

Corporate Entrepreneurship and Environmental Sustainability in South Africa's Chemicals Sector

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**A research article submitted to the Faculty of Commerce, Law and
Management, University of the Witwatersrand, in partial fulfilment of the
requirements for the degree of Master of Business Administration**

Johannesburg, 2023

Protocol number: WBS/BA0613188W/200

Version June 2023

DECLARATION

I, Itukiseng Ntshani, declare that this research article is my own work except as indicated in the references and acknowledgments. It is submitted in partial fulfillment of the requirements for the degree of Master of Business Administration in the Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.



Itukiseng Ntshani

Signed at Johannesburg

On the 27th day of February 2023

ACKNOWLEDGEMENTS

I dedicate this report to my husband, Mikhuva Ntshani, and my daughter, Unahina Ntshani, for their unwavering support throughout the MBA journey and everything else happening in parallel. Thank you for tolerating my absence and being my constant pillar of strength. I couldn't have done this without you!

My sincere gratitude to:

- My research supervisor, Dr. Kagiso (TK) Pooe, for sharing your wisdom and guidance to enable me to complete this study.
- The individuals from nature conservation NGOs and government agencies for generously contributing your time, information, referrals, and views to this study.
- My colleagues in the 2021/2022 WBS MBA cohort. Thank you for your company through the MBA “struggle.” My interactions with you have resulted in what I believe will be life-long friendships and networks.
- My colleagues, coaches, and mentors for continuously supporting and fuelling my interest in environmental sustainability and business management topics.
- My family, especially “Mmane” and “Kokwani,” my two mothers, for your unconditional love and prayers. Thank you, Refilwe Sebopa and Charles Sebopa, for laying a solid foundation for my future and raising me to have a passion for education and learning.

Above all, I thank God for giving me good health, ambition, a solid support structure, grit, and the belief that I can achieve anything I set out to achieve.

SUPPLEMENTARY INFORMATION

Nominated journal: Southern African Journal of Entrepreneurship and
Small Business Management

Supervisor / Co-author: Dr. Kagiso Pooe

Word count: 14 043

Supplementary files: Interview schedule; Information Sheet

ABSTRACT

Companies in the South African chemicals industry are under pressure to reduce greenhouse gas emissions from their operations while ensuring job preservation and value creation for all their stakeholders. Greenhouse gases primarily emanate from burning and processing fossil fuels like crude oil and natural gas. Over 90% of the feedstock for chemical production is obtained from fossil fuels (IEA, 2018), which is not environmentally sustainable.

Literature suggests that applying the concept of corporate entrepreneurship can play a vital role in developing solutions to enhance a company's economic, environmental, and social outcomes (Aparicio et al., 2020). Despite this suggestion, the amount of research done on the application of corporate entrepreneurship to address environmental sustainability challenges is limited, especially in the South African context. This study applies a qualitative research methodology, using a case study research method to investigate if corporate entrepreneurship can address environmental sustainability challenges in South Africa's chemicals manufacturing sector. Secondary data on companies in South Africa's chemicals manufacturing value chain was obtained from various digital platforms and triangulated with primary data from interviews to conduct this research. Interview participants included individuals from environmental conservation NGOs and government agencies. The collected data was analyzed in ATLAS.ti through coding and visualization techniques. The results indicate that companies in South Africa's chemicals manufacturing sector are applying elements of corporate entrepreneurship theory to develop strategies to address environmental sustainability challenges. Individuals from environmental conservation NGOs and government agencies believe corporate entrepreneurship can effectively address environmental sustainability challenges in the chemical manufacturing sector. Most strategies, plans, and projects announced by the companies are yet to be implemented. Therefore, it is yet to be confirmed if these strategies will effectively address the environmental sustainability challenges.

KEY WORDS

Case study

Chemicals manufacturing

Climate change

Corporate entrepreneurship

Environmental sustainability

Fossil fuels

Green Products

Just Transition

Non-Government Organizations (NGOs)

Petrochemicals

Qualitative

ACRONYMS

CBM	Circular Business Model
CoP	Conference of the Parties
EU	European Union
GDP	Gross Domestic Product
NDC	Nationally Determined Contribution
PCC	Presidential Climate Commission
UK	United Kingdom
UN	United Nations
US	United States of America

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SECTION 1: INTRODUCTION AND PROBLEM STATEMENT

1. Introduction

Environmental sustainability and climate change have been increasingly under the spotlight recently. South Africa is one of the more than 190 countries that have signed the Paris Agreement to reduce greenhouse gas emissions to combat climate change (United Nations, 2015). Manufacturing companies in South Africa's chemicals sector contribute over 10% of the country's total greenhouse gas emissions (NBI et al., 2021). As a result, these companies are under pressure to reduce their greenhouse gas emissions and shift towards more sustainable value chains. This study will examine how existing manufacturing companies in the chemicals sector will survive and thrive in a low greenhouse gas emissions future South Africa. This problem will be examined through the lens of corporate entrepreneurship, exploring the potential application of this concept to address environmental sustainability challenges in the South African chemicals industry.

2. Background and problem definition

It is essential to understand the history and causes of climate change and why corporates must include environmental sustainability matrices in their short, medium, and long-term goals. The landscape of environmental sustainability can be global, country-related, or industry-specific (Alola & Akadiri, 2021). Exploring the application of theoretical concepts to resolve environmental sustainability-related problems may benefit corporations in various industries and regions.

2.1 Global environmental sustainability challenges

Various scientists and authors (Boorman, 1997; Dale et al., 2000; Hulme et al., 1999; O'brien & Leichenko, 2000) have highlighted the concepts of climate change and global warming over decades. Global warming refers to the harmful effects of human activity on the planet's climate patterns (Houghton, 2005). These activities include burning fossil fuels like coal, oil, and natural gas to produce energy and other products like petrol and plastics (Janssens-Maenhout et al., 2017; Johnsson et al., 2018). Gases like carbon dioxide, sulphur dioxide, and nitrogen oxide are released as by-products from the processes and remain in the atmosphere, creating a greenhouse effect on planet earth. This greenhouse effect results in a general increase in ambient temperatures associated with unpleasant climate change (Johnsson et al., 2018).

The United Nations signed the Paris Agreement in December 2015 in recognition of the need to combat global warming and its effects on the planet. It is a legally binding agreement signed by 196 countries globally to limit global warming to below 2 degrees Celsius and further below 1.5 degrees Celsius below pre-industrial conditions (United Nations, 2015). The Paris Agreement comes with a framework to reduce global warming and respond to the effects of climate change. The agreement requires participating countries to submit their nationally determined contributions (NDC) that indicate their plans to reduce greenhouse gas emissions by 2030 and beyond (United Nations, 2015).

Scientific research indicates that, apart from unwanted climate change, greenhouse gases and other particulate matter emissions into the atmosphere can cause respiratory illnesses and other medical conditions in human beings, which often lead to mortality (World Health Organization, 2019). In light of these findings, several non-government organizations (NGOs) and social activists pressure governments and corporates to set and achieve more ambitious emission reduction goals (African Climate Alliance, 2022; Greenpeace Africa, 2022).

Scientific research indicates that the effects of global warming and climate change are increasingly being witnessed globally, increasing the consensus that the current dependence of human beings on fossil-based resources is not environmentally sustainable (Houghton, 2005). Consumers are, therefore, increasingly placing a higher value on more environmentally sustainable products, using sustainable resources like biomass (Morone et al., 2021).

2.2 Environmental sustainability landscape in South Africa

South Africa is one of the participating countries of the Paris Agreement; therefore, it is required to achieve the NDC towards a global reduction in climate change emissions by 2030. Apart from pressure from the Paris Agreement, South Africa is also experiencing the adverse effects of climate change through droughts, localized flooding, and extreme ambient temperatures (PCC, 2022a). Additionally, developed regions like the European Union are reviewing their international trade laws to introduce carbon border adjustment mechanisms to restrict carbon-intensive goods from being imported to their countries (European Commission, 2021). This will have a negative impact on South Africa's exports and economic growth (AFD, 2022).

Carbon tax is one of the levers the South African government uses to compel companies to decrease their annual greenhouse gas emissions (SARS, 2020). Companies are charged a specified tax rate per ton of greenhouse gasses (expressed in carbon dioxide equivalent) emitted to the atmosphere due to their operations. Companies are, however, permitted to offset the impact of their primary greenhouse gas emissions through investing/funding other activities that either remove greenhouse gasses from the atmosphere or reduce the number of greenhouse gasses that would have been emitted in the absence of their interventions (SARS, 2020). For example, a company can fund a renewable energy project that would then be used to power a community, replacing the power that the coal-based electricity supplier, Eskom, would have supplied. Renewable energy produced from solar and wind is considered clean energy, as it results in negligible

greenhouse gas emissions compared to Eskom's current coal-based electricity generation (RSA, 2021).

The company would then be credited (awarded carbon credits) for reducing the greenhouse gas emissions Eskom would have emitted to produce the electric power. Investment in projects that offset greenhouse gas emissions (carbon offsets) are often achieved at a lower cost than modifying existing industrial processes to reduce greenhouse gas emissions (RSA, 2021). The challenge with carbon offsets is that the government has set a limit to the percentage of greenhouse gas emissions that may be offset in this manner (SARS, 2020). The integrity and sustainability of carbon offsets is often questioned as to whether the projects are initiated to offset greenhouse gas emissions or if the projects would have occurred regardless of the offset benefit (Gillenwater, 2012; TED, 2022).

Apart from carbon tax, companies considered high greenhouse gas emitters, like Eskom and those in the chemicals industry, are often pressured by social activists and members of nearby communities to reduce greenhouse gas emissions (WWF, 2017). Several complaints and media reports allege that respiratory illnesses directly result from greenhouse gas emissions from nearby industrial operations (African Climate Alliance, 2022). The current global focus on greenhouse gas reductions created by the Paris Agreement has amplified these complaints, increasing the damage they can cause to a company's reputation (Han & Ahn, 2020). The companies would prefer to be perceived as caring to their employees and surrounding communities instead of causing damage to their health (BP, 2023; IEA, 2020; SAPREF, 2019; Sasol, 2022).

The pressure to reduce greenhouse gas emissions requires companies that rely on fossil fuels like coal and crude oil as feedstock to their processes to consider shifting towards cleaner alternatives (Denchak, 2022). The challenge is that these alternatives are likely to come at higher costs, require new technologies that are not readily available, and require skills that are different from those that the current workforce possesses (eNCA, 2022). The companies are also responsible for

ensuring that the transition towards more sustainable feedstocks and products is done justly, minimizing job losses and other side effects (PCC, 2022a).

Achieving a Just Transition has recently been highlighted and debated in various forums (CSIS, 2021; TED, 2022). A Just Transition is a concept that politicians, business leadership, and civil society frequently reference to highlight the need to ensure that no one is disadvantaged by the global transition of industries from fossil fuels towards greener feedstocks like biomass and cleaner energy sources like solar and wind (CSIS, 2021). A Just Transition is also referenced to highlight the need to ensure everyone gains from the economic and health benefits of transitioning from fossil fuels to a greener economy (EBRD, n.d.).

Examples of these forums include the 26th United Nations Conference of the Parties (COP26, 2021), which was geared towards accelerating progress to achieve the goals of the Paris Agreement. The president of South Africa has also established a Presidential Climate Commission (PCC) that includes government officials, social activists, private business representatives, and various other stakeholders. The PCC intends to “facilitate and oversee a just and equitable transition towards a low-emissions and climate-resilient economy” (PCC, 2022b).

To support a Just Transition, the Paris Agreement recognizes the responsibility of developed countries to help developing countries with funds and other resources (United Nations, 2015). In November 2021, the EU, USA, UK, Germany, and France committed to mobilize \$8.5 billion in grants and other low-cost funding to aid South Africa’s transition towards a low-emissions economy (Swilling, 2022). This presents an opportunity for private and State-owned enterprises (SOEs) to access low-cost funding to facilitate a Just Transition.

2.3 South Africa’s chemicals manufacturing sector

The chemicals manufacturing sector in South Africa contributes 13% of the total country’s greenhouse gas emissions (NBI et al., 2021). This is one of the main

reasons why environmental sustainability and climate change NGOs, civil society, and the government are pressuring companies in this sector to reduce their greenhouse gas emissions. At the same time, this sector currently contributes over 6% of the country's gross domestic product (GDP) (NBI et al., 2021). The top three contributors to SA's GDP in 2019 in this sector include (NBI et al., 2021):

1. Sasol, a multi-national company that mainly processes coal, natural gas, and crude oil to produce a variety of fuels and petrochemicals (Sasol, 2022);
2. AECL, an international company that specializes in chemicals, agrihealth, water treatment, and mining solutions (AECL, 2023); and
3. Omnia, a South Africa-based company specializing in chemicals, mining and agriculture solutions, and operates in over twenty other countries (Omnia, 2022).

The three companies highlighted above do not necessarily form part of this study. They are included to indicate the types of companies that form part of this sector by mentioning three of the most famous brands in the South African chemicals sector. Trade unions, civil society, and government recognize the risk of job losses as companies implement various strategies to reduce their carbon footprint (350Africa.org, 2022; ITUCCSI, 2019; PCC, 2022c). The PCC intends to drive South Africa toward a Just Transition away from fossil fuels (PCC, 2022a).

Companies in sectors that currently rely on fossil fuel-based feedstock and energy are at the forefront of the global climate change challenge. The chemicals manufacturing sector's contribution of over 10% to the country's greenhouse gas emissions places it in the spotlight of climate change debates. Companies in this sector must respond to external pressures to transition towards environmentally sustainable operations while remaining competitive and profitable. Therefore, the chemicals manufacturing sector will be the basis of this research, exploring the application of the corporate entrepreneurship theory to overcome environmental sustainability challenges.

2.4 Problem statement and research question

2.4.1 Problem statement

The South African chemicals industry is under pressure to reduce carbon emissions while ensuring job preservation and value creation for shareholders and other stakeholders. Decisions that the leadership of these companies will make in this decade will potentially determine whether they will thrive in the new low-carbon economy or perish. Many of these company strategies have leveraged fossil-based feedstock, skills, and technologies thus far.

The problem this study will examine is how existing manufacturing companies in the chemicals manufacturing sector will survive and thrive in a future low-greenhouse gas emissions South Africa. This problem will be examined through the lens of corporate entrepreneurship, exploring the potential application of this concept to address environmental sustainability challenges in South Africa's chemicals manufacturing industry.

2.4.2 Research questions and objectives

2.4.2.1 Research questions

- **Main Research question**

How can companies in South Africa's chemicals manufacturing sector use corporate entrepreneurship to address environmental sustainability challenges?

- **Sub-question 1**

What is the state of South Africa's chemicals manufacturing sector concerning environmental sustainability?

- **Sub-question 2**

What is meant by the idea of corporate entrepreneurship?

- **Sub-question 3**

Can the concept of corporate entrepreneurship assist companies in the chemicals manufacturing sector in addressing environmental sustainability challenges?

2.4.2.2 Objectives

The objectives of this study are:

1. To examine the state of South Africa's chemicals manufacturing sector concerning environmental sustainability.
2. To investigate what is meant by the idea of corporate entrepreneurship.
3. To investigate if the concept of corporate entrepreneurship can assist companies in the chemicals manufacturing sector to address environmental sustainability challenges.

2.4.2.3 Purpose of the Study

This study aims to explore corporate entrepreneurship in addressing environmental sustainability, using manufacturing companies in South Africa's chemical manufacturing sector. Due to the sensitivity of the environmental sustainability topic in this sector, the research will not be based on a specific company. The chemicals industry in South Africa will be researched by gathering information from available secondary data on manufacturing companies in this sector, triangulated with data collected from interviewing individuals from environmental conservation NGOs and government agencies. No company names are included in this report's results section to prevent potential backlash and increased criticism from civil society directed to specific companies as a result of the publication of this study.

SECTION 2: APPLICATION OF PRIOR RESEARCH

1. Introduction

To investigate the applicability of corporate entrepreneurship to address environmental sustainability challenges, it is crucial to investigate how various scholars describe the two concepts, namely: i) corporate entrepreneurship; and ii) environmental sustainability. This section seeks to do a literature review on the identified concepts in order to identify a theoretical framework that will form a basis for further research to contribute towards existing theories and findings.

2. The theory of corporate entrepreneurship

The concept of corporate entrepreneurship can be separated into sub-elements, depending on how the organization uses internal and external resources to improve or maintain its competitive advantage. Christensen (2004) identifies (i) corporate venturing; (ii) the use of internal resources; (iii) internationalization; and (iv) the use of external networks as the four perspectives of corporate entrepreneurship.

The first three perspectives emphasize the organization's ability to apply its internal resources and capabilities to create new value for the business. In contrast, the fourth perspective focuses on the corporate's ability to form strategic partnerships or alliances to complement its current skills with resources and capabilities in areas where it lacks. As such, Christensen (2004) categorizes the first three perspectives as intrapreneurial activities, while the fourth perspective is referred to as exopreneurship.

The view of corporate entrepreneurship by Chang (1998) is aligned with that of Christensen (2004) in that they both recognize intrapreneurship and exopreneurship as two perspectives that fall under the corporate entrepreneurship umbrella. Chang (1998) argues that it is often not practical to distinguish between

the benefits gained by corporates through intrapreneurship versus exopreneurship because organizations usually apply both approaches simultaneously.

Åmo (2010) differs from Chang (1998) and Christensen (2004) in that he recognizes corporate entrepreneurship and intrapreneurship as two different lenses that can be used to study employees' innovative behaviour. Åmo (2010) identifies corporate entrepreneurship as a lens that can be used to study the influence of an organization's leadership on employees' innovative behaviour. On the other hand, intrapreneurship is a lens used to study individual employees' innovative behaviour, regardless of the support or resistance experienced from leadership. Nonetheless, Åmo (2010) also recognizes that both corporate entrepreneurship and intrapreneurship result in innovations that ultimately positively impact the organization's bottom line.

In this research project, corporate entrepreneurship is recognized as the umbrella term used to define all elements of intrapreneurship and exopreneurship, in line with the views of Chang (1998) and Christensen (2004).

3. The theory of Environmental Sustainability

Morelli (2011, p. 6) defines environmental sustainability as “.. meeting the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them..”. Environmental sustainability is a concept that studies the impact of human behaviour on the ecosystem that they live in, as they go about their daily lives and accessing resources to improve their welfare (Moldan et al., 2012). Human behaviour contributes to environmental challenges like increased waste, pollution, and climate change, which impair the ecosystem's ability to sustain the welfare of the current population efficiently.

Although society generally accepts that humans should live in a manner that preserves the environment, views about the extent to which people ought to change their behaviour to achieve this varies (Cherian & Jacob, 2012). Osbaldiston & Schott

(2011) investigated methods that may be effective in encouraging pro-environmental behaviour. These behaviours include simple daily lifestyle changes like waste segregation and energy saving.

In the South African context, many corporates include sections about environmental sustainability in their annual reports (BMW Group, 2021; BP, 2023; Standard Bank, 2021). Although South African companies indicate commitment towards environmental sustainability through strategy revisions and commitment to allocating significant budgets towards environmental sustainability initiatives, they also suggest that transitioning to environmentally sustainable operations requires funding in excess of hundreds of billions of rands (TEDx Talks, 2022). On the other hand, the South African government is implementing a carbon tax to penalize heavy greenhouse gas emitters and pressure them to shift towards environmentally sustainable operations (SARS, 2020). Thus, companies must balance the need to create value for their shareholders with investments in environmental sustainability solutions to avoid penalties and operate in an environmentally responsible manner.

4. Literature review on corporate entrepreneurship in relation to environmental sustainability

Fischer et al. (2018) indicate that there is a balancing act that entrepreneurs must consider when addressing sustainability challenges. This balance includes economic value creation and a company's operations' environmental and societal impact. Hegeman & Sørheim (2021) indicate that some big corporate companies in Norway invest in corporate venture capital to gain access to new markets and technology and position themselves as environmentally sustainable corporates. Zhao et al. (2021) present that companies that apply international corporate venturing can gain exposure to environmentally sustainable solutions in foreign countries that they can subsequently leverage to gain a competitive advantage locally.

Young & Tilley (2006) summarizes the evolution of corporates from eco-efficiency, where companies recognize the negative impact of their activities on the environment. They then embrace the opportunity to improve economic performance by using natural resources more efficiently through waste reduction while reducing their negative environmental impact. Young & Tilley (2006) highlight that companies must shift their mindset from a linear cradle-to-grave use of natural resources towards a cyclical approach, where products are recycled instead of discarded after use.

Guldmann & Huulgaard (2019) argue that companies must develop circular business models (CBM) to achieve the desired participation in the circular economy. They present a model to guide companies to gradually transition from linear business models to systemic CBM, where companies must collaborate with business partners along their value chains. As discussed in part 2 of this section, this collaboration would be a form of corporate entrepreneurship. The company collaborates with external partners to achieve specific goals or gain access to other technologies, such as recycling (Christensen, 2004).

Like Guldmann & Huulgaard (2019), Miles et al. (2008) recognize the need for companies to reconstruct their business models to transition to more sustainable products and services. They introduce the concept of sustainable corporate entrepreneurship, where companies question the assumptions that form the basis of their existing business models to innovate new, sustainable ideas. Miles et al. (2008) present Ford's collaboration with Toyota to develop technologies as one of the examples of sustainable corporate entrepreneurship, as this was likely to enable Ford to transition towards more sustainable products. Again, referring to Section 2, this would be a form of corporate entrepreneurship through the use of external networks.

Miles et al. (2008) indicate that sustainable corporate entrepreneurship initiatives can either be triggered by i) changes in demand, where consumers' preferences shift towards more sustainable products and services; ii) where there are changes

in policy compliance requirements; or iii) the companies voluntarily improving sustainability as a competitive advantage. Referring back to Section 1, one may argue that change in demand is the main trigger for the transition of chemical companies in South Africa.

Spitzeck et al. (2013) suggest a model for corporate social entrepreneurship similar to the sustainable corporate entrepreneurship model presented by Miles et al. (2008). Instead of changes in demand and supply, Spitzeck et al. (2013) argue that companies should consider non-market related triggers such as social and environmental risks and opportunities as motivation for sustainable innovation. The article by Spitzeck et al. (2013) presents a case study based on a Brazilian business holding company that applied entrepreneurial approaches to address social and environmental risks and opportunities on two projects.

This company used the vision and drive of its internal social entrepreneurs (Austin et al., 2006) to partner with external stakeholders such as the government, civil society, banks, and other organizations to access resources and funding while enhancing its reputation as an environmentally responsible company. Based on the concepts presented in Section 2, one may conclude that this company applied at least two of the entrepreneurial perspectives, namely: i) the use of internal resources; and ii) using external networks.

Ramos-González et al. (2017) highlight that companies can use sustainable entrepreneurship to improve their corporate reputation. Their definition of sustainable entrepreneurship encompasses creating economic value for the company's stakeholders while positively impacting the environment and the people who live in it, similar to the description of sustainable corporate entrepreneurship by Miles et al. (2008). As discussed in Section 1, perceptions about whether a company conducts its operations responsibly towards the environment can significantly impact its reputation. Ramos-González et al. (2017) argue that sustainable entrepreneurship can be used by companies to proactively anticipate

environmental and social challenges and opportunities and act with integrity in this regard, to enhance their corporate reputation.

Literature indicates that large corporate companies struggle to implement innovative/entrepreneurial solutions due to a lack of adaptability in their existing processes and systems (Veleva & Bodkin, 2018). This phenomenon is called “organizational inertia” (York & Venkataraman, 2010, p. 5). According to Veleva & Bodkin (2018), this challenge may be addressed by collaborating with smaller, entrepreneurial companies that seek to create economic value while enabling the corporates to achieve their environmental sustainability goals. Collaborating with external partners to allow corporates to participate in a circular economy is aligned with the theory presented by Guldmann & Huulgaard (2019), which emphasizes the need for companies to collaborate with external partners to develop systemic circular business models. This use of external resources is recognized by Christensen (2004) as a form of corporate entrepreneurship.

Bowcott et al. (2022) highlight the importance of setting a vision for sustainable entrepreneurship, and identifying strategic partners to achieve the set vision. Ameer & Khan (2022) recommend using policy and regulations as a catalyst to encourage organisations to develop and implement solutions to improve environmental sustainability. On the the other hand, Di Vaio et al. (2022) discuss how individuals with an entrepreneurial mindset can enable an organisation to develop innovative products that can increase their profits while achieving their environmental sustainability goals.

Aparicio et al. (2020) indicate that entrepreneurship and intrapreneurship can be vital in developing solutions to enhance economic, environmental, and social outcomes. They further argue that sustainable entrepreneurship is among the types of entrepreneurial activities that are less explored. This necessitates further studies into this field.

5. Theoretical framework

Christensen (2004) identifies four perspectives of corporate entrepreneurship as follows:

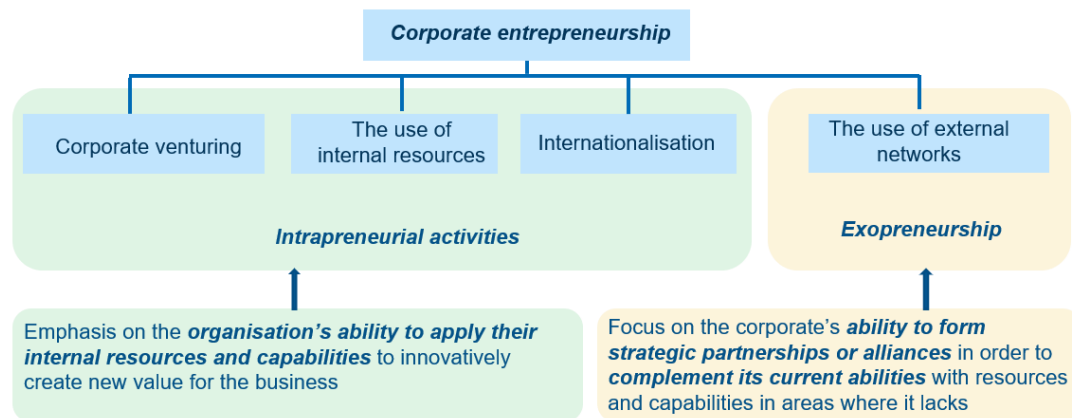


Figure 1: Corporate entrepreneurship, adapted from Christensen (2004)

This research project uses this framework to analyze the research data to identify which elements of corporate entrepreneurship are evident in how companies in South Africa's chemicals sector are addressing environmental sustainability challenges.

SECTION 3: RESEARCH STRATEGY

1. Introduction

A research strategy was developed to determine how the study will be executed in order to apply a systematic approach to ensure that the research is done efficiently and in a structured manner (Norwichlibrary, 2016). This includes selecting the research method and methodology, research site, and methods for gathering and analyzing data (Myers, 2013).

This section reflects on the initial strategy formulated during the conceptualization of this study. The next section presents how the research strategy was applied during execution and how deviations from the initial plan were managed during data collection and analysis.

2. Research methodology and method

The study intended to investigate how companies in South Africa's chemicals manufacturing sector can use corporate entrepreneurship to address environmental sustainability challenges. The amount of literature on this topic in the South African context is limited. An exploratory approach is used to research this topic, as literature on the application of corporate entrepreneurship to address environmental sustainability challenges is still evolving, as indicated by the literature review in Section 2. Although a qualitative research methodology is most commonly used to conduct inductive research in order to build theories and hypotheses, this methodology may also be used for deductive research (Myers, 2013).

A quantitative research methodology, on the other hand, tends to focus on gathering and analyzing numbers with the intent to generalize the research findings to a broader population (Myers, 2013). This research examines how manufacturing companies respond to environmental sustainability challenges in South Africa's chemicals manufacturing sector. This research is, therefore, not aimed at generalizing the results to a broader population. A deductive approach is taken to test the relevance and application of the corporate entrepreneurship concept in the highlighted context. For this reason, a qualitative research methodology is applied in this research project (Myers, 2013).

Myers (2013) presents action, case study, ethnographic, and grounded theory as the four qualitative research methods commonly used in business and management. An exploratory approach is taken to research this topic. This project assesses the applicability of the corporate entrepreneurship theory to the chemicals industry in South Africa. This is aligned with one of the common uses of case

studies in qualitative research, which is to test whether a particular theory is applicable to specific scenarios (Myers, 2013).

The action research method is not selected as this study does not intend to simultaneously foster organizational change during the research process (Myers, 2013). The ethnographic research method is also not selected as the author does not intend to study the research participants as they do their regular duties (Myers, 2013). This research project is based on a hypothesis that companies in the chemicals manufacturing sector can use corporate entrepreneurship to address environmental sustainability challenges. On the other hand, a grounded theory research method is generally suitable for research projects that do not intend to test a specific hypothesis but rather to derive a theory from the data being gathered (Myers, 2013). Grounded theory is, therefore, not deemed suitable as the primary research method for this project.

3. Data collection strategies

Myers (2013) discusses three data collection techniques that are commonly used in business and management, namely: i) Interviews, ii) fieldwork, and iii) using documents. As discussed in Section 1, there is pressure on companies in the chemicals manufacturing sector to demonstrate that they acknowledge and are willing to address their current negative impact on the environment. These companies also desire to protect their corporate reputations as companies that conduct their operations responsibly towards the environment.

A significant amount of secondary data is already available in the public domain regarding their impact on the environment and how they address environmental sustainability challenges. These sources include annual reports, media interviews, and others. Documents review is one of the primary data collection techniques applied in this research project, as they provide readily available information that can be used to supplement the information obtained through other avenues.

Conducting interviews is a strongly recommended data-gathering technique for researchers applying a case study method under the qualitative research methodology (Myers, 2013). This research project triangulates data from document reviews and from interviewing individuals from environmental NGOs and government agencies to gain in-depth knowledge about how they perceive companies in this sector to be responding to environmental sustainability challenges. Interviews present an opportunity to capture the context in which study participants respond to the questions, as opposed to electronic surveys (Fusch & Ness, 2015).

The interviews are semi-structured, with the interview schedule included in Appendix A. Myers (2013) indicates that one interview conducted with a participant for one hour can easily result in the collection of 7000 words. Interviewing six to twelve participants is expected to generate sufficient data for this project. A semi-structured interview is selected to strike a balance between obtaining consistency from the different interviews and allowing space for participants to share additional information that could be useful for the study, even if it is not explicitly included in the interview schedule (Myers, 2013).

The initial strategy was to conduct interviews in person. Where physical meetings are impractical, online platforms like Microsoft Teams and Zoom video calls would be used, depending on the participant's preference. Interviews would be recorded using mobile devices and transcribed using automatic transcription software like Microsoft Teams or Microsoft Word's "dictate" functionality. The transcriptions would then be manually reviewed to ensure the conversations are accurately captured. The cover letter (included in Appendix B) is shared with potential participants to motivate them to participate in the research. To ensure that the most relevant participants are included in the study, snowball sampling (Myers, 2013) is also applied.

Table 1: Targeted interview participants

No.	Potential participants
1.	Individuals from environmental protection NGOs
2.	Individuals from government departments or agencies

Although focus groups would allow participants to discuss and share ideas that could result in richer data collection (Myers, 2013), this approach was not selected due to the practical challenges it would likely present. For example, it would be logistically challenging to gather individuals from the agencies for this study, and their diaries may not be aligned to enable simultaneous participation. Due to the problems discussed in Section 1, environmental sustainability can be a sensitive subject. Therefore, the author believes the challenges introduced by managing group dynamics are not worth the potential benefit. For the same reason that phenomenology was not selected under research methods, fieldwork or participant observation techniques are not used in this study (Myers, 2013).

4. Case site and sample size

The case study is on companies in the chemicals manufacturing sector in South Africa. Boddy (2016) and Yin (2003, as cited in Myers, 2013) indicate that the sample size for qualitative research depends on the context and objective of the study. Denny & Weckesser (2022) suggest that qualitative research data continues until a point of saturation is reached. Fusch & Ness (2015) argue that although there are no strict requirements regarding sample size in qualitative research, certain guidelines may be used to improve the study's replicability. One such guideline is deciding on the sample size of participants needed to reach data saturation.

Guest et al. (2006, as cited in Fusch & Ness, 2015) indicate that data saturation can even be achieved with six participants, depending on the research context. This research project aimed to conduct one-hour interviews with a total of six to twelve participants, with the intent to achieve saturation.

5. Data analysis

For this research study, a top-down approach is predominantly used for data analysis, where themes obtained from literature are used to analyze the data instead of a bottom-up approach (Myers, 2013). The study intends to investigate how companies can use corporate entrepreneurship to address environmental sustainability challenges; therefore, themes from the literature are used as a starting point for data analysis.

Coding can be a helpful technique to compress large amounts of data obtained from qualitative research (Myers, 2013). Given the amount of data obtained from interviews and document reviews, coding is used to analyze the data so that meaning is extracted from it.

Another technique used for data analysis is to list the series of events (Myers, 2013) that occurred in the companies of interest. Although the sequence of events is not published in the final research project due to data sensitivity, the author uses this technique to make sense of changes in this industry in response to environmental sustainability challenges. The series of events technique is used together with the critical events analysis (Myers, 2013). These techniques are selected to complete an in-depth analysis of the critical events that would have occurred in response to or due to environmental sustainability challenges.

Once the data gathered is compressed and organized using the abovementioned techniques, content analysis is used as an over-arching technique to analyse the data. The content analysis approach assesses the frequency of specific themes emerging from the data and assimilates meaning from it (Myers, 2013).

6. Validity and reliability

Literature indicates that qualitative research validity can be improved by addressing potential biases that may occur during data gathering and analysis. This research

project focuses on managing three types of biases, namely: i) researcher bias; ii) research participant bias; and iii) bias induced by the researcher's being the main instrument in the data-gathering process (Golafshani, 2015; Park & Lee, 2010; Poduthase, 2015). **Triangulation** of document reviews and interview responses is done to improve the validity of the research (Curtin & Fossey, 2007; Golafshani, 2015).

This study set out to schedule interviews with each participant for at least one hour at a convenient time to ensure that the participants are comfortable and not rushed or tired. The one hour is intended to ensure that the researcher spends sufficient time with the participant to understand what the respondent is communicating (Myers, 2013).

Considering the caliber of the target participants, it could be challenging to secure follow-up interviews with them. For this reason, the initial interview is also used as a **member-checking** exercise (Buchbinder, 2010) to verify that the researcher's understanding is what the respondents intended with their responses. The researcher set out to use other avenues, including email communications, to confirm with the participants if the researcher has captured the essence of their responses. **Engagement** with the research data would be further **prolonged** (Poduthase, 2015) by manually comparing audio recordings of interviews to automated transcripts to ensure that the interviews are accurately captured. Documents are reviewed multiple times to increase engagement with the research content further.

An **audit trail** (Poduthase, 2015) of interviews, documents, and data analysis is kept to demonstrate the credibility of the data and the process followed. **Peer debriefing** (Poduthase, 2015) is done frequently with the applied research supervisor allocated to the researcher by the Wits Business school to manage biases from the researcher. The need for debriefing with other peers is assessed, and where necessary, the data from interviews is adequately generalized to maintain the confidentiality of interview participants.

A negative case analysis (Park & Lee, 2010) is done as recommended by literature. Data that appears to contradict the majority of interview responses and documents is revisited and analyzed in detail to elicit meaning and evaluate what this data means for the overall research. It is recognized that the researcher is unlikely to receive the same responses from a particular participant, even if the same interview schedule is utilized each time. The researcher upholds reliability by being mindful of imposing her understanding onto interview participants. Instead, she focuses on allowing them to freely share their views even if they contradict the researcher's understanding (Golafshani, 2015).

7. Potential weaknesses

Besides being time-consuming to the researcher, who is the main instrument in imperial data gathering, the qualitative research methodology results in a large amount of data that consumes even more time to analyze and report (Myers, 2013). This introduces a risk that the researcher might not be able to analyze the data in enough detail to develop a strong output (Boddy, 2016). This risk is managed by applying a positivist approach to data analysis and adhering to the interview schedule as much as possible.

The interview data-gathering method may introduce biases in the data due to various factors, including a lack of trust between the researcher and participant and the researcher channeling the participant's thinking process (Buchbinder, 2010). These are managed by arranging sufficient time for the interview to build a connection with the participant. The researcher is conscious of her potential biases and avoids projecting them onto the participant.

Using a qualitative research methodology and a case study research method means that the sample of companies and interview respondents do not necessarily represent the broader population of companies in the chemicals manufacturing sector (Boddy, 2016). However, the study includes the actions included in Section 6 to ensure high transferability and credibility of the results (Curtin & Fossey, 2007).

8. Potential ethical issues or concerns

Literature indicates that ethical concerns often emanate from areas where the research is not focused. The five capitals framework can be applied to identify potential ethical issues for research projects (Porritt, 2007, p. 139, as cited in Stacey & Stacey, 2012). Table 2 highlights how ethical issues are addressed based on the five capitals framework.

Table 2: Addressing potential ethical issues

No.	Capital	Addressing potential ethical issues
1.	Natural	If not adequately managed, recommendations from this project could have adverse side effects on the natural environment. The researcher is mindful of the possibility of companies applying the recommendations to appear environmentally responsible without achieving a tangible positive impact on the natural environment.
2.	Human	Human participants in the study are treated with respect. Consent is obtained before data gathering commences. The data is treated with adequate confidentiality, and the respondents can opt out of the research process at any point.
3.	Social	The issue of environmental sustainability is contentious, particularly in South Africa. The risk of unfounded public backlash to companies in the researched sector is managed by presenting the results as truthfully as possible, managing the confidentiality of research

		participants, and refraining from naming specific companies in the results section of this report.
4.	Manufactured	Companies are exploring avenues to shift their manufacturing processes from fossil fuels to green products. Care is taken to ensure that this study does not promote “greenwashing,” which enables companies to present systems that are not green as green products.
5.	Financial	The outcome of this research has the potential to positively or negatively influence how companies in the chemicals industry are viewed in South Africa. Care is taken to ensure the results are presented truthfully without causing companies financial losses due to erroneous reporting.

SECTION 4: DATA COLLECTION AND ANALYSIS

1. Introduction

Section 4 presents how the research strategy presented in Section 3 was applied during execution. All the plans presented in Section 3 were used during execution. Where the initial strategy could not be applied, detail on how these gaps were addressed is included.

2. Company and NGO selection

Consistent with the case study approach, three chemical companies in South Africa were selected for secondary data analysis and research based on the following criteria:

1. They have chemicals manufacturing facilities in South Africa (i.e., excluding those that only trade in chemicals); and
2. The companies are listed on the Johannesburg stock exchange. This criterion is applied to ensure that the company's annual reports are readily available for research use.

In deciding on the specific companies to focus on, it was discovered that a significant overlap exists between companies manufacturing chemicals and other activities upstream and downstream of the chemicals value chain. Although there is a high consensus regarding the origin of chemicals in literature, there are variations in what is referred to as chemicals versus petrochemicals. Petrochemicals are chemical compounds obtained from refining petroleum (crude oil). However, the same compounds can be obtained from natural gas, coal, or more sustainable sources like biomass (IEA, 2018; NBI et al., 2021). IEA (2018) refers to compounds like ethane and naphtha as petrochemicals that become feedstocks to produce chemicals.

IEA (2018) refers to olefins and aromatics as chemicals produced from petrochemical feedstock. On the contrary, NBI et al. (2021) refer to olefins and aromatics as petrochemicals, simply chemicals derived from the upstream petroleum industry. These definition variations are observed throughout other literature sources (Speight, 2011; Sulzer Pumps, 2010). These variations in definition, together with the fact that petrochemicals are by-products of petroleum refining plants (BBC, 2020; Engen, 2023; Sasol, 2019), it was decided that comments relating to the upstream petroleum refining companies will also be

analyzed. Figure 2 depicts a simplified diagram to indicate how various parts of the chemicals value chain may be categorized.

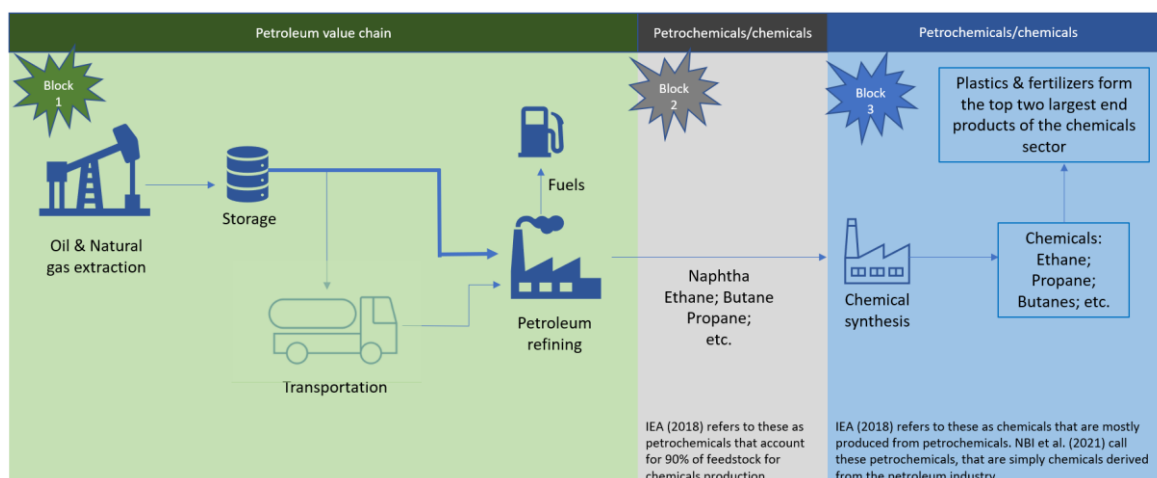


Figure 2: A simplified diagram of the chemicals value chain – adapted from Eland Cables (2023); NBI et al. (2021); Speight (2011); and Sulzer Pumps (2010)

When gathering primary data through interviewing individuals from environmental conservation NGOs and government officials, it was established that it is challenging to receive responses focusing only on companies operating in the petrochemicals or chemicals sector (Block 2 and 3 in Figure 3). This is due to two reasons:

1. The primary feedstock to the chemicals sector is obtained from the upstream petroleum value chain, which is the main source of fossil fuels and environmental pollution; and
2. The overlap between petroleum refining (Block 1 in Figure 3) and chemicals synthesis (Block 3) requires this research to consider the entire value chain.

For these reasons, secondary data from three companies mainly operating in petroleum refining was also analyzed.

The three companies analyzed were selected based on the following criteria:

1. They have petroleum refining facilities in South Africa; and
2. Their petroleum refining facilities process at least 50 000 barrels of crude oil or equivalent feedstock per day (SAPIA, 2022).

Although these companies do not have chemical manufacturing processes in South Africa (Block 3 in Figure 3), they produce feedstock for chemical synthesis through petroleum refining.

Individuals from environmental conservation NGOs were selected based on the following criteria:

1. The NGOs they are part of, actively comment on the performance of companies in South Africa's petroleum and chemicals sector; and
2. They are knowledgeable about the impact of these sectors on environmental sustainability.

3. Secondary data gathering

Secondary data relating to the six companies' plans and actions to address environmental sustainability challenges was collected from the following sources:

1. Company websites;
2. Annual integrated reports, sustainability reports, and climate change reports; and
3. Video clips of company leadership obtained from various YouTube channels.

Although news reports were also considered, the researcher carefully ratified any media reports against the abovementioned three sources.

4. Primary data gathering

Eight individuals from environmental conservation NGOs and three from government agencies were interviewed using the interview schedule included in Appendix A. This brings the total number of interview participants to eleven, within the range of six to twelve initially targeted participants, highlighted in Section 3. By the eighth interview, it was evident that data saturation was being reached based on the similarities in responses from interview participants.

All eleven participants consented to participate in a physical meeting with automatic transcription of their verbal responses into written text. However, they did not agree to an audio recording of their voices being taken. The researcher, therefore, manually wrote notes and used the “dictate” functionality in Microsoft Word to capture responses from the participants. The “dictate” functionality in Microsoft Word often captured the verbal responses inaccurately. 15-to-30-minute breaks followed interview sessions to enable the researcher to edit interview transcripts before reconvening with the interview participants for a member-checking exercise.

Interview periods lasted 45 minutes to an hour each, while member-checking exercises lasted 20 minutes on average. Each interview resulted in 3 000 to 4 000 words transcribed.

5. Data analysis

ATLAS.ti qualitative data analysis software was utilized to analyse both primary and secondary data, using a top-down approach, where themes obtained from literature were used to analyse the data, as highlighted in Section 3. The following methods of analysis were applied in ATLAS.ti:

1. Coding – codes were created to represent each element of corporate entrepreneurship depicted in the theoretical framework (Section 3).

Additional codes were created to analyze themes relating to the aspects of corporate entrepreneurship;

2. A series of events were noted manually to make sense of changes in the various companies concerning environmental sustainability challenges; and
3. Content analysis was used as an overarching technique to analyse the data. This was achieved by analyzing the frequency of specific themes in the data, creating visuals, and tracking quotations linked to the particular themes.

SECTION 5: RESULTS AND DISCUSSION

1. Introduction

Results from the primary and secondary data analysis are presented in this Section. Part 2 presents results from secondary data analysis, representing the voice of the companies being used for this case study. Section 3 represents the voice of participating individuals from environmental conservation NGOs and government agencies.

2. Results from secondary data

Analyzing secondary data resulted in the following findings:

All six companies:

1. refer to challenges relating to environmental sustainability in their annual reports and other publicly available sources like company websites and media interviews;
2. acknowledge the negative impact that industrial operations have on environmental sustainability and climate change;
3. have revised their companies' vision or mission statements to reflect an intent to improve their environmental sustainability performance;

4. have set greenhouse gas emission reduction targets, targeting to achieve net zero greenhouse gas emissions by 2050; and
5. indicate an intent to lead/play a meaningful role in the transition towards the production of green chemicals, with the word “green” frequently mentioned (ranging from 17 to over 200 times) in their 2021 integrated annual reports, except for one company that operates mainly in the petroleum refinery part of the value chain.

Apart from environmental sustainability challenges, the companies face other difficulties, including volatile macroeconomic environments, the COVID-19 pandemic, and changing customer preferences. It is, therefore, at times not explicitly stated whether changes made by the companies are aimed at addressing environmental sustainability, other challenges, or both. This uncertainty was addressed by obtaining further information on the companies through online research and analyzing the series of events relative to an increased focus on environmental sustainability. This additional research resulted in the exclusion of one company from further evaluations. The excluded company mainly operates in the petroleum part of the value chain (Blocks 1 and 2 in Figure 2). Although this company mentions its commitment to achieving net zero greenhouse gas emissions by 2050, there is little evidence to indicate that its application of corporate entrepreneurship is motivated by environmental sustainability challenges.

The theoretical framework discussed in Section 3 was used as a baseline to create codes in ATLAS.ti. An inductive research method was used to test the applicability of corporate entrepreneurship theory to companies in the chemicals sector. The baseline codes that were created in ATLAS.ti included the four elements of corporate entrepreneurship, namely: i) corporate venturing; ii) the use of external networks; iii) the use of internal resources; and iv) internationalization. Secondary data collected about the five companies was then analyzed for themes relating to the baseline codes to determine if these companies applied elements of corporate entrepreneurship to address environmental sustainability challenges. Figure 3 depicts a matrix created in ATLAS.ti to visualize the results.

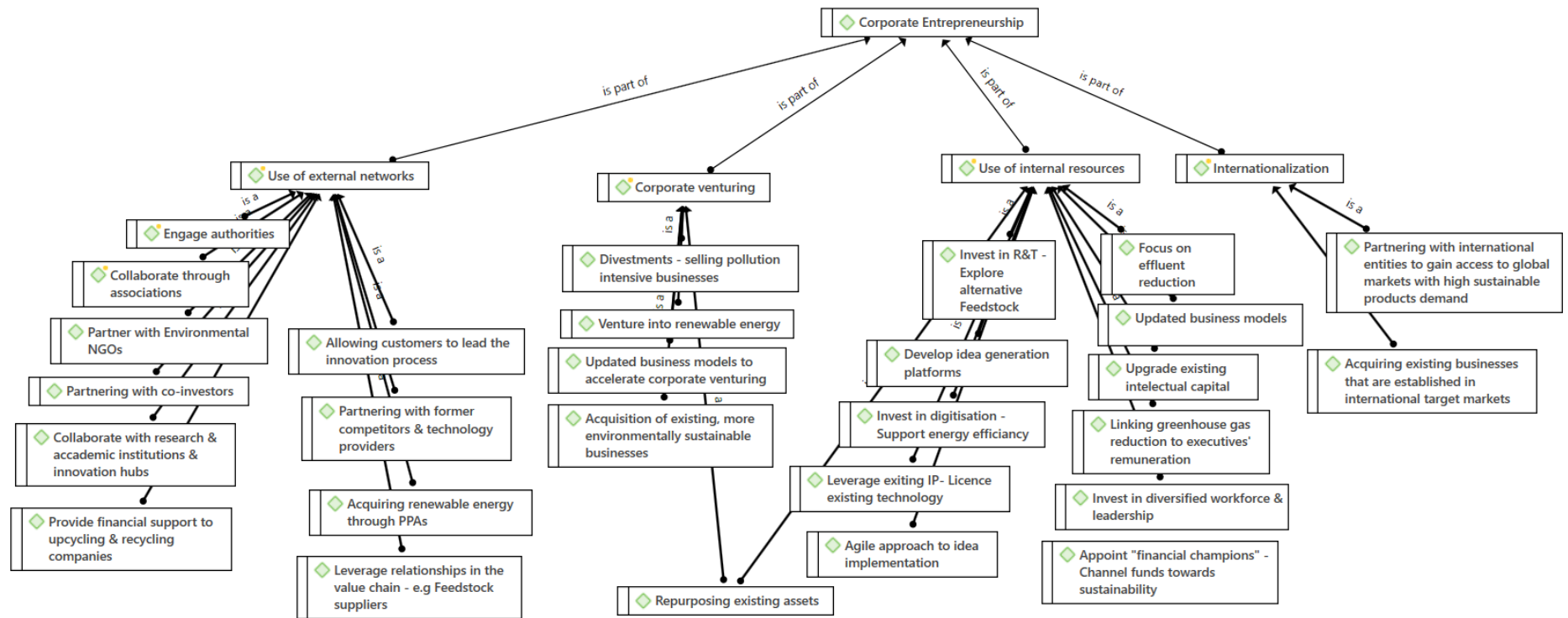


Figure 3: Matrix visualizing themes relating to corporate entrepreneurship elements obtained from secondary data of manufacturing companies in South Africa's chemicals industry.

Figure 3 highlights the following findings concerning each of the four elements of corporate entrepreneurship:

a) The use of internal resources

As shown in Figure 3, numerous themes relating to corporate entrepreneurship emerged from data analysis. Using internal resources is the dominating element, where companies rely on their existing resources and capabilities to address environmental sustainability challenges.

There is a strong focus on research and technology (R&T) development, where existing intellectual property is leveraged to explore alternative feedstocks or improve efficiency to reduce the company's environmental impact. There is also frequent reference to harnessing ideas from the existing workforce through idea-generation platforms and applying agile methods to implement research/demonstration projects for ideas with high potential success.

Another internal resource use theme is applying digitalization to improve existing operations through increased energy efficiency and effluent reduction. The companies are also repurposing existing assets currently operating on petroleum-based feedstock to produce greener products or convert them to serve a different purpose. This also reflects the corporate venturing element of corporate entrepreneurship.

There is frequent reference to upskilling and reskilling the existing workforce or upgrading existing intellectual capital to enable a transition to future, environmentally sustainable operations. One company also indicates that the greenhouse gas emission reduction targets have been linked to their executives' remuneration to encourage a focus on achieving environmental sustainability targets.

b) The use of external networks

There is a strong focus on collaborating with research/academic institutions and innovation hubs by two companies that operate mainly downstream of the chemicals value chain (Block 3 in Figure 2). These companies also collaborate with their customers to improve their products' efficient use to reduce environmental impact.

Investment in research is frequently mentioned to explore alternative feedstock to transition their operations from producing petroleum-based chemicals towards greener feedstock like biomass and recycled plastics. However, there is a lack of collaboration between downstream chemical companies and upstream petroleum companies, which are currently the leading feedstock suppliers to chemical production. There is frequent reference to collaborating with NGOs, technology suppliers, policymakers, and research institutions to identify sustainable feedstocks and processes to transition towards renewable energy and green product value chains.

Four companies that also operate in the petroleum part of the value chain strongly emphasize the need to collaborate with regulatory authorities like the Department of Environmental Affairs and other government entities. This is mainly to develop practical policies enabling a transition towards more sustainable products. They are exploring unconventional partnership strategies, where companies previously viewed as competitors are willing to collaborate on technology and value chain development.

The companies also collaborate through various voluntary platforms like the South African Petroleum Industry Association (SAPIA) and the Chemical & Allied Industries Association (CAIA). Although these companies indicate they intend to leverage their knowledge and expertise to transition towards environmentally sustainable operations, they also plan to partner with co-investors to share the inherent risk of investing in new technologies and producing green products. To improve the value chain's environmental impact, there is also a reference to

providing financial support to companies that participate in other parts of the value chain, including sustainable feedstock supply and plastic recycling.

c) Internationalization

Internationalization is one of the levers used to diversify a company's geographical reach. This is also used to establish/strengthen networks in global markets that are likely to support the off-take of green products faster than the South African market. The link between internationalization and addressing environmental sustainability challenges is difficult to ascertain for many of the actions taken by the companies because it is not always explicitly stated that they are intended to address environmental sustainability challenges.

Some actions include expanding a company's core business into global markets. These expansions can potentially protect the companies from being severely impacted by rapid changes in the South African market that are motivated by environmental sustainability. They could also enable the companies to establish a presence in international markets, increasing their probability of benefiting from financial incentives offered by authorities in alternative geographies to encourage environmentally sustainable operations. The themes highlighted under internationalization in Figure 3 include acquiring operations already established in alternative geographies or establishing joint ventures to enter new countries to minimize and share risk with local companies.

d) Corporate venturing

Analyzing the secondary data has indicated that revising companies' business models and strategies often resulted in some of their businesses ceasing to be their core business. These assets are subsequently divested. The change in strategy is motivated by environmental sustainability; therefore, one may argue that some divestments are motivated by sustainability.

While divesting non-core businesses, new ventures are initiated, often into renewable energy and the exploration of green product manufacturing. Some of the ventures include strategic investments in operations that produce more sustainable products, creating strategic business units or divisions dedicated to venturing into green products, or incubating and growing new businesses to create new value pools for the company. Incubating businesses enables large corporates to develop entrepreneurial and more agile business units that are not hindered by the effects of “organizational inertia” discussed in Section 3.

Conclusions on secondary data analysis

All four elements of corporate entrepreneurship, namely: i) the use of internal resources, ii) the use of external networks, iii) internationalization, and iv) corporate venturing, are evident in how the companies in South Africa’s chemicals manufacturing sector are addressing environmental sustainability challenges.

The use of internal resources is the most evident element highlighted in the secondary data. The use of external networks is the second most prominent, especially for companies with operations in the petroleum refining part of the value chain. Corporate venturing is emphasized by acquiring businesses that already produce more sustainable products, forming partnerships to develop new biomass-based operations, or venturing into renewable energy.

3. Results from primary data

As discussed in Section 4, the interview schedule included in Appendix A was used to obtain unconstrained answers from eleven participants without asking leading questions or influencing their views. The transcribed responses were then analyzed in ATLAS.ti, with the intent to identify themes that relate to the four elements of corporate entrepreneurship discussed above. Codes were created for the various themes identified.

It was challenging to match the themes to elements of corporate entrepreneurship because the sentiments expressed by all eleven participants generally highlighted a lack of action and urgency from corporates when addressing environmental sustainability challenges. Instead, codes were created to highlight themes from all the negative sentiments (Figure 4), with a few positive sentiments indicated by the themes included at the bottom of Figure 4.

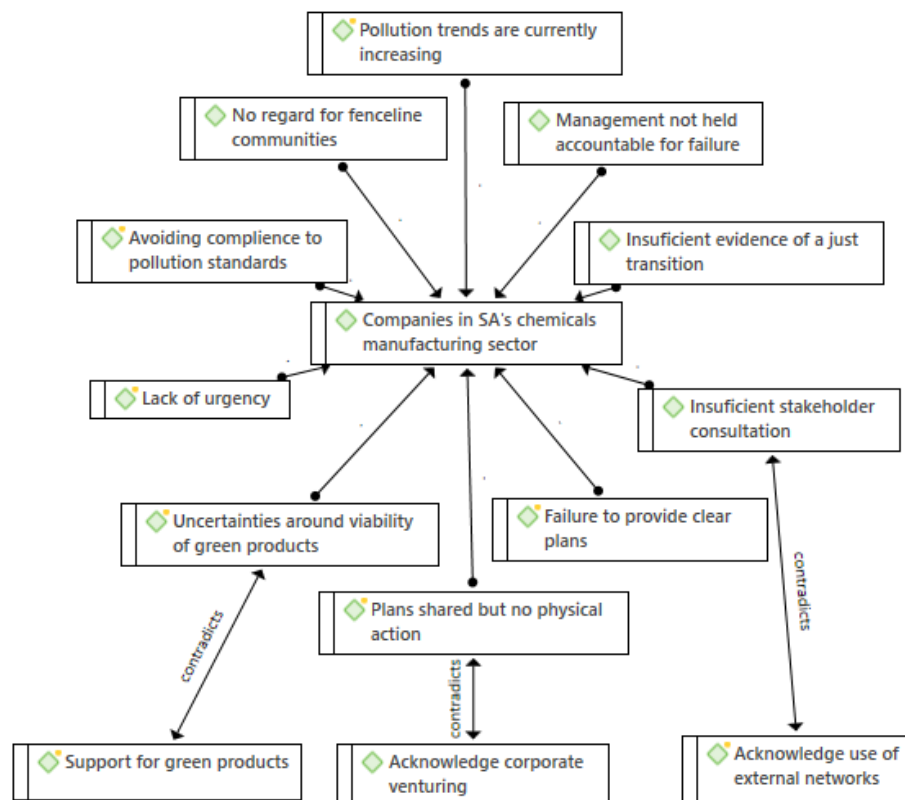


Figure 4: A matrix visualizing views expressed by individuals from environmental conservation NGOs and government agencies.

Results from the participants indicate that although many companies operating in the chemicals value chain have announced targets to achieve net zero carbon emissions by 2050, they are failing to provide clear plans for achieving these targets. Six of the participants from NGOs believe that the companies have set targets as part of a corporate reputation management strategy to appear more environmentally responsible without genuinely intending to achieve these targets.

Seven interview respondents from NGOs and two from government agencies indicate that the companies are setting ambitious targets because of pressure exerted by civil society.

The participants indicate that the companies could make their net zero targets more believable by setting short-to-medium-term milestones against which their performance can be tracked. Instead, they are taking the easy route by matching their milestones to those set by the United Nations (UN): 45% emissions reduction by 2030 and net zero by 2050. Most companies have their 2030 emission reduction targets below the 45% set by the UN, while others are only committing to timelines relating to project completions rather than actual emissions reductions.

Another challenge highlighted by the interview respondents is that the set targets are not legally binding to the companies; therefore, there is ample room for them to default on these targets without significant repercussions for the company or its executives. A sentiment expressed by individuals from NGOs is that corporates do not set targets and execution plans in consultation with other stakeholders. This unilateral process introduces a lack of transparency and disregards the needs of fenceline communities in areas where the companies run their operations.

One indicated that environmental pollution trends are increasing for many of the companies in this sector despite numerous announcements regarding projects, partnerships, and explorations to reduce their environmental footprint. The participants are concerned about the sector's plans to use natural gas as a transitional feedstock toward achieving net zero carbon emissions. Their concerns are that natural gas is a fossil fuel and, therefore, not a sustainable feedstock.

Investing in natural gas extraction, transfer, and processing infrastructure would result in the industry migrating from oil and coal as primary feedstock towards natural gas. The participants argue that investing in natural gas as a transitional feedstock increases the risk of stranded assets once sustainable feedstocks are introduced. This implies that the companies will likely delay investment into sustainable feedstocks further.

Five of the respondents from NGOs are skeptical about whether the companies' plans to invest in green hydrogen production and nascent technologies like carbon capture, utilization, and storage (CCUS) will achieve zero greenhouse gas emissions without exacerbating other sustainability challenges like water scarcity. Companies that include the introduction of biomass into their processes are also criticized for the viability of replacing current fossil-based feedstock with the limited amounts of sustainable biomass available.

Three respondents from NGOs and three individuals from government agencies added some positive outlooks to the topic, as depicted in the bottom part of Figure 4. They agree with the companies' intent to venture into renewable energy generation and produce green products like green hydrogen and biochemicals. With the right policies and regulations in place, the government can ensure that producing green products does not aggravate sustainability challenges like water scarcity and the removal of trees.

The three individuals from NGOs believe that although it could be possible for the companies to achieve net zero emissions before 2050, this is unlikely to happen because corporates are unwilling to invest in green products since this would negatively affect their bottom line. The individuals from government agencies indicate that the capital required to develop operations that produce green products is excessive. It will be necessary for companies in the chemicals sector to collaborate with international companies and agencies to gain access to funding. Figure 5 indicates how the interview participants expect/recommend companies in the chemicals sector to apply the concept of corporate entrepreneurship.

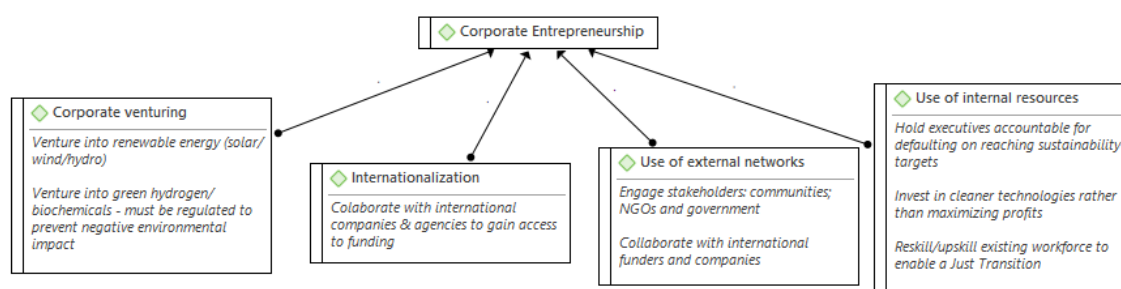


Figure 5: How individuals from environmental conservation NGOs and government agencies expect/recommend chemicals sector companies to apply the corporate entrepreneurship theory.

Conclusions on primary data analysis

Individuals from environmental conservation NGOs and government agencies believe that the four elements of corporate entrepreneurship could effectively address environmental sustainability challenges encountered by chemical manufacturing companies. All eleven participants, however, indicate that companies in this sector have taken insufficient action thus far. This makes it difficult to assess whether the plans included in their public announcements and annual reports will effectively reduce their environmental footprint.

CONCLUSION AND RECOMMENDATIONS

1. Introduction

This study intended to explore corporate entrepreneurship in addressing environmental sustainability, using manufacturing companies in South Africa's chemical manufacturing sector. It set out to:

1. Examine the state of South Africa's chemicals manufacturing sector concerning environmental sustainability;
2. Investigate what is meant by the idea of corporate entrepreneurship; and

3. Investigate if the concept of corporate entrepreneurship can assist companies in the chemicals manufacturing sector to address environmental sustainability challenges.

This section presents conclusions from the research, highlights the study's contribution to existing literature, and identifies limitations and recommendations for further research.

2. Conclusion

The chemicals manufacturing sector in South Africa is pressurized to transition towards environmentally sustainable operations due to its significant contribution to the country's greenhouse gas emissions and other forms of pollution. The concept of corporate entrepreneurship was researched and translated into a theoretical framework that was successfully applied to investigate its applicability to addressing environmental sustainability challenges.

Companies in South Africa's chemicals manufacturing sector are applying elements of corporate entrepreneurship theory to develop strategies to address environmental sustainability challenges. Individuals from environmental conservation NGOs and government agencies believe corporate entrepreneurship elements can effectively address environmental sustainability challenges in the chemical manufacturing sector.

Most of the strategies, plans, and projects announced by the companies in South Africa's chemicals manufacturing sector are yet to be implemented. Therefore, it is yet to be confirmed if these strategies will effectively address the environmental sustainability challenges. Suppose the announced strategies become implemented and achieve the targeted greenhouse gas emission targets and improved environmental sustainability. In that case, it can be concluded that the corporate entrepreneurship theory can be applied to address environmental sustainability challenges.

3. Contribution and limitations

This project contributes to existing research on corporate entrepreneurship by testing its applicability to addressing environmental sustainability challenges. The results from this research have the following limitations:

1. A qualitative research methodology and case study research method were used, focusing on five companies in South Africa's chemicals manufacturing sector. The sample of companies and interview respondents who participated in this study do not necessarily reflect all companies in this sector;
2. Even when asked the same question twice, some research participants did not provide the same responses to the interview questionnaire. This reduces the level of replicability of this study; and
3. Most of the strategies and plans announced by the companies to address environmental sustainability challenges have not yet been implemented. It cannot be concluded that applying corporate entrepreneurship theory will effectively address environmental sustainability challenges. It can be concluded that the leadership of companies in this sector and individuals from environmental sustainability NGOs and government agencies believe this could be the case.

4. Recommendations

The companies researched in this case study have set sustainability targets to be achieved by 2030 and net zero carbon emissions to be achieved by 2050. Therefore, similar research should be done between 2030 and 2050 to test if the set strategies and plans are indeed implemented and effective in addressing environmental sustainability challenges. Similar research can also be done in other geographies or based on different selection criteria to supplement the findings of this research.

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APPENDIX A: INTERVIEW SCHEDULE

1. How can you describe your role/interest in the petrochemical and chemicals manufacturing sector? Select one of the following:
 - 1.1. Individuals from environmental protection NGOs
 - 1.2. Individuals from government departments or agencies
 - 1.3. Other – Please provide an alternative description
2. In your view, how do environmental sustainability challenges impact manufacturing companies in the chemical manufacturing sector in South Africa?
3. When do you believe that the impact of environmental sustainability challenges became more prominent on manufacturing companies in the chemicals manufacturing sector in South Africa?
4. What is your view on how the following items/groups relate to environmental sustainability challenges?
 - 4.1. Policy changes
 - 4.2. South African citizens
 - 4.3. Civil society organizations
 - 4.4. Government Organizations
 - 4.5. Changes in the market
 - 4.6. Big corporate companies
 - 4.7. Small to medium enterprises
5. In your view, how are chemical manufacturing companies addressing environmental sustainability challenges in South Africa?

6. How do you think they should be addressing these challenges?
7. Do you see any patterns in how various companies in this sector address environmental sustainability challenges?
8. Which approaches to environmental sustainability challenges are most effective in your view?
9. How does the need to respond to environmental sustainability challenges impact the following?
 - 9.1. Organizational structures
 - 9.2. Resource allocation
 - 9.3. Collaboration with external parties
 - 9.4. Internationalization
 - 9.5. The companies business model

Appendix B: PARTICIPANT INFORMATION SHEET

Dear Sir/Madam

I am a student at the University of the Witwatersrand (Wits Business School), studying for a Master of Business Administration (MBA). As part of my studies, I am undertaking an applied research project (ARP) under the supervision of Dr Kagiso Pooe. My ARP intends to investigate how companies in South Africa's chemicals manufacturing sector can use corporate entrepreneurship to address environmental sustainability challenges.

This letter requests you to contribute towards this research project's success by participating in an interview. The interview will be semi-structured, using the questions in the attached schedule. The discussion will last for roughly 60 minutes, and with your permission, I would like to record the interview using a digital device. You will not incur additional personal costs apart from contributing your time and knowledge to the discussion, and there are no direct benefits to you for participating in the interview. There are also no negative consequences to you should you decide not to participate or withdraw your participation at any point during the interview. You may also choose not to answer some questions if you feel uncomfortable doing so.

The interview will be conducted by myself as the researcher on this project; therefore, your responses will not be anonymous to the researcher. However, the data gathered from the interview will be completely confidential and anonymous, as no record of your name or any identifying information will be recorded or included in the research report. You are requested to respond to the interview as a professional in the environmental protection NGO or government department/agency in your individual capacity and not representing any specific companies. Data collected from the discussion will be stored in a personal computer, protected through a password for a period of 2 years. The outcome of

this research project will be a written report made available through the University of the Witwatersrand library website. The final research report will contain information from all the interview participants, and pseudonyms (false names) will be used where necessary.

You are welcome to contact me through the details listed below with any questions regarding the interview or the research project. Any ethics-related concerns or complaints regarding this research project may be directed to the University Human Research Ethics Committee by email: hrec-medical.researchoffice@wits.ac.za or telephone: +27(0) 11 717 1408.

Yours Sincerely

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