes, landfill sites, and land reserved for commercial agricultural activities. The landfill sites can grow by 6% and the bicycle lanes by 30%. The infrastructure discovered in the South African context is similar to what has been discovered in international contexts (Adenle et al., 2019; Agathokleous et., 2017; Alcamo, 2017; Amankwah-Amoah, 2015; Andrews & Nwapi, 2018; Bamwesigye & Hlavackova, 2019; Brilliantova & Thurner, 2019; Burma, 2016; Carrera et al., 2018; 2019; Crossman & Pollino, 2018; de Groot et al., 2017; Dube & Nhamo, 2021; Gassner et al., 2019; Gujba et al., 2012; Grum et al., 2017; Javadinejad, 2019; Lonergan, 2018; Loock, 2012; Mukonza, 2020; Pamucar et al., 2021; Richter, 2012; Richter, 2013; Waha et al., 2018; Walsh, 2012; Yu et al., 2016). However, there is a difference in the type of variables and the methodology used in this study. There has not been a research focus nor a simulation on the land reserved for agricultural activities and the bicycle lanes as part of the green economy infrastructure. The land reservation focus was mainly on domestic agriculture or the redistribution of land for development (Julien et al., 2019), with less attention on the land reserved for agricultural and commercial activities. Most of the sources are dated, and few recent sources are calling for continued research in green infrastructure to take place.

Table 5.1

South African green infrastructure capability

Dynamic variable name	Current data	Ratio conversion of current data	Capability of growing by the following percentage in 2030
Number of business incubator	58%	5.8	40%
Number of water treatment plants	824	8.24	6%
Land reserved for commercial agriculture	37.9%	3.79	3%
Energy infrastructure	12.79%	1.28	9%
Landfill site	826	8.26	6%
Bicycle lanes and routes	4376	4.376	30
Number of economic development zones	11	1.1	8%

The additional infrastructures modelled in Figure 5.8 are business incubators (including the innovation hub) and economic development zones. The business incubators can grow by 40% and the economic development zones by 8% from now until 2030. Upon reviewing the number of incubators and the economic development zones, which are widely accessible on the internet (see Appendix B), there is not much focus on business incubators or the acceleration opportunities for green or environmental entrepreneurship in South Africa. As alluded to in Chapter 2, the green entrepreneurial ecosystems can be viewed through the lens where opportunities, such as the business incubators and the mandate for economic development zones to create jobs, alleviate poverty, and contribute to the country's overall economy. This discussion is in line with the findings from previous research (Yakovleva, 2018; Massa-Saluzzo & Toschi, 2018; Nikolaou et al., 2018; Rajan, 2019; Antolin-Lopez et al., 2019; Domańska et al., 2018). However, this study contributes to simulating the business

incubators with green infrastructure using a dynamic variable and a capability graph (see Figure 5.8) and Appendix C.

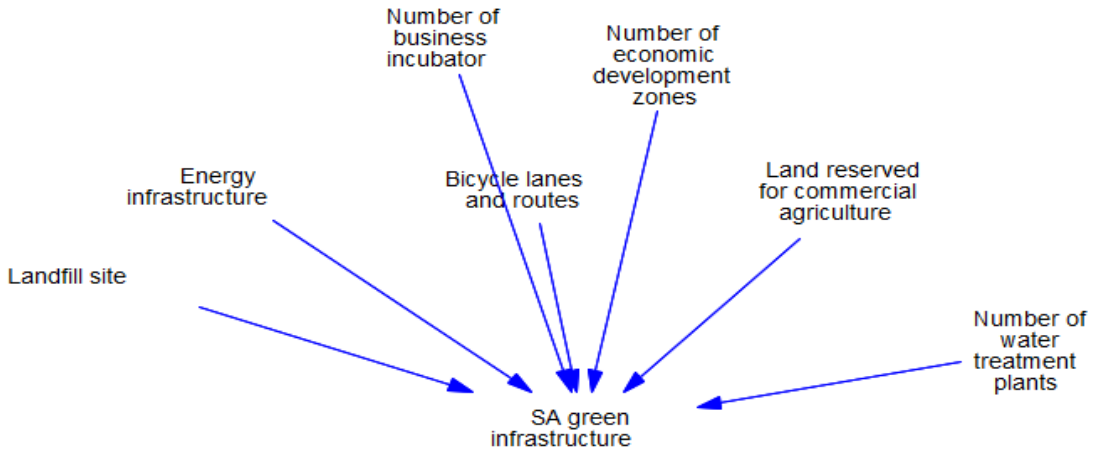


Figure 5.8: SA green infrastructure

5.3. DISCUSSIONS ON THE SOUTH AFRICAN CAUSAL LOOP FOR GREEN ENTREPRENEURSHIP DYNAMIC VARIABLES

Research question 3: Do the green entrepreneurship key drivers have a positive or a negative relationship in an iterative causal loop within a South African context?

The causal loop shows a positive iterative relationship, as per Figure 5.9. Equations 1, 3-7 were used to simulate the dynamic variables in Chapter 4. The causal loop has not been modelled, contributing to the body of knowledge.

Other studies using system dynamics focused on modelling environmental entrepreneurship, focusing specifically on the behavioural and social factors (Diale et al., 2021a). Studies using causal loop modelling did not focus on green entrepreneurship, but on the technical level of the wetlands systems (Colleta et al., 2021), creative problem-solving (Delgado-Maciel,2018), and the use of Twitter and biogas technology (Comrie et al., 2019; Roubík et al., 2020). These studies were conducted in international markets. The close causal loop

modelling deals with environmental challenges, sustainable market transformation and assessment of sustainable development goals (Colleta et al., 2021; Downing, 2022; Nijhof et al., 2021). The use of causal loops within system dynamics is under-researched. The current study thus contributes to the methodological convictions.

The equations of the table mentioned earlier from Appendix B are explained in Chapter 4 (see Section 4.1.2)

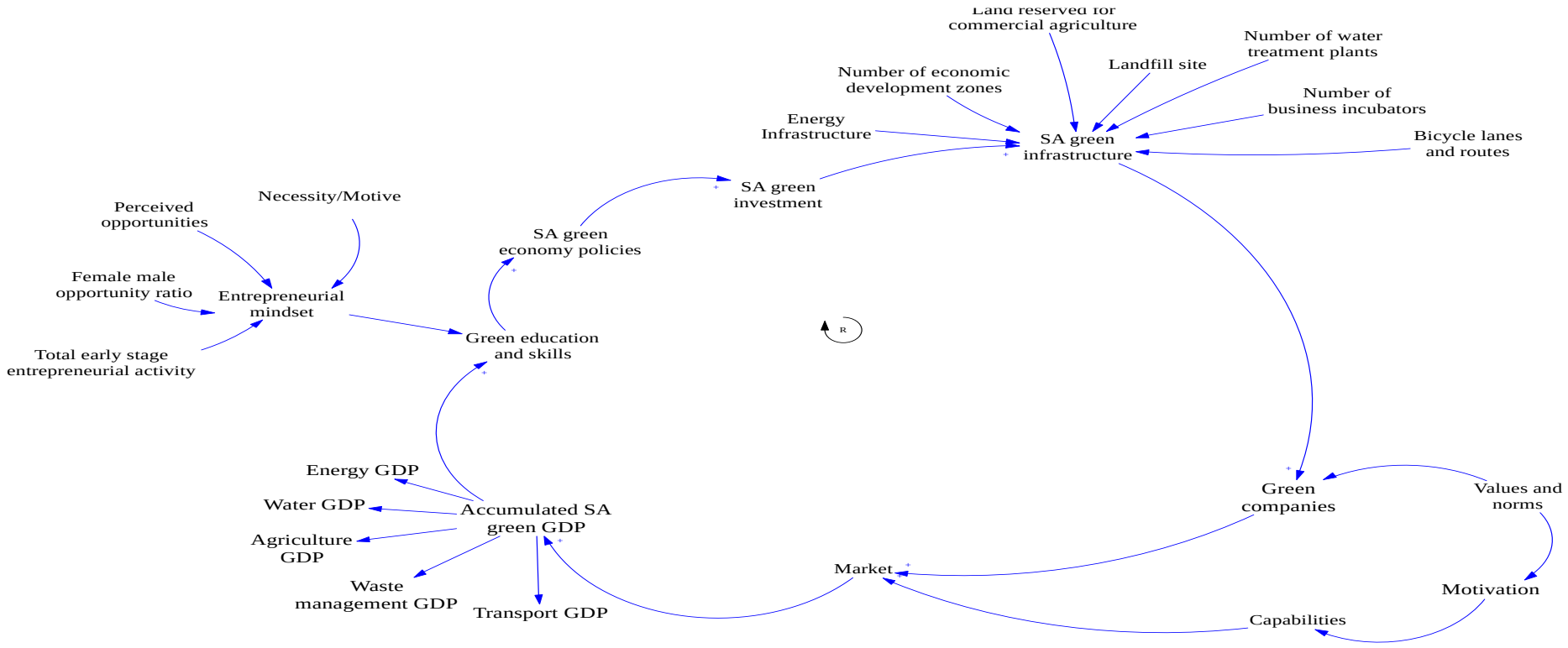


Figure 5.9: South African green entrepreneurship mental causal loop

5.4. DISCUSSION ON SUSTAINABLE BEHAVIOUR AND GREEN ENTREPRENEURSHIP TECHNOLOGY AS A MISSING LINK TO TRANSITION ONTO A GREEN ECONOMY IN A SOUTH AFRICAN CONTEXT

This section starts with a discussion on sustainable behaviour, proceeds to green entrepreneurship, and then discusses the contributing factors to a green economy.

Research question 5: Are sustainable behaviour and green entrepreneurship technology the missing links transitioning onto a green economy in South Africa?

As sustainable behaviour increases, so does the green economy (see Figure 5.10). Sustainable behaviour for enterprises and awareness must be considered and integrated into a policy (see Appendix C). This study shows the relationship between sustainable behaviour and green economy on the behavioural graph depicted in Figure 5.10. Upon discussing the sustainable behaviour of the enterprises, the subsequent section illustrates and discusses the relationship between sustainable behaviour and a green economy.

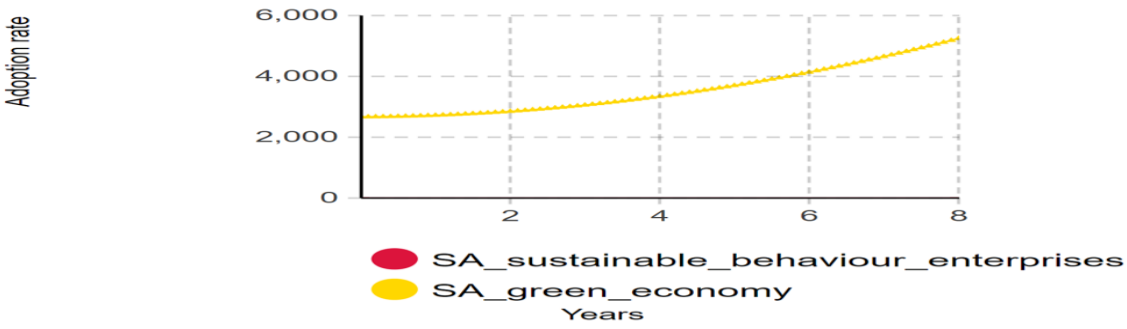


Figure 5.10: Sustainable behaviour as a missing link to a green economy

Figure 5.10 shows that the behavioural element can help transition into the green economy. It also illustrates that if more businesses adopt green behaviour to save the environment while benefiting society and contributing to the economy, the green economy adoption rate will increase. This study contributes

to the sustainable behaviour of green enterprises and modelling through dynamic variables and parameters. The cause of environmental challenges is due to human behaviour. The awareness on sustainable behaviour including the behavioural aspect with the lens of green entrepreneurship has been tested and validated in this research. The behavioural aspect serves as a significant factor in the field of industrial and organisational psychology as it not only focuses on the strategic elements of ensuring effectiveness in organisations and the well-being of employees, but it also focuses on organisational and employee behaviour (Barnard & Fourie, 2007; Barkhuizen et al., 2014; Khan et al., 2020; Schreuder, 2001; Troth & Guest, 2020; Van Vuuren, 2010). Other efforts conducted in sustainable behaviour were focused on the societal sphere. For instance, Fritsche et al. (2011; 2018) in their study paid less attention to the sustainable behaviour of enterprises.

As discussed in Chapter 2, sustainable behaviour entails preserving resources, saving the environment and benefiting society. While this study contributes to the adherence of sustainable behaviour within green entrepreneurship, previous research focused on sustainable behaviour or pro-environmental behaviour, such as recycling, using lift clubs to decrease the number of cars on the road, and the electricity and water usage within the communities (Busic-Sontic et al., 2017; Fritsche et al., 2018); however, and to a lesser stance, previous research also focused on the behaviour within the entrepreneurial ecosystem. The ecological constructs that were revealed by the previous research focus on anthropogenesis, biocentrism and the ecologisation (Afinegentova, 2018; Alade, 2019; de Groot & Thøgersen, 2018; Ivlev et al., 2019; Kovtun, 2020; Koziuk, 2020; Sabadash, 2020; Marina, 2020; Sabadash, 2020; Mou & Azees, 2019; Qazi et al., 2020; Ye et al., 2020; Zeng et al., 2020).

The ecological constructs call for the inclusion of social and people centrism in environmental and entrepreneurial policies. Anthropogenesis and ecologisation

focus on the triple bottom line of social, economic, and environmental savvy characteristics, comprising individual well-being, the legislature, and the political will and policy makers' buy-in. The buy-in and support are needed especially in putting aside the resources to build the business incubators and ecosystems. The support must come from both financial and non-financial pillars as part of the key drivers explained in sub-sections 2.6; 5.2.1.5-5.2.5.

As mentioned earlier, the discussions on green companies can be summarised in the dynamic variables and parameters (see Figure 5.11) and the capability (see Table 5.2).

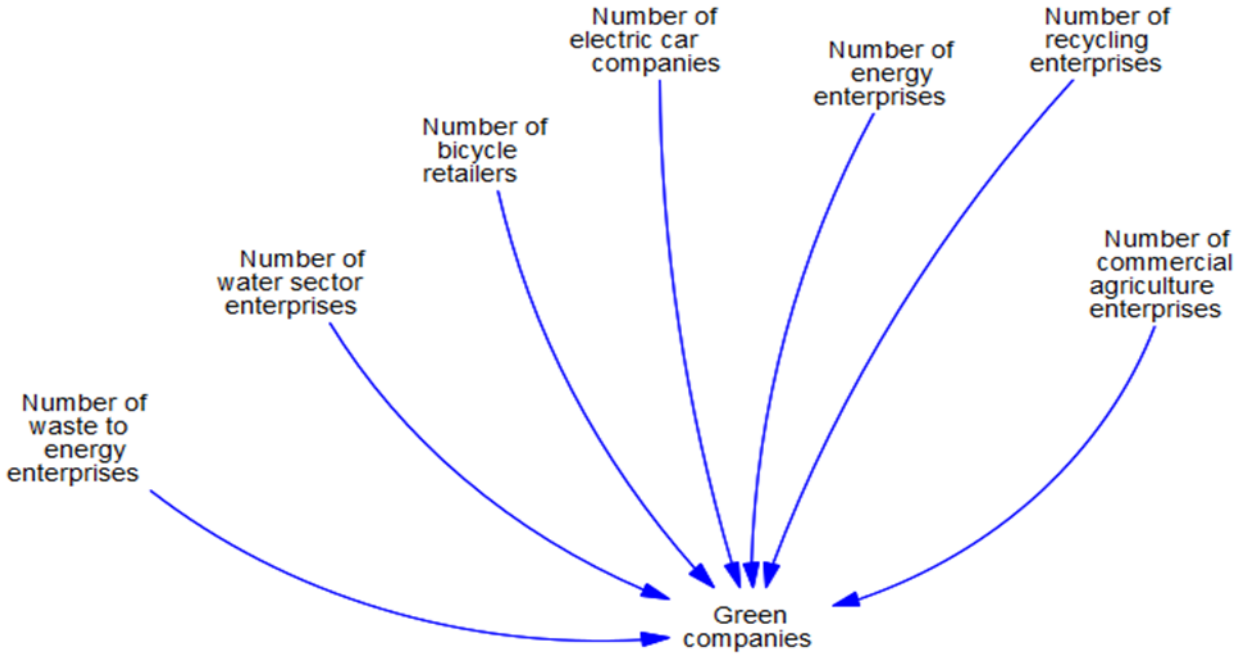


Figure **5.11**: SA green companies' dynamic variable with parameters

Table 5.2

South African green companies' capability

Dynamic variable name	**Current data**	**Ratio conversion of current data**	**Capability of growing by the following percentage in 2030**
Number of energy enterprises	42%	4.2	1%
Number of bicycle retailers	200	2.00	4%
Number of commercial agriculture enterprises	5%	0.5	84%
Number of electric cars companies	29.9%	2.9	1%
Number of recycling enterprises	300	3.00	6%
Number of waste to energy enterprises	3	0.3	0
Number of water sector enterprises	2.1%	0.21	0

Table 5.2 illustrates the dynamic variables with the parameters and the capability of the green companies focusing on the prioritised green thematic areas. The thematic area showing the capability of growing even much higher is within the agriculture sector. The other sectors, such as energy and water, would remain the same. However, the number of green companies will increase if more resources, such as infrastructure, increase, as illustrated in Figure 5.11.

5.6. DISCUSSION ON THE GREEN ENTREPRENEURSHIP AS A MISSING LINK TO TRANSITION ONTO THE GREEN ECONOMY

Figure 5.12 illustrates the validation that green business serves as a missing link to the green economy and that more adoption of green entrepreneurship boosts the green economy (See Figure 5.12, and equation 2 in Chapter 4). Green

enterprises within the South African context include enterprises specialising in the energy sector, bicycle retailers, commercial agriculture, electric cars, recycling, wastewater treatment companies, waste-to-energy companies and the water sector. As mentioned, the organisations are modelled as they have already adopted sustainable behaviour by finding alternative energy, water, agriculture, and waste management, thereby engaging in sustainable transport and mobility by focusing on bicycles and electric vehicles. Using bicycles promotes sustainable and healthy living, and creates community cohesiveness through fun rides (Kwiatkowski, 2018; Verlinghieri & Schwanen, 2020). The argument contributes to the social and the environmental spheres as there are zero emissions from riding a bike, and economically, the enterprises focusing on selling bikes creates jobs and generate profits. Electric vehicles are environmentally friendly (GreenCape Electric Vehicles Market Intelligence, 2020), and open further business opportunities in developing more charging stations or batteries. The innovation within the charging stations is enforced to ensure that the charging stations do not consume more electricity.

Commercial sustainable agriculture is another green entrepreneurial sector that ensures food security and a nourishing diet, generates profits, and benefits society. Sustainable agriculture further contributes to the sustainable development goal of alleviating hunger (Adenle et al., 2019; Gassner et al., 2019; Waha et al., 2018). Individuals often engage in farming or agriculture for personal gain but do not participate in the entrepreneurial space. The study discovered that investment needs to be strengthened to increase the capability of sustainable enterprises within the green economy thematic areas, similar to the discovery made by other scholars (Elsner et al., 2021; Kuyper et al., 2018).

The energy capability in this study is foreseen as an opportunity to create alternative forms of energy and waste-to-energy as there are only three organisations currently specialising in the space in South Africa. While the capability from 2022 to 2030 shows that the thematic area of energy has potential to grow, the growth rate could be better. Mechanisms such as investing in solar, hydro, renewable energy, and other alternative ways of ensuring

sustainable energy are foreseen to boost the sector (Amankwah-Amoah, 2015; Lonergan, 2018). Not only will the mechanism help with load-shedding, but it will bring cutting-edge innovation to alleviate the pressure of waste management using landfill sites. It will also engage with new ways of ensuring the environment is clean, contributing to green GDP and benefiting society. The investment in hydropower is influenced by the water sector, which, if the green entrepreneurs seize the opportunity, will indirectly reduce the impact of water crises, similar to findings by Lonergan (2018).

The golden thread from all the green companies that have adopted sustainable behaviour is the aspect of innovation. Innovation is expected to grow by 29% between now and 2030. The visualisation and the methodology of testing and validating the relationship between green economy and green entrepreneurship is explored in this thesis. The validation is depicted in Figure 5.12. However, there is a notable difference in the current study's contribution concerning system dynamics.

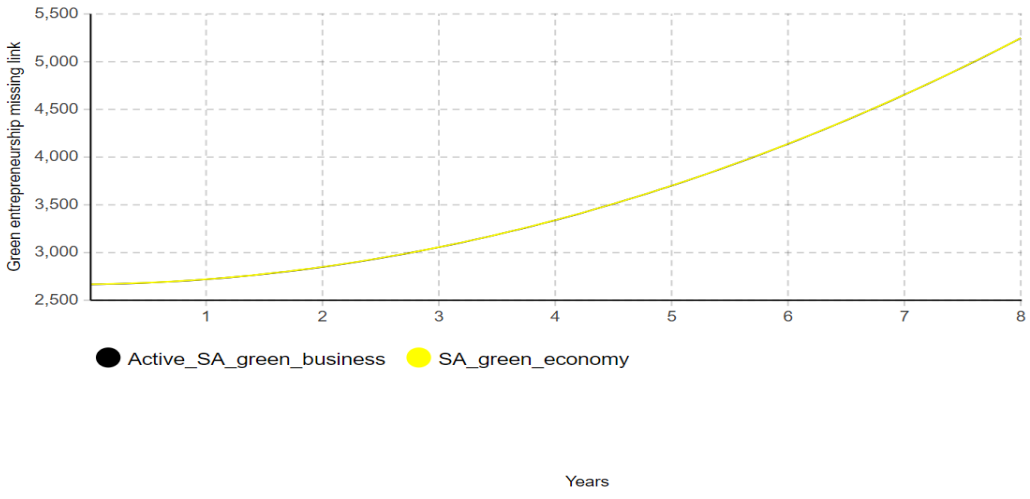


Figure 5.12. Green entrepreneurship as a missing link to green economy behavioural graph validation

5.7. CONCLUSION OF THE CHAPTER

The chapter discussed the findings and key drivers in formulating the model. The researcher further simulated the key variables using the causal loop, stocks

and flows, behavioural graphs and time series. Modelling and combining the entrepreneurship framework with an entrepreneurial mindset further contributed to the body of knowledge. The contribution has been unearthed using the study's key findings in answering the research questions. Time series was conducted in a quest to make the projections. The study further contributes by combining and grouping key variables such as green infrastructure and entrepreneurial mindset, to assess their capability.

CHAPTER 6: CONCLUSIONS, PRACTICAL APPLICATIONS, RECOMMENDATIONS, LIMITATIONS OF THE STUDY AND SELF-REFLECTIONS

6.1. CONCLUSION, APPLICATION, AND RECOMMENDATION TO THE FIELD OF INDUSTRIAL AND ORGANISATIONAL PSYCHOLOGY

The previously mentioned results and the discussion of the key drivers and the ecosystems (see sections 5.1-5.5) contribute to the transformed principles of industrial and organisational psychology with the integration of entrepreneurship. Industrial psychologists, through the formulated model in Figure 4.8, can offer accelerator programmes for emerging green entrepreneurs, leveraging on the entrepreneurial mindset sub-variable of the green entrepreneurship model. Industrial psychologists can facilitate SDG 8 of decent work and quality, specifically on the green infrastructure sub-variable, to promote productivity and ensure wellness, as well as a coaching and mentoring session as part of green business incubators and economic development zones. The model formulated in figure 4.18 contributes to the fourth industrial revolution, particularly on the elements of the internet of people [element of 4th industrial revolution] as well as contribution through the emergence of the green internet, ultimately resulting in the green industrial revolution. The fourth industrial revolution is supported by the level of innovation, which serves as a supporting sub-variable in the current study. A valid, reliable and fair recruitment and selection process conducted by industrial psychologists, especially in realising the green jobs sub-variable, is recommended. The tailored mechanisms supporting intrinsic and extrinsic motivation, giving emergence of green motivation, values, norms and accelerating capabilities and efficacy is recommended to form part of the scope of industrial psychologists. Subsections 6.1-6.9 provide further contributions where the discipline of industrial and organisational psychology can be utilised, especially with the green economy spectrum. A green entrepreneurship policy is formulated using the study results whereby industrial psychologists can assist and train various organisations,

including NGOs, learning institutions, and private and public sectors. The policy is available as Appendix C.

6.2. CONTRIBUTION THROUGH GREEN CAREER GUIDANCE

The best remedy is for the government and industrial psychologists to cooperate and collaborate in educating the youth, women, people living with disabilities, and non-binary people. Involving employees in adopting an ecological way of running the organisation and utilising green human resources creates green entrepreneurship as a career orientation (Diale et al., 2019). Career guidance needs a broadened scope to include the green savvy and ecological factors as well as the innovation in implementing green behaviour in any job role, be it accounting, management, engineering, or medicine. Managing obsolescence and leading different generational groups as part of career guidance within the green space broadens the scope of industrial and organisational psychologists. The most common career guidance procedure only focuses on guiding an individual in entering a workplace or pursuing a professional career (Coetzee et al., 2016) but with less attention to guiding an individual in pursuing a career within a green entrepreneurship journey. The latter shortfall is experienced in practice and forms part of a research journey.

6.3. CONTRIBUTION OF A GREEN ECONOMY TO HUMAN RESOURCE PSYCHOLOGY

Building on section 2.4.6 (a), the industrial psychologists' role, identity, and applicability have not received much attention, let alone the exploration of the IOPs' role in accelerating the sustainable development goals and transitioning to a green economy. It should be noted that although rewards and management are subfields of human resources, they need to be looked at from psychological and strategic levels. The ecologisation, biocentrism or pro-environmental behaviour, as explained in section 2.4.1.1 to formalise the process within the

human resource psychology perspectives, is recommended. A literature review was formulated drawing from the work of prominent authors concerning the green economy, green entrepreneurship, and green human resources practice (Ahmad, 2015; Ahmed et al., 2019; Diale et al., 2019; Diale et al., 2021b; Fritsche et al., 2018; Nhamo, 2017; Nhamo, 2020). The researcher has singled out elements from the literature to create a framework for industrial and organisational psychology. It was effected by reviewing various subfields of the IOP and green efforts to date. There is minimal research and contribution of the latter ecosystem in South Africa.

6.4. CONTRIBUTION OF THE INDUSTRIAL REVOLUTION, INNOVATION AND THE AFRICAN TRADE WITHIN THE GREEN SPACE

Some emerging industrial and organisational psychology fields are organisational citizenship behaviour, Industrial Revolution 4.0 and Knocking 5.0. The organisational citizenship behaviour tested through the lens of the impact of green behaviours, personality and traits is an emerging trend to which industrial psychologists can contribute. Work and organisation design 4.0 and 5.0 further evolve. The latter argument may take place by developing the competence to assist individuals, teams, and organisations in thriving in the green space. The development is premised on the nature and type of work, the required leadership, how work is organised and how the teams and the organisations are structured and organised to maintain the viability of green human resource practices.

Green entrepreneurship can be integrated within organisational development, disruption, agility, and sustainability as part of the green economy. Disrupting the known norms and culture within the green spaces, as well as tapping into the transformational and the laissez-faire types of leadership, can further be incorporated within the field of green economy, and they can further be championed by industrial and the organisational psychologists. The IOPs can

use strategic and scientific perspectives to plan and implement green talent and recruitment, complemented by the war for talent practices. Assessments, simulations, and in-basket activities will need to be developed focusing on the green economy or the sustainable development goals and using knowledge in administering, scoring, and interpreting the scores within the green assessments. In ensuring sustainability and impact, the IOPs can determine the standardisation, fairness, reliability and validity of the green assessment and the green management consulting processes. The latter argument may contribute to the employee's sense of belonging. Some studies have shown that employees pride themselves in being part of an organisation that integrates sustainability into the business processes or their functioning (Ahmad, 2015).

The fourth industrial revolution, particularly artificial intelligence tools, ethics, and managing role of each stakeholder, engages in paperless mechanisms and the management of the Internet of Things (IoT) to the Internet of People (IOP) with the auspices and the lenses of green entrepreneurship. The IOP may be premised within the interventions from people's perspective, as discussed in sub-sections 2.4 and 2.5.3.

The field of industrial and organisational psychology can serve as an expansion of the fourth industrial revolution and the green economy. Furthermore, it forms part of a person's wellbeing and uses machine learning by leading with innovation. Disruption through the different strategies is needed for industries to manage and adapt to the new behaviour methods. In this instance, the adoption and agility in transitioning into a green economy could be part of a disruption tactic. Disruption refers to a smaller company with fewer resources being able to successfully challenge established businesses (competitive advantage) by balancing products or technical innovation with social innovation norms (von Mutius, 2017). African and transformative perspectives must be focused on innovation and social norms.

There is a need to adopt and practise sustainable behaviour in preserving resources for current and future generations to combat environmental challenges in the global sphere. To incorporate “green” in business strategies, organisational functioning, and ecological footprint to complement industrial psychologists’ identity and role in assisting organisations to transition into a green economy effectively and efficiently is needed. The latter can be seen as living by the motto of incorporating innovation into leadership through the lens of an industrial psychologist in a green space. Innovation in the current study promoted new ways of using green and making a profit. The notion of disruption and free trade in Africa is recommended to steer innovation. Disruption requires different ways of embarking on entrepreneurship, through green entrepreneurship and for existing and emerging businesses to adopt new ways of behaving through pro-environmental behaviour. The foundation of pro-environmental behaviour, as suggested by Busic-Sontic et al. (2017), Fritsche et al. (2011), Fritsche et al. (2018) and Jugert et al. (2016), can be used to act as a catalyst in the green entrepreneurial environment. African free trade forms part of the innovation and new ways of thinking, and disruption by acquiring new knowledge and new ways of contributing to the economy and benefiting society.

Establishing, maintaining and monitoring change could be implemented using organisational behaviour principles – a subfield of industrial and organisational psychology. The intra-African trade countries could include green entrepreneurship in the agenda, strengthen collaboration through case studies, share best practices, and hold roundtable discussions. The return on investment must be monitored, especially within green education and training, rewarding responsible behaviour and encouraging agility. These tactics are to instil confidence in Africa as a means to support local green entrepreneurship, the green entrepreneurship curriculum, community engagement and research. This argument gives emergence to green agility and sustainability through entrepreneurship, including green and social entrepreneurship, which was detailed in Chapter 2 (see section 2.5.3).

6.5. CONTRIBUTION OF ORGANISATIONAL BEHAVIOUR AND THE DEVELOPMENT OF A GREEN ECONOMY

Organisational development and behaviour is another subfield of industrial and organisational psychology. Organisational development and behaviour should be represented more in the literature on green practices. The subfield can contribute to the organisation through behaviour modelling, skills development, the awareness to minimise wastage, preserving resources, holding dialogical conversations, and introducing interventions from individual, group, and organisational levels using the lens of a green economy. Sustainable and innovative leadership could foster inclusiveness. Organisational development and organisational behaviour emerge from change management. Upon reflecting on the theory of change as explained by Cummings and Worley (2016) and Cummings (2020), the application of the theory is explained in this section.

Change programmes can benefit organisations by retaining its values and culture, as well as ensuring that the strategy is always aligned with the culture, the vision, and the mission (Diale et al., 2022). Change management interventions can assist organisations in building optimistic and self-assured leadership and fostering innovative and collaborative environments with increased cohesiveness and morale (Miller, 2018). The framework can be used within a green enterprise. The organisations embarking on change are proactive, which leads to learning organisations because they focus on demanding external forces and pressures, which may lead to mechanisms that counter any threats (Miller, 2018). Other initiatives enabling the transition to a green economy are to choose ambassadors or champions in different sectors, such as private and public spaces and tertiary institutions. However, society or communities are often bypassed, which may add to change or the adoption of a new behaviour. Infrastructure and sponsorship must be in place to ensure that the resources are adequate for change. Some studies show a need for thorough

project planning and management as they are critical points for project efficiency (Diale et al., 2022; Malerba & McKelvey, 2020).

The communication of strategy throughout the change project should be maintained. A change champion needs to communicate the support they might need at an early stage, and they must also communicate progress in the form of the milestones that have been achieved, and all of which should be tracked and publicised (Malerba & McKelvey, 2020). People need to understand the reasons for change and the level of attribution of value if they need to embark on such change activities (Cummings & Cummings, 2020). Culture should be based on business strategy and objectives, which will feed into the change interventions (Cummings & Cummings, 2020; Rajanet et al., 2017). The affected employees' feelings, behaviour and thoughts must be investigated and addressed by supporting, training and reinforcing behaviour (Luthans & Youssef-Morgan, 2017).

With minimal peer-reviewed publications on creating readiness to change within the fourth industrial revolution and the green economy, the researcher proposes that fourth industrial revolution elements such as the internet of things, internet of behaviour (IoB), block chain and data mining can be intregated into sustainable development goals. The latter can be implemented using the literature framework from the IoB and the psychology of human interaction with a machine (Sundar, 2020).

The need to have leadership and change management academy training in the organisation is crucial as it will support the internal change management capability (Tidd & Bessant, 2020). The process of internal capacity building on change management can begin with mapping the responsibilities of change management, as well as matching and identifying talent pools that match the identified criteria of change managers (Tidd & Bessant, 2020). Although no published material exists on change management and the green economy or on

green entrepreneurship, closely related fields to change management such as human resources management can serve as the beginning stages in the quest to build theory onto industrial and organisational psychology.

6.6. CONTRIBUTION THROUGH GREEN ERGONOMICS

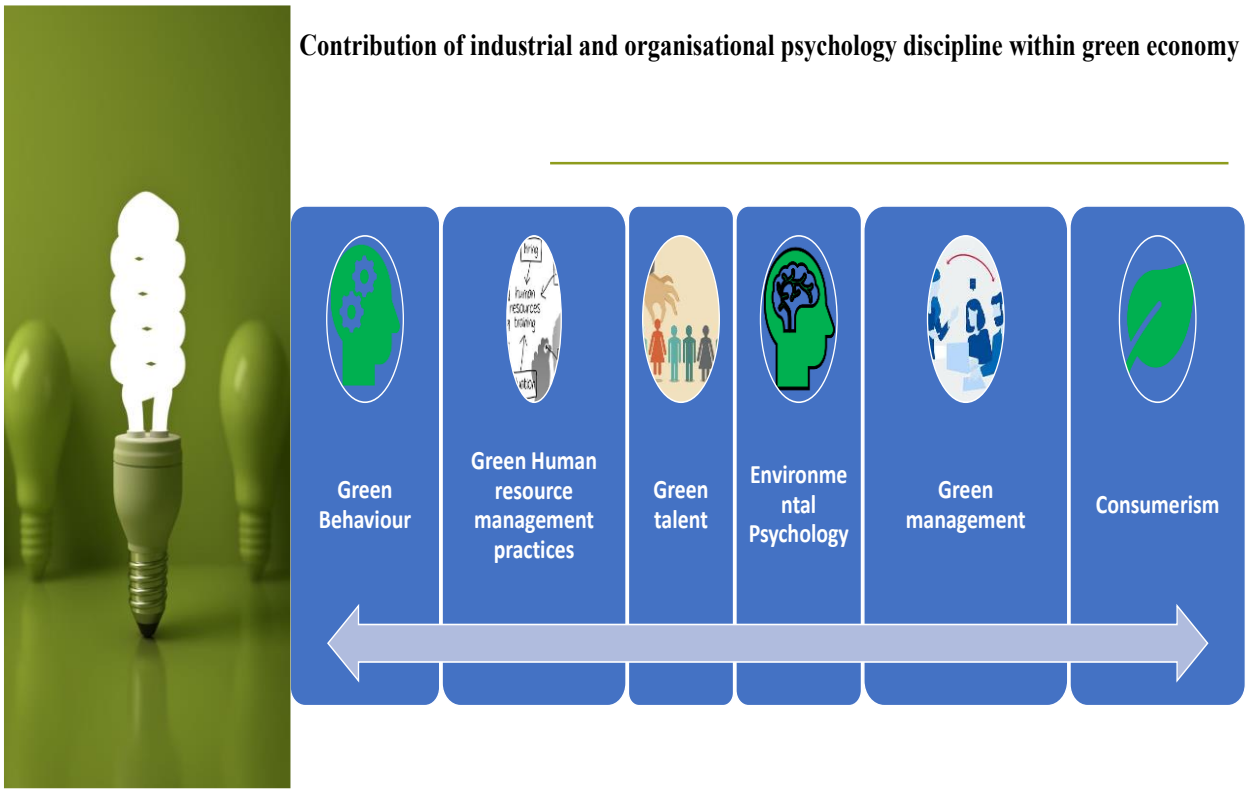
The emergence of smart and sustainable manufacturing to feed into green ergonomics was highlighted in sub-section 2.4.6. The IOP can manage and monitor the process from a people's perspective by ensuring wellbeing, productivity, team morale and cohesion. Green ergonomics can be integrated into the green sectors of green buildings and sustainable livelihoods as well as into furniture manufacturing using recycled materials. Green ergonomics can be closely linked to the principles of green building, and they may be included in one bylaw. As briefly explained in 2.4.6, a green building is often characterised as a building that is designed using environmentally friendly materials and sustainable resources. Green building indicators such as the energy efficiency dimension, the indoor environmental quality dimension, the sustainable site planning and the management dimension, the materials and resources dimension, and the water efficiency dimension, as advocated by Basset et al. (2021), can be adequately managed to enhance an employee's performance and wellbeing through the lens of ergonomics.

6.7. CONTRIBUTION THROUGH CAPACITY DEVELOPMENT

Capacity development and skills enhancement as a subfield of IOP is the cornerstone to transitioning to a green economy. The argument may assist individuals and organisations in adopting and monitoring sustainable behaviour as part of a business strategy (Ahmed et al., 2019). Training employees to preserve resources, education, separating waste at source, and saving the planet are missing links within the South African context. The HRM policies can be modified and expanded to manage and accelerate the use of resources and to promote environmentalism, ultimately contributing to satisfaction and employee morale (Ahmad, 2015).

6.8. CONTRIBUTION THROUGH GREEN CONSUMER PSYCHOLOGY

Green consumer psychology, emerging from the variable of the green customer serves, is discussed in subsection 2.6.3.3 and subsection 5.2.4. The subfields discussed in subsections 2.4.6 and 6.1-6.6 can be effected using scientific and behavioural competencies, assessments, facilitation and management consulting through applied organisational development training interventions, emotional intelligence, and green strategic human resources practices – the discussion is be summarised in Figure 6.1.



Own compilation

Figure 6.1: Contribution of industrial and organisational psychology discipline within green economy

6.9. ADDITIONAL CONTRIBUTIONS

An additional contribution concerning African values and the *botho* principles is supported in section 6.9.1, and the environmental challenges are turned into

entrepreneurial opportunities (see sections 2.1; 6.9.2). The sustainable development goals and the triple bottom effect of the economy, the environment, and the social sphere are explained throughout this study and highlighted in section 6.9.4.

6.9.1. African human attributes perspectives and green entrepreneurship

Upon reviewing the literature on individual human attributes, the concept of Africanism using the principles of *botho* emergef. Humanising green entrepreneurship and system dynamics needs to consider the concept of *botho,* empathy and managing power relations. The *botho* concept has been investigated in Botswana as a key driver to sustainable development and focuses on humanity as a whole (Mihigo, 2019). There needs to be more literature on *botho* principles, especially from the perspective of green entrepreneurship. Mkhize (2018) has investigated the *ubuntu* principles from the ethics governing the fields of psychology and argues that the process is Western and that the African perspectives must be incorporated. Using the concept of *ubuntu*, Maphalala (2017) provides a conceptual framework for interpersonal, intrapersonal, and environmental values.

Individuals using *ubuntu* as a philosophy know the importance and value of saving the environment. This study focused less on the concept and the environment of environmental entrepreneurship. The terms are somewhat similar, with a slight difference. While one term is used in Nguni languages (Ubuntu), the other is translated into Setswana or Sesotho. Although the Nguni languages and Setswana or Sesotho are all African languages, some ideologies define and differentiate the cultures or traditions, so the definition of green entrepreneurship may differ for different cultures. The concept of *botho* can be explained as a social contract of mutual respect, humanity, responsibility, and accountability the members have with each other (Mihigo, 2019). It can be implemented within sustainable development in terms of sharing resources, knowledge and culture, while also ensuring equality and humanising the

engineering field (system dynamics). The *botho* principle and treating the environment humanely while generating profits and benefiting society is imposed by introducing the concept of *green botho.* The principles of *botho* within green entrepreneurship can be translated as the driving force or motivational tactics that people have about the environment, the ethos and moral obligations, character and people's perception on environmental values. People's enjoyment, passion, and fulfilment of the environment can help preserve natural resources while generating wealth and jobs. The awareness *human* people have about the environment and the roles they need to fulfil in order to save the environment or transition to a green economy and establish enterprises to assist in job creation and green skills serve as the lenses of the *botho* principles, which forms part of African values.

Humanising physical fields is premised on social turn and efficacy. Furthermore, humanising physical fields is founded on taking into consideration individuals' feelings and inputs. It ensures that individuals co-create the journey of green entrepreneurship. Therefore, the current study aimed to integrate attitudes and values within the green economy and the green entrepreneurial perspectives from a macro perspective. The expectations and assumptions about green entrepreneurship must be at the forefront of the process between the community, the researcher, and emerging green entrepreneurs. The journey's outcome may result in a positive relationship may be if there is mutuality, partnership and collaboration. Sensitivity, motivation, resilience and self-efficacy can further contribute to the *botho* framework. Helplessness and pressures to succeed, as well as a work-life balance and mentorship or coaching, are emerging concepts that need close attention, especially when looking at the transformative practices within the green entrepreneurship journey.

The following brief discussions are opinion-based with borrowed theory from Mamman et al. (2016) and Wairire and Muiruri (2016) because of the minimal literature on the African perspective. The concept of *botho* may aid in

humanising engineering, the green economy and entrepreneurship. Furthermore, humanising the scientific fields may be argued to take a person-centred approach. The field of industrial and organisational psychology will play a significant role through change management, societal norms, values, motivation, commitment, and transformative mechanisms. Humanising the process could mean deconstructing and re-defining structures to enable social justice in ensuring equality through, for instance, access to green entrepreneurial markets and empowerment. Humanising the scientific perspectives may tap into civic virtue, community development and poverty reduction to ensure that green entrepreneurs are socially aware leaders of tomorrow (Mamman et al., 2016; Wairire & Muiruri, 2016). Collaboration, co-creation, and the multi-disciplinary nature of the current study can contribute to transformative practices.

A shift from being individualistic to being a collectivist within the auspices of *botho* is needed to contribute to the current context, thereby accelerating humanising the fields. Upon reflecting on the *botho* concept, giving back using one's own culture, beliefs, and customs in entrepreneurship contributes to African psychology and does not necessarily rely on international perspectives. Entrepreneurial ecosystems can be viewed from the lens of cultural and social structures, institutions, and legacy whereby the community will benefit in the form of business incubators, accelerators, or entrepreneurship centres to alleviate poverty and contribute to the overall economy of the country (Roundy, 2016; Spigel, 2015).

For entrepreneurship to be understood and seen as a sense-making tool, it must be understood from the social constructions and narratives that emerge for society to benefit from the discourse (Roundy, 2016). The success factors or the success stories can only emerge from the life story approach to disseminate and communicate the lessons learned (Isenberg, 2016). Within the notion of transformation, part of social justice can be related to culture, whereby society

focuses on how knowledge is generated. Transformation can also be seen as instilling Africanism because it looks at collectivism, inclusivity, and engagement (Diale, 2022). The previous statement contributed to the transformation of green entrepreneurship to include culture and Africanism, primarily through collectivism and shared ethos. Collectivism is reinforced with collective efficacy under environmental psychology, as discussed in the previous section. When discussing the transformation social aspects of the green economy, pro-environmental behaviours (Hassan, 2020) emerge and are further reinforced in the previous section on environmental psychology.

The impact of the green economy mechanism will need to be carefully designed and mapped for current and future generations. The mapping may include benefits of learning more about climate change and how to capitalise on pro-environmental action or behaviour in transitioning into green entrepreneurship in the South African context.

6.9.2. Environmental challenges turned into entrepreneurial opportunities.

Of all the reviewed empirical literature, turning the challenges mentioned in each thematic sector into profit could cause stress and pressures in an attempt to save the environment while benefiting society (green entrepreneurship). There is pressure to perform and offer solutions from the multi-disciplinary approach of industrial psychology and from engineering perspectives to thrive and cope in unprecedented times. Furthermore, the scenarios formulated can be a toolkit for coaching green and emerging entrepreneurs.

6.9.3. Contribution through a triple bottom

The triple bottom effect of social, economic, and environmental factors is implied in Chapter 2 and section 5.2.1, and the environmental sphere is discussed in section 2.2.1 to 2.5.3 as well as sections 5.2.2 and 5.2.3. The social and behavioural sphere are also discussed. The latter spheres form part of the ecosystem for green entrepreneurship.

6.9.4. Contribution through sustainable development goals

Upon discussing the results from tangible, complex and people-centred perspective, innovation and infrastructure embedded within industrial and organisational psychology emerged in the application of entrepreneurship to address SDG goal 1, 2,8 and 9. The integration of psychology, green entrepreneurship and engineering contributes to the theory of the psychology of entrepreneurship and the psychology of engineering through the green economy. The history of industrial psychology began during World War II to bring awareness to the psychological factors, human behaviour and the observation and emergence of the Hawthorne studies in the 1920s. The need emerged to introduce industrial psychology as, at the time, industrial engineering was the main focus. As a scientific and behavioural field, industrial psychology was needed because human behaviour and the role of well-being were missing (Schultz & Schultz, 2020). Therefore, industrial engineering and industrial psychology are somewhat similar. For instance, industrial psychology uses systems thinking, and industrial engineering uses system dynamics. Both fields ensure efficiency and agility in organisations, with one focusing on people and the other focusing on machines and processes.

A further contribution is creating a green business incubator using the key drivers of green entrepreneurship, the sustainable development goals, and social entrepreneurship leveraging *botho* principles. Furthermore, the contribution of the role of the industrial psychologists, which is represented within the economic, environmental and social spheres, is depicted in Figure 7, which is then supported by the simulation and analysis in Chapter 4 and the policy in Appendix C. The incubator suggests that green entrepreneurship support should be viewed from something other than financial and physical infrastructure. However, it should be people-centric, and the values and psychology of entrepreneurship need to be the cornerstones of the incubator. The incubator's mandate is to raise awareness that green entrepreneurship

could assist in the transitioning into a green economy by contributing to the economy through job creation and saving the environment by being aware of one's behaviour and being in a position to turn challenges posed in the environment into opportunities for entrepreneurship. The key stakeholders that need to support the incubator are listed on the policy in Appendix C, namely the IOPs, the community members, the political buy-in and industrial engineering with careful regulatory requirements set as in Appendix C. The economic pillar to which the IOPs could contribute is through job seeking and career and entrepreneurship guidance. The IOPs could contribute through behavioural monitoring and rewarding green behaviour or green champions as premised within environmental psychology and the ecological theory constructs described in Chapter 2. Lastly, the IOPS could contribute to the social sphere by eliciting values, norms and awareness concerning the green economy and entrepreneurship.

6.10. FUTURE RESEARCH AND LIMITATIONS OF THE STUDY

In terms of the future research agenda, the entrepreneurial mindset characteristics, such as the entrepreneurial intentions and the total entrepreneurial activity, could be investigated by undertaking a qualitative study on the lack of action to pursue entrepreneurial endeavours, primarily in the green economy space. The variable green customers can be investigated using consumer psychology principles. The perceptions and attitudes of people living with disabilities and the non-binary within an entrepreneurial mindset can be investigated as a future research agenda. More research on ecologisation, biocentrism and the anthropogenesis of environmental values is needed in the African context.

The study's limitations were that some sources were outdated, and some were non-existent. However, the latter served as an advantage as the researcher could contribute to the body of knowledge. Job creation could not be pulled and simulated entirely as the existing data is only on waste management. At the

same time, there is no published data on job creation regarding the other prioritised green thematic areas. So, due to the shortcoming, the researcher could not simulate the job creation variable using the system dynamics modelling approach. However, the shortcoming calls for the research agenda to model green jobs using system dynamics modelling.

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APPENDICES

APPENDIX A: ETHICAL CLEARANCE

UNISA

UNISA SOE ETHICS REVIEW COMMITTEE

Date: 13/12/2019

CREC Reference # :
2019/CSFT_SOE/MGK/001
Name : Dr Mukondeleli Grace Katumba
Student #:
Staff #: 90138469

Dear Dr Mukondeleli Graco Katumbu

Decision: Ethics Approval from 13/12/2019 to 13/12/2024

Researcher(s): Name: Dr Mukondeleli Grace Katumba
E-mail address: katumg@unisa.ac.za
Telephone #: 011 670 9222

Supervisor (s): N/A

Co-Researcher(s): Name: Ms. Carol Dineo Diale
E-mail address: c.diale@rdi.ac.za
Telephone #: 0466037379/0815106404

Working title of research:
Green Entrepreneurship model utilising the system dynamics approach; A review

Qualification: Non-Degree

Thank you for the application for research ethics clearance by the Unisa SOE Ethics Review Committee for the above mentioned research. Ethics approval is granted for 5 years.

UNISA

UNISA SOE ETHICS REVIEW COMMITTEE

Date: 13/12/2019

CREC Reference # :
2019/CSFT_SOE/MGK/001
Name : Dr Mukondeleli Grace Katumba
Student #:
Staff #: 90138469

Dear Dr Mukondeleli Graco Katumbu

Decision: Ethics Approval from 13/12/2019 to 13/12/2024

Researcher(s): Name: Dr Mukondeleli Grace Katumba
E-mail address: katumg@unisa.ac.za
Telephone #: 011 670 9222

Supervisor (s): N/A

Co-Researcher(s): Name: Ms. Carol Dineo Diale
E-mail address: c.diale@rdi.ac.za
Telephone #: 0466037379/0815106404

Working title of research:
Green Entrepreneurship model utilising the system dynamics approach; A review

Qualification: Non-Degree

Thank you for the application for research ethics clearance by the Unisa SOE Ethics Review Committee for the above mentioned research. Ethics approval is granted for 5 years.

APPENDIX B: RESULTS AND SOURCES OF DATA

Variable	Data used to feed onto the model.	Source type to support the variable. (Readily available online or the internet)	Links readily available
Population	South African population stats	Stats SA	https://www.google.com/search?q=south+african+population&rlz=1C1GCEA_enZA994ZA994&oq=south+african+population&aqs=chrome..69i57j0i512l9.7995j0j15&sourceid=chrome&ie=UTF-8
Green policies and framework	South African Green economy activities 60% [page 14 of the report]		https://www.un-page.org/files/public/green_economy_inventory_for_south_africa.pdf https://www.dffe.gov.za/projectsprogrammes/greenfund

		United Nations; Green economy inventory for South Africa: An overview	https://www.dffe.gov.za/sites/default/files/reports/greeneconomy_policyreview.pdf https://www.statssa.gov.za/?p=11527

Green companies	**Green companies' goods and services:** Number of bicycle retailers = 200. Number of busses enterprises = 41 (Buses that are environmentally) Electric car companies 29.9% Number of enterprises in water sector = 2.1%. Number of energy companies= 24%.	Tread media magazine SA facts GreenCape electric Vehicles 2020 Market Intelligence Report. GreenCape Water 2020 Market Intelligence Report	https://www.treadmtb.co.za/sa-bicycle-industry-faces-unprecedented-challenge/#:~:text=While%20many%20industries%20are%20either,Is%20it%20going%20to%20last%3F https://safacts.co.za/list-of-bus-companies-in-south-africa-3/ https://www.greencape.co.za/assets/ELECTRIC_VEHICLES_MARKET_INTELLIGENCE_REPORT_25_3_20_WEB.pdf https://www.greencape.co.za/assets/WATER_MARKET_INTELLIGENCE_REPORT_19_3_20_WEB.pdf https://safacts.co.za/list-of-energy-companies-in-south-africa-2/ https://agriorbit.com/a-closer-look-at-sustainable-farming-trends-in-south-africa/

	Number of commercial sustainable agriculture 5%.	Agriorbit	https://www.plasticsinfo.co.za/2019/08/23/the-state-of-south-african-recycling-companies/
	Number of recycling companies' enterprise=300	Plastics SA.	https://www.environmental-expert.com/companies/keyword-water-treatment-929/location-south-africa
	Number of wastewater treatment companies 155 number, ratio 1.6	Water treatment companies and suppliers	http://www.energy.gov.za/files/biogas/2017-Biogas-Conference/day2/New-Horizons-Waste-to-Energy.pdf

	Number of waste to energy companies 1 large scale waste to energy company New horizon situated in Cape town	New Horizon	https://www.yokogawa.com/za/industries/renewable-energy/waste-to-energy/
			https://www.engineeringnews.co.za/article/ground-breaking-waste-to-energy-plant-opens-in-cape-town-2017-01-24/rep_id:4136
	1 small scale incorporated from the Netherlands titled Yokogawa South Africa (Pty) Ltd	Yokogawa South Africa (Pty) Ltd	w.gemconsortium.org/file/open?fileId=50411
			https://www.gov.za/about-government/government-programmes/eco-schools-programme
	Anaergia technology waste to energy company specialising in	Anaergia technology waste	https://www.ru.ac.za/elrc/researchprojects/eco-schools/

Entrepreneurial mindset	converting organic waste to energy Total 3 waste to energy enterprises in SA. Values and social norms 4.40 Male and female representation total entrepreneurial ratio 0.69 Innovation 29.7% Perceived capabilities 39.9%.	South African Government eco schools' programme Global Entrepreneurship Monitor (2017) Eco schools and business school's website	https://www.giz.de/en/worldwide/17848.html

	Number of green education skills programme 10 258 [inclusive of formal, informal education, universities, colleges, eco schools and government training programmes. The information retrieved as follows: 10229 eco schools 3 Business schools at universities have curricular on green economy 7 TVET colleges with a green economy curricular.	TVET and the promotion of innovation for climate and environment-related employment; Skills for Green Jobs (S4GJ)	

	Then government initiatives on green education are as follows: 19 waste education informal, for instance mascots, awareness days advocated by DEA, TVET and the promotion of innovation for climate and environment		
	SA entrepreneurial mindset includes: total early-stage entrepreneurial activity [11%], ratio; female male opportunity ratio	Global Entrepreneurship Monitor	https://www.gemconsortium.org/file/open?fileId=50411

	[0.80], entrepreneurial intentions [11.7%], necessity or motivation [1.5]; perceived opportunities 42%.		
SA green infrastructure	No of bicycle lanes or routes 4594 ratio of 45.94 Landfill sites 826 ratio of 8.26 Accumulated energy infrastructure capability 127%, or ratio of 12.7 derived as follows: Electricity 25%; ratio 2.5 Coal 83%; ratio 8.3	Bike Map GreenCape Business tech DBSA Green Fund Department of Energy [DOE]	https://www.bikemap.net/en/l/953987/ Energy http://www.energy.gov.za/files/media/explained/2019-South-African-Energy-Sector-Report.pdf

	Nuclear 4%; ratio 0.4 Gas 5%; ratio 0.5 Pumped storage 6%. Ratio 0.6 Hydro power 2%; ratio 0.2 Wind power 0.2%. Number of water treatment plants 824 ratio [8.24] Land reserved for commercial	Mail and Guardian Stats SA on land reserved for commercial agriculture Climate policy DBSA	https://mg.co.za/article/2017-07-21-south-africas-shit-has-hit-the-fan/ https://www.statssa.gov.za/?p=13144 https://www.climatepolicyinitiative.org/wp-content/uploads/2021/01/South-African-Climate-Finance-Landscape-January-2021.pdf https://www.dbsa.org/sites/default/files/media/documents/2021-

	agricultural activities 37.9% ratio of 3.79 Number of SA business incubators 58		09/DBSA%20Integrated%20Annual%20Report%202021.pdf https://www.entrepreneur.com/en-za/starting-a-business/the-definitive-list-of-south-african-business-incubators/327566 https://mg.co.za/special-reports/2021-10-22-sas-special-economic-zone-programme-gains-ground/#:~:text=South%20Africa%20has%2011%20designated,Mpumalanga%2C%20Free%20State%20and%20Gauteng.

	Number of SA economic development zones 11		
Macro variable: Market	**The green market is simulated through customers as follows:**	Open book UCT	https://openbooks.uct.ac.za/uct/catalog/download/29/43/1401?inline=1
	Total SA customers [derived from data on people who can afford to buy goods	Business Live	https://www.businesslive.co.za/redzone/news-insights/2016-01-07-consumers-willing-to-pay-more-for-brands-committed-to-sustainability-/

	and services in South Africa=18 million. Commitment to green product and service 68% ratio 0.68 Knowledge about green product and service 52% ratio 0.52	Mastercard	https://newsroom.mastercard.com/mea/press-releases/98-of-adults-in-south-africa-willing-to-take-personal-action-on-sustainability-issues/
Green GDP	11.93 [aggregated GDP from energy and water [0], [transport 6.5%] [waste management	Stats SA Economic status	https://www.statssa.gov.za/?p=14643

	2.9%], [agriculture 2.53%]	Statista	http://www.statssa.gov.za/publications/P0441/P04413rd Quarter2021.pdf
		Department of Transport	https://www.statista.com/statistics/371233/south-africa-gdp-distribution-across-economic-sectors/
			https://www.transport.gov.za/documents/11623/39906/4_EconomicStatus2017.pdf/c47470b7-90f4-48cf-bd96-b82878d651fa#:~:text=Economic%20data%20indicate%20that%20the,income%20within%20a%20national%20economy.
	No documented policy on energy, water, transport, agriculture and waste management enterprises contribution to the GDP in SA	World Bank	https://www.worldbank.org/en/news/press-release/2022/06/07/stagflation-risk-rises-amid-sharp-slowdown-in-growth-energy-markets

Green jobs	Number of People employed in agriculture 868 000	Statista	https://www.statista.com/statistics/1134712/employment-in-agriculture-hunting-forestry-and-fishing-in-south-africa/
	Number of people are employed in sustainable energy in south Africa 28 000	Mail and Guardian	https://mg.co.za/article/2017-05-29-00-renewable-energy-sector-turns-into-employer-of-note/#:~:text=More%20than%2062%20000%20people,renewable%20industry%20on%20the%20continent. https://www.environment.co.za/sustainable-green-business-news/bottled-water-industry-vital-player-in-sa-economy.html#:~:text=While%20certainly%20not%20the%20largest,sales%20of%20R3%20550%2Dmillion.
	Number of people employed in sustainable water in south Africa 1 800	Environment	https://www.esi-africa.com/industry-sectors/energy-efficiency/e-mobility-already-exists-in-sa-and-business-opportunities-abound/#:~:text=GreenCape's%20report%20points%20out%20total,900%2C000%20people%20directly%20and%20indirectly.

	People are employed within electric vehicle sector in South Africa 900 000, Currently, South Africa's waste management industry is estimated to be valued at R15bn, supporting around 30 000 jobs - *but these numbers could be a lot higher if more of our waste is recycled.*	GreenCape WWF	https://www.iol.co.za/weekend-argus/news/more-than-29-000-jobs-in-the-waste-management-sector-c0c681a5-a66a-49bb-bfa5-736f2002fec6 https://tgh.co.za/wp-content/uploads/2017/10/wwf_transport_employment_brief_online.pdf

	30 000 jobs Number of people employed in sustainable transport 453 000		

APPENDIX C: SOUTH AFRICAN GREEN ENTREPRENEURSHIP POLICY

Formulated by Carol Dineo Diale, registered Industrial Psychologist
Email: PhD holder's email
Formulated on 16 August 2022

1. Background

There is pressure to transition to a green economy globally, and innovative ways are encouraged. This policy bridges the gap in ensuring that the green entrepreneurial mindset can contribute to the economy by assisting in transitioning into a green economy and benefitting society while protecting the environment. The policy aims to ensure that green entrepreneurship materialises as per the guidelines of the National Development Plan Agenda 2030.

2. Purpose

The policy aims to protect the green entrepreneurs' environment and to foster access to green entrepreneurship. Furthermore, this policy seeks to foster training and development principles in encouraging intentions or maintaining green entrepreneurship through acquiring green skills and green finance.

3. Scope

Provision of various interventions to support green entrepreneurship, such as financial and non-financial support. The non-financial support focuses on green infrastructure, green entrepreneurial skills and education, and green marketing.

5. **Applies to** women, men, non-binary youth, learners, students, and people living with disabilities within waste management, transport and mobility, sustainable energy, agriculture, and water. The policy should

favour more women and non-binary people, and then the focus can be on men.

5. Regulatory departments

Department of Economic Development and Tourism, Department of Small Business, Department of Trade and Industry, Department of Environmental Affairs, Department of Women, Youth and Persons Living with Disabilities, South African Development Agency, Green Youth Indaba, Umsombovu, Department of Energy, Department of Water and Sanitation, Department of Agriculture, Land Reform, and Rural Development; Department of Transport, Innovation Hub, Department of Basic Education and the Department of Higher Education and Training.

6. Regulatory frameworks

Green economy framework, carbon tax, sustainable behaviour, 4IR moving to 5IR tools, system dynamics principles.

7. **Practical steps to regulate the key drivers to foster a green entrepreneurial mindset**

7.1. The green fund or investment to be accessible by the target group mentioned in Sub-section 5;

7.2. Introducing short courses on green skills and education can later be built into a formal degree of green entrepreneurship;

7.3 More green finance to assist with green infrastructure;

7.4. Incentives for the enterprises that have adopted sustainable behaviour and profit as well as for those that create jobs out of the sustainable behaviour practice;

7.5. Necessary accommodation when it comes to tax;

7.6 Women, youth, non-binary, and people living with disabilities, followed by men, should receive high points in awarding of tender, by the BBBEE score card

[green BBBEE score card] looking at innovations, adherence to values and norms of a particular society, people staying in rural areas or semi-rural areas;

7.7. Finance, land for commercial agriculture, enterprises in electric cars or selling or manufacturing bicycles or rechargeable for electric vehicles, using efficient energy mechanisms owned by women, youth, non-binary, and people living with disabilities followed by men;

7.8. More awareness, campaigns, practices, and community hall talks should be held to raise awareness of green products and services to gain customers [green champions];

7.9. Training should be on green entrepreneurship alertness, business plan, executive compliance summary within green entrepreneurship, training green finance for non-financial green managers, training on motivation, sustainable behaviour, resilience, mindfulness, and design thinking to foster innovation, as well as testing the viability of green product and service;

7.10. Subsidy claims for training and development with green entrepreneurial organisations to be introduced;

7.11. Amendment of BBBEE codes to have sections on green entrepreneurship and the awarding of tenders within the green entrepreneurial sectors;

7.12. Amend the Skill Development Act to foster subsidy claiming for the training that is rolled out within a green entrepreneurial mindset;

7.13. Green entrepreneurship is part of the curriculum introduced in primary education, higher education and training.

8. Monitoring and evaluation

The monitoring and evaluation of green entrepreneurship should consist of the success factors, increasing the client base, how many people apply for funding, attending green entrepreneurial training, feedback collected during entrepreneurial endeavour, performance across different years, understanding green competitors, establishing the key performance indicators, and suggesting improvements.

8.1 Stakeholders

- Political buy-in support of the adoption of green entrepreneurship.
- Industrial psychologists formulate reliable, valid and fair assessments and introduce green entrepreneurship interventions from the individual, group and organisational levels.
- Using dynamic system modelling, industrial psychologists and engineers model the system's behaviour over time.
- The community members suggest and input on the policy and assist in implementation.
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APPENDIX D: EDITING CERTIFICATE

LoveToEdit

You Write. We Edit. You Love it.

23 January 2023

TO WHOM IT MAY CONCERN

RE: CONFIRMATION OF LANGUAGE EDITING SERVICES: CAROL DINEO DIALE

I confirm that I have done language editing for Carol Dineo Diale's thesis titled:

A SOUTH AFRICAN GREEN ENTREPRENEURSHIP MODEL UTILISING A SYSTEM DYNAMICS APPROACH

The thesis now conforms to the University of South Africa's language editing standards.

Yours sincerely

Mogo

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