**Gordon Institute
of Business Science**
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**The effect of environmental innovation on corporate sustainability of companies
in South Africa**

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Abstract

Now faced with climate change concerns and resource scarcity across various sectors, companies must possess the ability to implement sustainable practices and adapt to attain competitiveness by optimising the utilisation of their capabilities and limited resources, and adjust their operations to gain legitimacy and align with societal expectations in which their businesses operate in (Leal-Rodríguez et al., 2018). However, embracing sustainability requires significant investments in innovation, research and development (Dicuonzo et al., 2022; Fernandez et al., 2021; Buallay, 2019). Thus, companies typically exercise caution when considering investments in environmental sustainability initiatives due to concerns that such investments could potentially increase operational costs and undermine their competitiveness (Khanra et al., 2022). Stucki (2019) suggested that if environmental innovation leads to improved firm performance and sustainability, companies tend to invest in it.

The study's main objective was to understand how environmental innovation influences corporate sustainability of companies in South Africa. The secondary goals were to understand how environmental innovation affects the individual components of sustainability i.e., environmental, social, and governance aspects. The theoretical approach explored by the study was the resource-based view, dynamic capabilities, environmental innovation, and the sustainability concept. To test the study hypotheses, the study employed a positivism approach that utilised structured methods to enable generalisation and replication. Secondary data was collected from the Refinitiv Database. The study employed a longitudinal design, collecting panel data spanning from 2013 to 2022. The sample was obtained by using non-probability purposive sampling where a sample of 39 public companies listed on the JSE were chosen using both judgement and convenience sampling, with resulted to 390 observations.

The generalised least squares regression model was conducted to determine how environmental innovation affects corporate sustainability of firms in South Africa. The study revealed that there is a significant positive relationship between environmental innovation and corporate sustainability of companies in South Africa. The study also found that environmental innovation only has a significant positive relationship with the environmental aspect of corporate sustainability of companies. There was no significant relationship found between environmental innovation and the other two elements of corporate sustainability of companies.

Plagiarism Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Chapter 1 - Introduction

1.1 Background

The economy is being negatively impacted by adverse climate change effects such as extreme weather, rising temperatures, and frequent droughts, particularly sectors that are most sensitive to climate change like forestry, energy, agriculture, tourism, and fishing (Pörtner et al., 2022). Challenges like climate change, the exhaustion of natural resources, and pollution are the outcomes of irresponsible environmental behaviours (Dzomonda & Fatoki, 2020; Johnson et al., 2019). Firms' operations are influenced by environmental problems because they interact with the environment as they extract resources as inputs in production and release emissions into the environment (Girmay & Chikobvu, 2017; Johnson et al., 2019).

With rising global warming caused by increasing greenhouse gas (GHG) emissions and the depletion of resources, there are now increased economic constraints, stringent international legislations, and greater acknowledgment of the need for environmental preservation, thus, businesses across all industries are now adopting more sustainable practices (Fok et al., 2021). One of the sustainability initiatives supported by the international community to encourage businesses to invest in alternatives that support sustainability is the Paris Agreement and the Sustainable Development Goals (SDGs) (Dicuonzo et al., 2022; Ying & Xin-gang, 2021). According to Albort-Morant et al. (2016) and Chen (2006), in the last few years, governments across the world have adopted corrective measures aimed at lessening or addressing the growing environmental consequences caused by human actions. Thus, in today's world, companies must consider the interdependence between society, their economic goals, and the environment, as they cannot function effectively without acknowledging this interconnectedness (Thakhathi et al., 2019).

Companies are also facing growing pressure from society to incorporate sustainability matters into their everyday operations to realise their environmental, economic, and social purpose (Albort-Morant et al., 2016). Therefore, many multinational companies are implementing relevant policies that stimulate innovation to achieve sustainable development, especially considering the SDGs (Khanra et al., 2022). The incorporation of environmental sustainability practices by companies into their business strategies and the promotion of eco-friendly innovation processes are now viewed as strategic opportunities, regardless of the specific goals that drive companies to engage in environmental

management, such as adhering to environmental laws and regulations, enhancing competitiveness, and acceptance form their stakeholders (Khanra et al., 2022; Albort-Morant et al., 2016).

Albort-Morant et al. (2016) suggested that now faced with climate change concerns and resource scarcity across various sectors, companies must possess the ability to allocate their available resources among different alternatives. Leal-Rodríguez et al. (2018) added that companies must adapt competitively to attain competitiveness by optimising the utilisation of their capabilities and limited resources and adjust their operations to gain legitimacy and align with the expectations of the society in which they operate in. Hence, companies need to cultivate dynamic capabilities to progress, thrive, expand, adapt, and ensure their long-term viability (Albort-Morant et al., 2016). Dynamic capabilities are associated with the transformation of regular capabilities, leading to modifications in the firm's production methods, products, or the creation of better capabilities (Albort-Morant et al., 2016). Since the primary aim of any business is to generate profits and ensure its survival in the market (Chan et al., 2016), to thrive in today's turbulent and hypercompetitive environments, Leal-Rodríguez et al. (2018) recommended that companies must foster innovation. Albort-Morant et al. (2016) added that this will enable them to adapt swiftly and effectively to the changing external environment.

The research is structured as follows: Chapter 1 is the introduction providing the necessary background information of the study, with a clear statement of the research problem and research purpose. Chapter 2 is the literature review covering different relevant concepts and theories such as the resource-based view, dynamic capabilities, environmental innovation, and sustainability. Chapter 3 outlined the research questions and hypotheses addressed by the study. Chapter 4 presented the methodology that was followed to answer the research questions. Chapter 5 outlined the results. Chapter 6 discussed the main findings of the study results and lastly, Chapter 7 gave a summary of study and provided recommendations.

1.2 Research Problem

According to Bender et al. (2019), there is a global shift in the evaluation of companies' long-term sustainability, with investors now considering climate change as a crucial factor that affects the company's future earnings, including stock price and profitability. As a result, companies are now placing increased emphasis on environmental and social

issues, driven by the growing knowledge and awareness among investors and stakeholders regarding sustainability matters (Melinda & Wardhani, 2020).

Consequently, companies are now integrating sustainability commitments into their business strategies through environmental, social, and governance (ESG) measures to attain the SDGs (Dicuonzo et al., 2022). These sustainability commitments are often disclosed through sustainability reports (Melinda & Wardhani, 2020). The adoption of ESG practices by companies typically yields positive outcomes, including enhanced customer satisfaction, improved product quality, and reduced expenditures (Dicuonzo et al., 2022; Magon et al., 2018). In the end, these positive gains lead to an improved company performance (Dicuonzo et al., 2022).

However, some studies have implied that the incorporation of ESG practices does not always lead to increased profits. This is because embracing sustainability requires significant investments in innovation and research and development (R&D) (Dicuonzo et al., 2022; Fernandez et al., 2021; Buallay, 2019). Thus, companies typically exercise caution when considering investments in environmental sustainability initiatives due to concerns that such investments could potentially increase operational costs and undermine their competitiveness (Khanra et al., 2022).

According to Saunila et al. (2018), achieving an ecological value proposition requires businesses to recognise the balance between service performance and best product, and improved social and environmental outcomes. According to Zhang et al. (2019), technological progress, driven by environmental innovation, plays a crucial role in enabling companies to achieve sustainability while experiencing growth. Therefore, Saunila et al. (2018) suggested that prioritising the enhancement of environmental innovation should be a key focus for companies, as innovation requires significant investments (Zhang et al., 2019).

Stucki (2019) highlighted that companies tend to prioritise investments in environmental innovation if it leads to improved firm performance. To achieve sustainable growth, companies must embrace environmental innovation that enhances productivity by minimising the use of natural resources and utilising cleaner alternatives (Zhang et al., 2019). Therefore, to attain sustainability and garner support from stakeholders, pursuing green growth and environmental innovation is a logical path for companies. However, it is crucial for these initiatives to generate financial and economic benefits for companies (Zhang et al., 2019).

There are limited comprehensive studies on the influence of environmental innovation on business sustainability, as most research primarily focuses on the association of firm sustainability and financial performance (Xu et al., 2022; Dicuonzo et al., 2022; Zhang et al., 2020a). Consequently, the study aimed to bridge this existing gap in knowledge and provide valuable insights to companies regarding the influence of environmental innovation initiatives on sustainability. As emphasised by Zhang et al. (2019), while companies strive for sustainability, it is crucial that their integration of sustainable practices, such as adopting environmental innovation, allows them to maintain growth, profitability and sustainability.

Given that sustainability is an institutionalised value today and that many businesses are adapting their business models to meet new social needs focused on economic effectiveness, human rights, and environmental preservation, it is intriguing to examine if businesses, in response to social pressures and environmental regulations, recognise environmental innovation as instrumental in enhancing ESG implementation (Dicuonzo et al., 2022).Therefore, the analysis of environmental innovation is a recent area of focus within the academic field. Although researchers have shown increasing interest in it over the past few years (e.g., Albort-Morant et al., 2016; Chen, 2006; Saunila et al., 2018), such studies have not been applied yet in the South African context, therefore, little is known on how South African companies are utilising environmental innovation as they adopt sustainable practices. The study aimed to investigate the impact of environmental innovation on corporate sustainability in the context of South African companies.

1.3 Research Purpose

The primary goal of the study was to understand how environmental innovation influences corporate sustainability of companies in South Africa, drawing upon public companies listed on the Johannesburg Stock Exchange (JSE). The secondary objectives of the study were to understand how environmental innovation influences the environmental, social and governance elements of corporate sustainability, individually.

This is important because environmental innovation contributes to the growth and success of businesses. By fostering innovation, organisations can enhance their ESG practices by creating business models that promote corporate sustainability and facilitate the adoption of sustainable measures (Albort-Morant et al., 2016; Forcadell et al., 2019). Environmental innovation offers companies the potential to carry sustainable practices in their operations, thus enhancing their competitiveness (Albort-Morant et al., 2016). As there are

environmental challenges, it is essential for companies to integrate sustainable concepts into their business operations making environmental innovation an important element in achieving this objective (Albort-Morant et al., 2016). Effective implementation of environmental innovation initiatives not only allows companies to improve their operational efficiency but also enables them to develop and reinforce their core capabilities while enhancing their environmentally responsible reputation, which can ultimately lead to better output and boosted profitability (Albort-Morant et al., 2016).

The next chapter is the Literature Review which provided a thorough examination of fundamental theories and constructs that are significant to the study, covering the RBV, dynamic capabilities, environmental innovation, and lastly, the sustainability concept. Each of these theories gave a different angle on how environmental innovation and corporate sustainability are crucial in addressing the problem identified above.

Chapter 2 - Literature Review

2.1 Introduction

The study aimed to establish how environmental innovation affects corporate sustainability of companies in South Africa. The motivation behind this study stemmed from the realisation that environmental innovation can significantly contribute to business growth and success by encouraging innovative practices that promote sustainability, enhance competitiveness, and improve overall operational efficiency, ultimately leading to increased profitability and a stronger reputation for environmentally responsible business practices.

This chapter adopted a sophisticated approach in defining the theoretical foundation of the study by building upon relevant frameworks and constructs, providing references and evidence that support the study's arguments, and identifying gaps in existing literature. This chapter provided the foundation of the study, detailing key theories and constructs that are integral to the study. It explored the resource-based view (RBV), dynamic capabilities, green dynamic capabilities, environmental innovation, and lastly, the sustainability concept. Each of these theories provided unique insights how innovation relates to corporate sustainability. Section 2.2 provided the context on environmental innovation and corporate sustainability in South Africa. Section 2.3 outlined the RBV theory which explained how firms use their internal capabilities and resources to achieve a competitive advantage in the market. Section 2.4 presented the dynamic capabilities theory which focused on firms' capacity to adjust and respond to changing market conditions, emphasising the significance of being flexible and respond quickly when adopting sustainability. Section 2.5 highlighted green dynamic capabilities as an extension of dynamic capabilities. Section 2.6 outlined the environmental innovation concept which looked at innovations aimed at reducing environmental impact and promoting sustainability. In Section 2.7 there is the sustainability concept which examined the broader aspects of sustainability, encompassing environmental, social, and governance aspects. Section 2.8 provided the literature review matrix and lastly, the literature review summary is in Section 2.9.

2.2 ESG and innovation context in South Africa

South Africa is already witnessing the impacts of climate change, and during the next few years, the country will confront several issues related to climate change (Department of

Forestry, Fisheries, and the Environment [DFFE], 2021). The evidence presented in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) strongly confirms extensive loss and damage experienced by natural and societal systems due to human-induced climate change (Ziervogel et al., 2022). This climate change has brought about hotter days, reduced rainfall in specific regions, prolonged droughts like the Cape Town crisis from 2016 to 2018, and led to a rise in both the number and intensity of extreme rainfall events, including the devastating 2022 Durban floods (Ziervogel et al., 2022). According to Zheng et al. (2019), greenhouse gases (GHG) emissions in South Africa increased by 70% during the period between 1990 and 2016. The energy sector contributes a bulk of emissions given that the country generates most of its electricity from coal (Chininga et al., 2023). Climate changes have worsened water scarcity issues and hindered economic growth in South Africa (Ziervogel et al., 2022). High unemployment, enduring poverty, and inequality have been associated with the recent 10 years' slow economic development (DFFE, 2021).

Thus, the country is determined to reduce its annual GHG emissions to 398-510 Mt CO_2-eq in 2025 and 398-440 Mt CO_2-eq in 2030 (DFFE, 2021). The Government of South Africa in its proposed updated Nationally Determined Contributions, have called upon all companies in the country to deploy cutting-edge technology and provide sustainable employment (DFFE, 2021). South Africa is ranked 59 out of 132 countries on the Global Innovation Index 2023 (World Intellectual Property Organization, 2023) This index, created by the World Intellectual Property Organization, evaluates and contrasts the performance and capacities of nations in terms of innovation on a worldwide level (World Intellectual Property Organization, 2023). Over the years, most businesses in South Africa have focused a lot on corporate social responsibility (CSR) to improve the society in which they operate (Johnson, 2020).

However, for companies to be sustainable, corporate leaders need to consider all aspects of ESG which are environment, social and corporate governance (Johnson, 2020; Linnenluecke & Griffiths 2010). In South Africa, the King reports provide a well-developed framework for local firms, where the adoption of corporate governance measures and policies is the initial step to be adopted by firms in ESG implementation (Johnson, 2020). South Africa was among the early adopters globally to implement corporate governance codes, known as the King reports (ranging from King I to IV). Although these codes are not legally mandated by legislation, they are integrated into the JSE listing requirements such that companies listed on the JSE are expected to adhere to these corporate

governance standards as part of their listing obligations. This demonstrates South Africa's commitment to promoting good governance and sustainability practices in its corporate sector (Toerien et al., 2023). According to Corvino et al. (2020), King III mandated the use of integrated reporting (IR) for listed firms in South Africa which marked a substantial change in the corporate reporting process. Integrated reporting represents a pioneering method in corporate reporting that integrates financial, environmental, and social information and it is closely tied to sustainability and addresses the need for transparency in light of the global financial difficulties (Corvino et al., 2020).

According to Mans-Kemp and Van der Lugt (2020), South Africa is acknowledged as a leader in responsible investment and ESG initiatives worldwide. Environmental initiatives are addressing specific identified environmental issues such energy and water scarcity and usage, climate change, damage to natural habitats, overfishing, waste management and pollution (Johnson, 2020; Mans-Kemp and Van der Lugt, 2020). Considering that sustainability has become an ingrained value in today's society, and numerous businesses are adjusting their operational models to address emerging social priorities, including economic efficiency, human rights, and environmental conservation, this study examined if businesses in South Africa, in response to social pressures and environmental regulations, recognise environmental innovation as a tool to enhance ESG initiatives implementation while at the same developing capabilities that will results to competitive advantage (Dicuonzo et al., 2022).

2.3 Resource-Based View

The Resource-Based View (RBV) offers a theoretical framework for understanding competitive advantage due to cultivating valuable organisational capabilities (Aragón-Correa & Sharma, 2003; Barney, 1991; Wernerfelt, 1984). These capabilities include organisational learning, continuous innovation, and the integration of stakeholders, all of which are linked to business approach that is proactive (Aragón-Correa & Sharma, 2003; Hart, 1995; Sharma & Vredenburg, 1998). However, Khanra et al. (2022) and Barney (2018) argued that a firm's profit appropriation should extend to include viewpoints from the society and the environment, in addition to the interests of direct stakeholders like owners, suppliers, consumers and employees. As a result, firms are faced with a trade-off - whether to maximise immediate benefits by consuming resources or to preserve resources for long-term advantages (Khanra et al., 2022; Kim et al., 2019). Thus, the existing body of knowledge recognises RBV as an appropriate theoretical framework for

addressing the trade-off between short-term profitability and sustainability or long-term success (Khanra et al., 2022).

The resources needed for a company to gain a lasting competitive advantage depend on its interaction with the natural environment (Hart, 1995; Khanra et al., 2022) and its contribution to social well-being (Khanra et al., 2022). Barney et al. (2011) and Hart (1995) suggested that the limitations and difficulties placed on businesses by the natural environment should be included in business models to create a sustainable competitive advantage. They emphasised the significance of understanding how a firm's use of resources and skills from its interactions with the environment may provide it a competitive edge. Ferreira et al. (2018) highlighted the significance of the RBV in understanding how companies combine their valuable and limited resources to achieve sustainable competitive advantages. In this context, the RBV offers insights into how environmental innovation may possibly address the balance between resource utilisation and conservation (Khanra et al., 2022).

Resources possessing qualities of being inimitable, not easily substituted, rare, and valuable, can serve as a foundation for superior performance and the realisation of long-lasting competitive edge (Ambrosini et al., 2009; Barney, 1991; Hartmann & Vachon, 2018 Khanra et al., 2022). Similar to RBV principles, variations in performance among companies can be attributed to the unique combinations of capabilities and resources they possess (Albort-Morant et al., 2016). Additionally, the RBV view also encourages the examination of managerial strategies aimed at acquiring and growing new capabilities (Teece et al., 1997; Wernerfelt, 1984). The RBV considers dynamic capabilities and explores how firms integrate environmental sustainability into their pursuit of competitive advantage (Barney et al., 2011; Hart & Dowell, 2011).

However, sustaining these advantages in dynamic environments is challenging (Ferreira et al., 2018). To remain competitive, firms must continuously reconfigure their resources to adjust to evolving market circumstances and stay ahead of the competition. Thus, the natural resource-based view, extends the RBV to include organisational expertise in removing environmentally detrimental initiatives and creating eco-friendly products as a specialised type of dynamic capability (Hartmann & Vachon, 2018).

2.4 Dynamic Capabilities

The RBV of the firm has evolved into the concept of dynamic capacities (Teece et al.,1997). Ambrosini et al. (2009) clarified that the dynamic capability view provides insight

into how firms can maintain resource-based advantages in changing environments whereas the RBV theory explains competitive advantage of firms based on stable environments. The theory of dynamic capabilities was introduced by Teece et al. (1997) as a company's ability to effectively incorporate, develop, and reconfigure external and internal capabilities to adapt to a fast-shifting business environment. Dynamic capabilities enable a company to respond proactively to shifts in the market, technological developments, and other external factors by leveraging its internal strengths and competencies while also acquiring new ones from external sources. This adaptability and ability to adjust to changing conditions are considered crucial for a firm's sustainability success and competitive advantage in a dynamic and ever evolving business landscape. Firms that effectively manage their environmental impact, leverage their unique resources, and adapt to changing environmental challenges have the potential to create a competitive edge and perform better with respect to environmental outcomes. Consequently, the dynamic capability is more appropriate to be adopted by companies to be sustainable. This capability contributes to a competitive advantage, particularly in a world with limited resources and increasing pollution concerns (Hartmann & Vachon, 2018).

Dynamic capabilities are the firm's capacity to successfully cultivate, incorporate, and adapt both external and internal abilities in response to quickly shifting environmental circumstances (Arshad et al., 2023; Barreto, 2010; Helfat et al., 2009; Teece et al.,1997). While "dynamic" refers to the need to adapt proficiencies to align with shifting business environment (Teece et al.,1997; Yuan & Cao, 2022), "capabilities" underscores the crucial part of strategic management in successfully modifying, incorporating, and tailoring organisational functional proficiencies, resources, skills to align to a shifting business landscape (Teece et al.,1997). Ambrosini et al. (2009) and Helfat and Peteraf (2003) highlighted that for a capability to be considered dynamic, it must not only bring about changes in the resource base but also be firmly embedded within the firm and capable of being repeated over time.

Aragón-Correa and Sharma (2003) explained that dynamic capabilities encompass distinctive and recognisable processes that, although unique to each firm in their specific details and shaped by their individual development paths, exhibit notable similarities in sharing best practices amongst businesses. Unlike the RBV, the dynamic capabilities perspective posits that since all resources can eventually be copied or replaced, the emphasis lies on the approaches through which organisations acquire and convert their current valuable resources into new ones to sustain a competitive edge (Hartmann &

Vachon, 2018). Hartmann and Vachon (2018) explained that dynamic capabilities are characterised as strategic and organisational processes that enable companies to adapt and attain new resource arrangements in response to changing market conditions. The definition suggests that while dynamic capabilities are specific to each firm, they share certain commonalities. Hartmann and Vachon (2018) suggested that dynamic capabilities encompass readily identifiable practises that are deeply integrated into the organisation's operations, indicating the importance of well-structured and embedded routines to drive adaptability and innovation in the context of environmental management.

Dynamic capabilities play a vital role in enhancing a firm's adaptability and competitiveness, with innovation and marketing capabilities serving as key factors in driving improved performance and sustained success in the market (Bianchi et al., 2022). This approach supports firms to stay competitive and profitable over the long term by continuously adapting to changing market conditions and evolving their business strategies accordingly (Teece, 2018; Ferreira et al., 2018). Additionally, when a firm possesses robust dynamic capabilities, it has the ability to shape the business environment in a way that benefits itself by establishing industry norms or influencing government regulations to align with its interests (Teece, 2018). Yuan and Cao (2022) pointed out that firms leverage dynamic capability effectively to convert knowledge into innovative services, products, and processes, leading to improved performance management and technological innovation. According to Ferreira et al. (2018), studies have demonstrated that dynamic capabilities can impact a company's performance in various ways, both directly and indirectly and can also impact competitiveness, primarily through their impact on innovation and marketing capabilities.

According to Ferreira et al. (2018) and Teece (2018), dynamic capabilities are a tool to help firms stay agile, competitive, and successful in a dynamic business environment. The idea of dynamic capability is being used to establish a relationship between sustainability and green dynamic capability (Arshad et al., 2023). According to the dynamic capability concept, a company's strategic capabilities, such as its capacity to innovate and adjust market shifts, are essential for the attainment of a competitive edge and achieving exceptional results through innovation. Therefore, businesses equipped with green dynamic capabilities have the potential to not only outperform their competitors but also positively impact the environment and society by promoting sustainable practices and solutions for the long term (Arshad et al., 2023; Teece; 2018). This adaptability enables businesses to incorporate environmental technology into their products and processes,

promoting sustainability. To achieve this, companies create and execute business models by leveraging their dynamic capabilities, which involve identifying market opportunities, seizing them through effective actions, and adapting or changing as needed (Arshad et al., 2023; Teece, 2018).

2.5 Green Dynamic Capabilities

Green dynamic capability stem from the dynamic capability, which relates to a firm's capability to perceive, understand, and adapt its external and internal resources, encompassing technical and green resources in reaction to shifts in the business landscape (Yuan & Cao, 2022). This adaptive process involves breaking away from existing dependencies and creating new organisational resources and strategies to effectively address environmental challenges and embrace sustainable practices (Kabongo & Boiral, 2017; Yuan & Cao, 2022; Zhang et al., 2020b). The green dynamic capability concept has evolved into a powerful strategy or approach to combat the negative impacts of pollution, the exhaustion of natural resources and climate change within the global economy (Arshad et al., 2023; Lin et al., 2021). Green dynamic capability prompts businesses to proactively address environmental concerns and minimise the adverse effects of new technologies as green dynamic capability equips companies to adapt and innovate in response to environmental challenges and sustainable practices and implement preventive measures for environmental protection (Arshad et al., 2023).

Green dynamic capability involves not only adapting to market changes but also actively pursuing sustainability objectives and contributing to green initiatives despite the ongoing shifts in the business environment (Qiu et al., 2020; Yuan & Cao, 2022;). It focuses on effectively creating, incorporating, and rebuilding both external and internal resources linked to environmental conservation which enables firms to be responsive to changing environmental demands, innovate with environmental technologies, and align their strategies with evolving environmental policies, ultimately contributing to more effective environmental protection and sustainable business practices (Kabongo & Boiral, 2017; Lin & Chen, 2017; Yuan & Cao, 2022).

Firms with robust green dynamic capabilities can recognise customer preferences for eco-friendly products and processes and monitor their competitors' activities in green innovation, enabling them to effectively recognise and seize opportunities for eco-products and process innovation (Dangelico et al., 2017; Yuan & Cao, 2022; Yousaf, 2021). They create new combinations of resources, such as expertise, human talent, financial capital,

and technology, specifically tailored for environmental innovation, which allows them to respond swiftly to market demands and implement environmental innovations efficiently, thus capitalising on market opportunities, enhancing their competitive advantage, and contributing positively to corporate sustainability (Dangelico et al., 2017; Teece, 2020; Yuan & Cao, 2022). They can then efficiently mobilise and allocate resources, including knowledge, manpower and capital necessary for environmental innovation, enabling them to quickly invest in and implement sustainable practices and solutions (Qiu et al., 2020; Yuan & Cao, 2022). Additionally, their strong green dynamic capability allows them to access and acquire abundant external technologies, patents, and knowledge related to environmental innovation (Yuan & Cao, 2022).

According to Arshad et al. (2023) and Zhang et al. (2020b), integrating company resources to cultivate a green dynamic capability enhances the viability of sustainable practices and green initiatives at both strategic and operational and strategic dimensions. By developing green dynamic capabilities, a company is better equipped to adopt and implement green innovations successfully, thereby improving its overall sustainability performance particularly in terms of environmental and societal impact (Arshad et al., 2023). According to Leonard-Barton (1992) and Teece et al. (1997), these abilities represent the firm's capability to attain competitive advantage using novel and innovative practices while considering its position in the market and its current operations' needs. These capabilities enable companies to develop innovative practices (Albort-Morant et al., 2016; Aragón-Correa & Sharma, 2003; Eisenhardt & Martin, 2000). Innovation is one of the dynamic capabilities that firms can adopt to align with a changing business environment, enhancing their competitive advantage while also being sustainable.

2.6 Environmental Innovation

Innovation involves the creation of new products, services, processes, resources, and organisational structures, with the aim of attaining a competitive advantage (Saunila et al., 2018). Innovation is necessary in advancing sustainability within businesses (Dicuonzo et al., 2022). By promoting growth and facilitating industrialisation, innovation and technology can contribute to both economic progress and the well-being of individuals (Carayannis et al., 2015; Dicuonzo et al., 2022). Hence, the capacity of firms to innovate is crucial, as innovative firms tend to exhibit stronger corporate sustainability, as measured by ESG factors (Araújo et al., 2022). Technological results like patents or patent applications, research and development expenditures can serve as indicators to measure a firm's capability for innovation (Broadstock et al., 2020; Dicuonzo et al., 2022).

The dynamic capacity theory highlights the contextual aspect, where a firm's competitive edge and environmental sustainability are interlinked with its green dynamic potential. Environmental innovation has been recognised as an approach to achieving a cleaner and greener business landscape (Arshad et al., 2023; Dicuonzo et al., 2022). While innovation is typically described as an ongoing enhancement in a company's capacity to create innovative solutions for developing new products to meet market demands (Dicuonzo et al., 2022), the transition towards environmental innovation involves redefining the notion of technological innovation to emphasise environmental innovation aspects (Ahmad & Wu, 2021). According to Long et al. (2017), businesses often spend more on environmental R&D to enhance their production processes when environmental rules are reinforced. Initially, these regulations may lead to higher production costs for firms in the immediate future, yet in the long term, they stimulate innovation, which enhances organisations' productivity and competitiveness (Long et al., 2017; Zhao & Sun, 2016). Therefore, in the context of the environment, it is crucial to examine how business operations affect the environment and a firm's capacity to offer services and goods that solve environmental and climatic concerns (Dicuonzo et al., 2022).

Normal measures taken by companies pursuing environmental innovation involve the advancement of technologies, optimisation of production processes and the efficient utilisation of natural resources aimed at reducing environmental impact (Dicuonzo et al., 2022; Khanra et al., 2022). Several social and environmental challenges pertaining to sustainable business practices may be addressed by adopting environmental innovation as a strategic corporate resource (Du et al., 2018; Duque-Grisales et al., 2020; Khanra et al., 2022). However, there is some misunderstanding regarding the many concepts and terminologies used to define innovation, like environmental and green innovation and eco-innovation, which actively mitigate the harmful effects caused by people and businesses on the environment (Leal-Rodríguez et al., 2018; Schiederig et al., 2012).

Leal-Rodrguez et al. (2018) claimed that Fussler and James (1996) were the first writers to present the idea of green innovation in their book. Fussler and James (1996) defined green innovation as the creation of new goods and procedures that benefit businesses and consumers while drastically lowering their negative effects on the environment. However, Saunila et al. (2018) and Li et al. (2017) added the creation of new concepts, services, and organisational systems to Fussler and James' definition. Abbas and Sağsan (2019) and Fernando et al. (2019) defined green innovation as the process by which

companies develop and implement new technologies, practices, or strategies to minimise the harmful effects of their actions on the environment.

Almost similar to Fussler and James' definition, Arshad et al. (2023) defined green innovation as making advancements in both the processes and products used by a company which improves production techniques and product design. Green innovation conserves energy, reduces pollution and waste as leads to reduced environmental negative impacts. Green innovation encourages companies to leverage modern technology to create environmentally friendly products and services. Green innovation encompasses various forms of innovation such as eco-friendly product design, energy-efficient technologies, waste recycling initiatives, pollution mitigation measures and environmental management strategies (Saunila et al., 2018; Chen et al., 2006). The goal of green innovation is to make enhancements in the production processes involved in converting raw materials into usable products (Abbas & Sağsan, 2019; Albort-Morant et al., 2016).

These enhancements aim to reduce natural resource consumption, utilise renewable resources for capitalisation purposes, as well as the minimisation of waste (Abbas & Sağsan, 2019; Rossiter & Smith, 2018). Green product innovation aims to either alter the design of new products that incorporate renewable or non-toxic materials during production (Abbas & Sağsan, 2019; Zhang et al., 2019). This dual approach aims not only to enhance energy efficiency but also to minimise the environmental impact during disposal. Companies that lead in green innovation have a higher likelihood of gaining several competitive advantages which include factors like earning the trust and loyalty of customers and experiencing improved profitability (Abbas & Sağsan, 2019; Albort-Morant et al., 2016).

Leal-Rodrguez et al. (2018) defined eco-innovation as the adoption of innovative or considerably better goods, processes, marketing tactics, institutional arrangements and organisational arrangements that result in environmental improvements, based on the Organisation for Economic Co-operation and Development (OECD). More precisely, eco-innovation is the active pursuit of SDGs through responsible behaviour aimed at reducing environmental challenges brought on by businesses and making sure natural capital is resilient to production processes pressures (Dicuonzo et al., 2022). However, Le- Kemp and Pearson (2007) and Rodríguez et al. (2018) argued that eco-innovation should extend beyond services or products developed solely for environmental motivations. Instead, the

term should encompass all types of innovations benefiting the environmental, regardless of if they are deliberate or unintentional.

The concept of environmental innovation extends beyond traditional technological improvements and includes solutions that focus on saving energy, preventing pollution, and enabling waste recycling (Chouaibi et al., 2022). It not only enhances a firm's environmental performance but also provides a competitive advantage (Chouaibi et al., 2022; Harel et al., 2020). Environmental innovation involves the development of improved or new technologies, goods, crafts, and systems designed at avoiding or minimising environmental damage (Kemp et al., 2001; Long et al., 2017). Environmental innovation is a multifaceted strategy that encompasses technological advancements, eco-friendly product designs, and sustainable practices, providing a proactive pathway to benefit both businesses and the environment. Environmental innovation is a proactive approach to achieving environmental development and sustainability (Chouaibi et al., 2022).

The implementation of environmental innovation can lead to environmental benefits and provide sustainability (Oltra & Saint Jean, 2009). Environmental innovation is closely tied to technological advancements, encompassing new practices and products. By embracing the environmental aspect, firms can effectively utilise resources in a balanced approach and prioritise the long-term value of the organisation (Melinda & Wardhani, 2020). Thus, environmental innovation is crucial for firms aiming to be at the forefront of innovation and positive change, as it allows them to address environmental challenges, reduce their carbon footprint, and offer sustainable solutions for the benefit of society and the planet, through developing and offering eco-friendly products and adopting sustainable business strategies and processes (Arshad et al., 2023; Lin et al., 2017).

Subsequently, these terms, namely environmental, green and eco-innovation, have been commonly used interchangeably to describe innovations that help preserve a sustainable environment through creating ecological advancements (Leal-Rodríguez et al., 2018; Long et al., 2017). However, since the definitions of these terms seems to be related or almost the same, for the purpose of this study, environmental innovation will be used as it is used on the Refinitiv database where environmental innovation consider the environmental assets under management, environmental products, equator principles or environmental project financing, renewable or clean energy products and fossil fuel divestment policy.

Different scholars have used various measures to analyse environmental innovation empirically (Long et al., 2017). These measurements include examining environmental

protection patents as indicators of knowledge production (Brunnermeier & Cohen, 2003; Long et al., 2017); assessing the costs associated with environmental R&D, environmental research personnel and associated costs of intangible resources and lastly, evaluating the resultant market performance (Kanerva et al., 2009; Jaffe & Palmer, 1997; Long et al., 2017; Mazzanti & Zoboli, 2006). The adoption of environmental innovation is considered essential for companies, as it serves as a valuable asset that drives them towards achieving sustainable growth and meeting the expectations and standards set by their stakeholders (Arshad et al., 2023; Hu et al., 2021).

Dicuonzo et al. (2022) used patents and R&D expenditure as proxies for innovation, where environmental innovation was represented by the total number of patents and firm's technological knowledge was measured by R&D investment. Araújo et al. (2022) and Chouaibi et al. (2022) used the environment innovation score developed by the Thomson Reuters, measuring how creative businesses are in terms of using eco-friendly procedures and their capacity to use technology for cost reduction and market development. To measure environmental innovation, Fernando and Wah (2017) used primary data collected from companies which assessed if a firm has adopted cutting-edge green technology, consistently harnessed the potential of green innovations, established an in-house research and development unit, and extensively incorporated green technology. To evaluate a company's capacity for environmental innovation Zhang and Chen (2023) used green patents as the main indicator where the number of issued green patents was seen to be a more accurate indicator of a company's level of environmental innovation.

2.7 Sustainability

There is limited understanding of successful adoption of sustainable business models (Cancino et al., 2018; Evans et al., 2017). The challenge lies in assessing the influence of sustainable innovations on the entire business network. Cancino et al. (2018) and Edgeman and Eskildsen (2014) indicated that the sustainability for firms relies on striking a balance between stakeholders' interests, which include societal and the environment consideration, to achieve sustainable competitive positioning. To promote sustainable growth, businesses should consider making a profit, social and environmental benefits, while maintaining a compromise among them (Cancino et al., 2018).

Therefore, the idea of corporate sustainability has gained popularity in recent decades, inspiring practitioners to consider new company models, strategic directions, and business process reform (Ahmed et al., 2021; Klettner et al., 2014). The theory of corporate

sustainability originates from the broader idea of sustainable development, based on World Commission on Environment and Development's (WCED) definition (Bansal & DesJardine, 2014; Thakhathi et al., 2019). According to Abbas and Sağsan (2019), the roots of the concept of sustainable development can be linked to the Brundtland Commission report called Our Common Future which was delivered at the of the United Nations (UN) General Assembly in 1987. The statement brought attention to two critical aspects: economic development and environmental stability (WCED, 1987). It emphasised the need to address both issues simultaneously to ensure a balanced and sustainable future for humanity.

Therefore, sustainable development aims to satisfy the current generation's requirements for economic growth, social progress, and improved quality of life while ensuring that these actions do not have a detrimental impact or deplete natural resources to the extent that the needs of future generations cannot be fulfilled (Abbas & Sağsan, 2019; UN, 1987). It advocates responsible resource management, conservation, and the awareness of how human activities affect the environment and future generations. In 1992, a third dimension to the theory of sustainable development was introduced, which is social sustainability expanding the scope of sustainability beyond just environmental and economic considerations (Abbas & Sağsan, 2019; Munasinghe & Lutz, 1992). The WCED emphasises the need for simultaneous pursuit of environmental, social, and economic well-being to achieve sustainability (Thakhathi et al., 2019). Corporate sustainability is achieved when organisations strategically manage and integrate these three considerations into their operations: social, economic and environmental (Baumgartner & Rauter, 2017; Cancino et al., 2018; Thakhathi et al., 2019). However, Buallay (2019), Dicuonzo et al. (2022) and Drempetic et al. (2020) noted that ESG aspects are often used to assess corporate sustainability.

Dicuonzo et al. (2022) studied the effect of innovation on ESG practices of 182 firms listed in France, Italy, Spain, USA, Germany and the UK, operating in the industrial sector, using a panel dataset from 2013 to 2020, where the fixed-effects model was used to analyse the panel data. Dicuonzo et al. (2022) found that companies that invest more in innovation as shown by their investments in R&D and the number of patents they tend to perform better than less innovative companies in terms of social, environmental, and governance measures, meaning that innovation and adherence to ESG principles seem to have a good impact on company sustainability. Araújo et al. (2022) employed the generalised least squares (GLS) regression model to analyse the impact of environmental innovation

on corporate sustainability for 202 Latin American firms from 2012 to 2019. Araújo et al. (2022) also found the same results that environmental innovation positively impacts ESG, meaning that companies that develop environmental innovation capabilities are able to build a competitive edge.

Chouaibi et al. (2022) established a link between improved financial performance and ESG companies with a strong emphasis on environmental innovation. Therefore, the model indicated that environmental innovation is valued as means to attain sustainable development as it results to better financial results for companies. The authors attributed this improvement to environmental innovation which improves firms' financial outcomes by simultaneously lowering costs and distinguishing their goods or services. According to Ahmed et al. (2021), sustainability involves three fundamental dimensions that organisations should address, environmental, social and corporate governance.

2.7.1 The Environmental Aspect

Dicuonzo et al. (2022) asserted that the environmental element pertains to a company's capacity to minimise its GHG emissions in its operations through the utilisation of natural resources, effectively. Cancino et al. (2018) explained that the environmental aspect encompasses minimal emissions, renewable resources, waste reduction, pollution prevention and biodiversity conservation. Over the past few decades, the environmental dimension has demonstrated the consequences of human-driven economic development, a growing population, overexploitation of natural resources, and an overestimation of technological advancements without acknowledging their limitations. This is evident through environmental degradation and climate change (Cancino et al., 2018). Therefore, in the environmental dimension, companies should adopt practices and strategies that are environmentally friendly and aim to minimise their negative effects on the environment. Although, Araújo et al. (2022) found that environmental innovation does not have influence on the environmental aspect.

2.7.2 The Social Aspect

The social aspect evaluates a firm's ability to establish trust among its employees and uphold ethical values, while also emphasising the importance of respecting human rights (Dicuonzo et al., 2022). The social aspect includes well-being, diversity, equality, ensuring secure livelihoods, community development, maintaining health and safety measures, and adhering to labour standards (Cancino et al., 2018). It aims to ensure human and labour

rights, social development, equity, justice and social support; thus, focusing on fostering a fair and inclusive society where the needs and rights of individuals and communities are respected and upheld (Abbas & Sağsan, 2019). Therefore, implementing sustainability practices in a business setting can lead to several positive outcomes, not only contributing to both societal benefits and profit maximisation for investors, but also, creating improvements for all stakeholders involved, like suppliers, employees, contractors, and community members (Ahmed et al., 2021). Moreover, sustainability actions positively contribute to the environment while simultaneously enhancing shareholder value.

2.7.3 The Governance Aspect

Dicuonzo et al. (2022) stated that the governance aspect pertains to a firm's ability to prioritise shareholders' interests by implementing effective processes and efficient corporate management systems. In the governance dimension, while being socially responsible and environmentally friendly, firms must also strive to create value and generate profit for their shareholders. This means balancing financial success with social and environmental objectives. Thus, the governance aspect examines a company's implementation of effective procedures and efficient corporate management practices that prioritise the interests of its shareholders (Dicuonzo et al., 2022). Institutional concept is key in understanding corporate sustainability as institutional factors, such as societal norms and competitive pressures, are influencing companies to adopt sustainable practices, recognising the benefits it brings to their overall performance (Ahmed et al., 2021). More companies are embracing corporate sustainability rather than avoiding it as management has recognised that adopting corporate sustainability can lead to increased efficiency and productivity, prompting a shift towards integrating sustainable practices into their operations (Ahmed et al., 2021). This outcome might be explained by the close link between corporate governance and the values of market openness, accountability, resource allocation, corporate sustainability, strategic management, and stakeholder rights protection, where these aspects within the governance aspect are open and responsive to environmental innovation to enhance environmental performance and open up new market opportunities (Araújo et al., 2022).

Finally, according to Melinda and Wardhani (2020), ESG serves as a non-financial indicator to assess sustainability practices. Technological innovations promote sustainable growth and economic development by offering solutions to create environmentally friendly conditions in the manufacturing of goods and services (Cancino et al., 2018). Companies with a strong commitment to ESG principles are better positioned

to enhance their product quality and streamline internal operations while reducing operational expenses through environmental innovation (Chouaibi et al., 2022). Therefore, environmental innovation is considered a proactive method to achieving environmental development and sustainability.

Liu and Lyu (2022) pointed out that there is limited research on how firms respond to ESG ratings in terms of their sustainability investments and its impact on environmental innovation. Environmental innovation has positive effects at both macro and micro levels, such as lowering costs, improving environmental conservation and promoting sustainable economic growth. However, the specific relationship between ESG ratings, strategic corporate decision-making regarding environmental innovation remains unclear due to the lack of comprehensive studies in this area (Liu & Lyu, 2022; Zhang et al., 2020a).

According to Dicuonzo et al. (2022), the positive influence environmental innovation has on a company's sustainability indicates that companies need to understand the need for investing in environmental innovation as a means of attaining sustainable development and guaranteeing long-term profitability. Since sustainability and competitiveness are strongly related, it is essential for businesses to align the two and recognise that environmental innovation could be adopted as a strategy for achieving both business success and ESG sustainability goals (Dicuonzo et al., 2022). Chouaibi et al. (2022) revealed that firms that prioritise ESG concerns and engage in environmental innovation experience improved financial performance, therefore, providing a compelling reason for managers to allocate resources to sustainability initiatives and environmental innovation practices to achieve sustainable growth. As a result, further research is needed to understand how ESG ratings influence corporate sustainability investments and their subsequent impact on environmental innovation initiatives.

2.8 Literature review matrix

The matrix in Table 1 provides a summary of articles and authors in environmental innovation and sustainability, highlighting the key findings from authors, methods they used and identifying gaps in current literature.

Table 1: Literature review matrix

Literature area	Authors	Findings and methods	Critique
Environmental Innovation	(Abbas & Sağsan, 2019; Albort-Morant et al., 2016; Broadstock et al., 2020; Chouaibi et al., 2022; Araújo et al., 2022; Arshad et al., 2023; Dicuonzo et al., 2022; Du et al., 2018; Duque-Grisales et al., 2020; Fernando & Wah, 2017; Hu et al., 2021; Khanra et al., 2022; Long et al., 2017; Melinda & Wardhani, 2020; Zhang & Chen, 2023; Zhao & Sun, 2016)	Findings show that companies that invest more in environmental innovation have improved corporate sustainability. Various measurements were employed by these studies to assess environmental innovation which include patents, research and development (R&D) expenditures, and proprietary innovation scores. Additionally, some studies used environmental innovation scores developed by organisations like Thomson Reuters, now known as Refinitiv. To delve deeper into a company's environmental innovation, some studies collected primary data directly from companies.	Different proxies for environmental innovation were used in different contexts and countries, thus there is a need to get environmental innovation from the South African perspective.
Sustainability (Environmental, Social and Governance Aspects)	(Abbas & Sağsan, 2019; Ahmed et al., 2021; Araújo et al., 2022; Buallay, 2019; Cancino et al., 2018; Chouaibi et al., 2022; Dicuonzo et al., 2022; Drempetic et al., 2019; Forcadell et al., 2019; Liu & Lyu, 2022; Melinda & Wardhani, 2020; Thakhathi et al., 2019; Zhang et al., 2020a)	Findings indicate that environmental innovation positively influences corporate sustainability, meaning that companies that develop environmental innovation capabilities are able to create a competitive advantage. Most studies used secondary data, where a panel dataset was employed and the fixed-effects model was used to analyse the panel data. Some used generalised least squares (GLS) regression model to analyse the impact of environmental innovation on corporate sustainability	A number of studies have assessed the effect of environmental innovation on corporate sustainability of companies in developed economies, and little is known in developing economies like South Africa.

2.9 Conclusion

The literature review has provided a comprehensive exploration of key theories that underpin the study's investigation into the influence of environmental innovation on corporate sustainability. The RBV theory explained how organisations utilise their internal resources to gain a competitive advantage, highlighting the importance of leveraging unique capabilities for sustainable practices. Dynamic capabilities emphasised the need for adaptability and flexibility in responding to changing market conditions fostering sustainability within firms. The concept of innovation is driving sustainable practices, with a particular focus on environmental innovation aimed at reducing environmental impact.

Lastly, the concept of sustainability provided a holistic perspective, encompassing environmental, social, and governance dimensions.

The framework in Figure 1 below provides a holistic view of the theories presented in this section and links them to the hypotheses of the study presented in the next chapter.
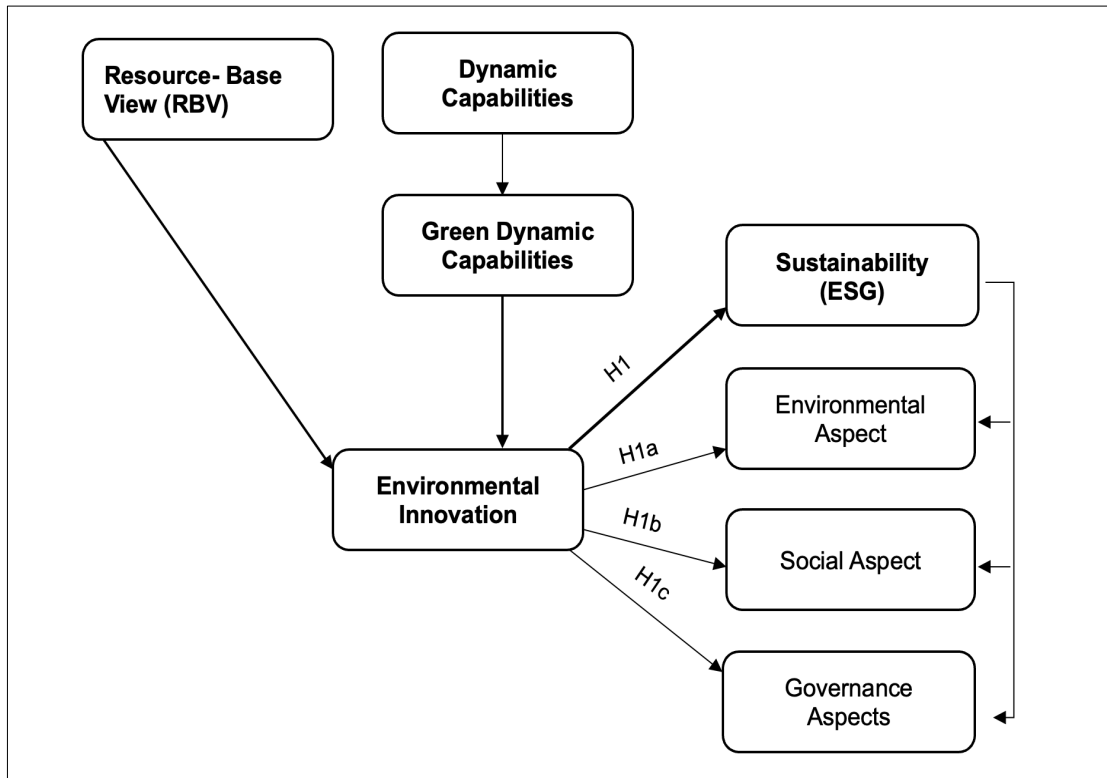
Figure 1: Framework for the study
Source: Author's construct (2023)

Chapter 3: Research Questions and Hypotheses

3.1 Research Questions

Long et al. (2017) stated that environmental innovation holds the capability to bring about benefits for both financial and environmental aspects, resulting in a win-win situation. Li et al. (2017) demonstrated a significant positive influence of environmental innovation practices on environmental implementation. Additionally, Long et al. (2017) indicated that financial performance of companies is influenced by environmental innovation because of the reduction of production costs, improvement in processes, and innovative products.

The study will address the following questions:

1) How does environmental innovation influence corporate sustainability of companies in South Africa?

Since corporate sustainability has three aspects: environmental, social and governance aspects, the proposed study will also determine how environmental innovation influences the three aspects individually, therefore the study will also be guided by the following sub questions:

1) How does environmental innovation influence the environmental element of corporate sustainability of companies in South Africa?
2) How does environmental innovation influence the social element of corporate sustainability of companies in South Africa?
3) How does environmental innovation influence the governance element of corporate sustainability of companies in South Africa?

Environmental innovation in organisations is influenced by both external and internal elements. Saunila et al. (2018) observed that the integration of sustainable practices in response to social and economic pressures is crucial in driving the adoption of environmental innovation by firms. Araújo et al. (2022) stated that evaluating the influence of environmental innovation on measures of corporate sustainability can provide valuable insights into firm performance. Dicuonzo et al. (2022) identified that there is a relationship between firm innovation and corporate sustainability, indicating that firms that embrace innovation not only achieve sustainability but also create enhanced value for their stakeholders. Araújo et al. (2022) further highlighted that companies that adopt environmental innovation realise their environmental goals together with indirect economic benefits in the process.

3.2 Research Hypotheses

From the research questions formulated above, the following four hypotheses were formulated:

1) H_1: There is a significant positive relationship between environmental innovation and corporate sustainability of companies in South Africa.

From the three dimensions of ESG, further sub-hypotheses were formulated:

2) H_{1a}: There is a significant positive relationship between environmental innovation and the environmental aspect of corporate sustainability of companies in South Africa.

3) H_{1b}: There is a significant positive relationship between environmental innovation and the social aspect of corporate sustainability of companies in South Africa.

4) H_{1c}: There is a significant positive relationship between environmental innovation and governance aspect of corporate sustainability of companies in South Africa.

3.3 Conclusion

Based on the hypotheses outlined in this chapter, a positivist approach was utilised to examine the study's hypotheses that were formulated from the theory outlined in Chapter 2. The next chapter present the methodology employed to address the study questions and test the hypotheses.

Chapter 4 - Research Methodology

4.1 Introduction

This chapter outlines the methodology and research design utilised to answer the main research question of how environmental innovation influences corporate sustainability and the three sub questions to determine if environmental innovation have an influence on the three aspects of sustainability, individually. A quantitative research approach was employed to determine if environmental innovation influences corporate sustainability. The study targeted a population of South African companies listed on the JSE. Due to data availability, a sample of 39 public was chosen using a combination of convenience and judgement sampling. Secondary data of the study's main variables and control variables was collected from the Refinitiv database, by collecting panel data spanning from 2013 to 2022. Data was analysed using the generalized least squares (GLS) regression model to determine how environmental innovation affects corporate sustainability of firms in South Africa. Data analysed using IBM SPSS version 29.

4.2 Philosophy and Approach to Theory Development

The study employed a positivism approach that utilised structured methods to enable generalisation and replication (Saunders & Lewis, 2018). Mohajan (2020) asserted that positivism is a philosophical stance that underlines the significance of observation in advancing knowledge within the field of science. Mohajan (2020) added that positivism's primary goal is to establish objective facts, legitimacies, and rules. Positivist research progresses by presenting evidence or support for a hypothesis (Mohajan, 2020; Popper, 2005). A positivist approach places emphasis on utilising quantitative methods (Mohajan, 2020). The primary aim of a positivist analysis is to investigate explanatory or causal relationships that facilitate the estimation and control of phenomena in question (Park et al., 2020).

Positivism endeavours involve the identification, measurement, and evaluation of various phenomena, while offering rational explanations that determines connections and linkages between many variables, thereby linking them to a certain concept (Collis & Hussey, 2003; Mohajan, 2020). The study employed the RBV theory, dynamic capabilities, green dynamic capabilities and environmental innovation in association to sustainability. The RBV theory helped to explain how businesses use their unique resources, like environmental innovation to promote sustainability. The dynamic capabilities theory is

derived from RBV and emphasises a company's capacity for change and adaptation through time in response to environmental problems and green dynamic capabilities are a particular type of dynamic capability that concentrates on methods and practices that are friendly to the environment. These ideas work together to make it easier for businesses to build new, sustainable practices when applied to environmental innovation. Thus, the theories helped to explain why things occur and predict future outcomes. Park et al. (2020) confirmed that this method is based on the hypothetico-deductive model.

The approach employed for theory development was deductive, as the study analysed the impact of environmental innovation on corporate sustainability. Saunders and Lewis (2018) explained that the deductive approach involves using a research strategy to examine a theoretical proposition. This strategy consisted of five sequential steps: utilising existing theory to formulate research questions, developing hypotheses, collecting data, analysing data, and ultimately validating the theory (Mohajan, 2020; Saunders & Lewis, 2018; Johnson & Onwuegbuzie, 2004). Johnson and Onwuegbuzie (2004) stated that the deductive approach offers the benefit of examining and confirming pre-existing theories regarding the occurrence of phenomena. This approach involves testing hypotheses that are formulated before the collection of data (Johnson & Onwuegbuzie, 2004). Therefore, from the RBV and dynamic capabilities theories, hypotheses were derived to conceptualised how environmental innovation relates to sustainability.

4.3 Choice of Methodology and Research Strategy

The research utilised a mono quantitative method, involving the collection and analysis of secondary data. Saunders and Lewis (2018) provided that a mono quantitative study uses one technique to collect data. Considering time constraints and ease access of data, the mono quantitative method seemed to be a suitable approach for this research. Dicuonzo et al. (2022) conducted a study on the effect of innovation on environmental ESG practices where the mono quantitative method was utilised.

Mohajan (2020) noted that the quantitative method uses standardised and pre-tested tools for gathering data which ensures that the information collected is accurate and reliable and it also enhances the validity of the data, making it suitable for repeated research studies. Moreover, study findings can be generalised if the sample accurately represents the population. Additionally, the results of quantitative research are straightforward and can be easily explained and understood. The quantitative method further allowed for statistical analysis which are considered reliable (Mohajan, 2020). Statistical analysis is

used to condense and structure data while identifying meaningful associations (Brink & Wood, 1998; Burns & Grove, 2005; Mohajan, 2020). The statistical package for social science (SPSS) was utilised for analysis in this study, where data was computed and performed by computer, saving time and resources (Mohajan, 2020).

The study utilised secondary data, which is information already available in the public domain, offering distinct advantages (Saunders & Lewis, 2018) like avoiding ethical concerns, reduced data collection mistakes and cost efficient. The collected secondary data was quantitative and continuous in nature. The study used secondary data collected from Refinitiv database because of ease of access as the data of the sampled companies was already reported on the variables utilised in this study and the database was accessed via the GIBS university Info Central. The data was available in a format that allowed for easy analysis as it was software compatible.

4.4 Purpose of Research design

The research is categorised as an explanatory study, as it established a causal relationship (Saunders & Lewis, 2018). The explanatory approach explores the potential correlation between two or more variables (Johnson & Onwuegbuzie, 2004; Queirós et al., 2017). In this instance, the study determined the relationship between environmental innovation and corporate sustainability. In the study, there was no manipulation of variables; instead, the focus was on examining the degree of association between the two variables environmental innovation and sustainability (Queirós et al., 2017). According to Johnson and Onwuegbuzie (2004), an explanatory study is valuable for collecting data that enable quantitative predictions to be made.

4.5 Population

A population refers to the complete collection of all elements (Johnson & Christensen, 2019; Saunders & Lewis, 2018). It represents the larger group to which a researcher aims to extend the findings from their sample (Johnson & Christensen, 2019). The study's population were public companies in South Africa; however, the target population were South African companies listed on the JSE. These listed firms were the population of interest because they are required to engage in integrated reporting (Moloi & Iredele, 2020), and are closely examined for their implementation of corporate sustainability practices (Dzomonda & Fatoki, 2020).

4.6 Time horizon

The study employed a longitudinal design, collecting panel data spanning from 2013 to 2022. The selected period was chosen because of the directive of the JSE for public companies to initiate reporting on their sustainability practices through integrated reporting, starting in the financial period of March 2010 (Setia et al., 2015). Thereafter, some listed started reporting on their sustainability practices. Additionally, in September 2011, the International Integrated Reporting Committee issued guidance to companies on integrated reporting. However, most listed companies were not reporting on all the sustainability practices, thus environmental innovation score is only available from 2013 for most companies. The selection of a longitudinal design is motivated by its ability to provide valuable data for addressing the research question. According to Bono and McNamara (2011), the longitudinal design is recommended when panel data is used to establish causal relationships between variables.

4.7 Unit of Analysis

The unit of analysis in the study was a group of public companies listed on the JSE.

4.8 Sampling

Sampling is the procedure by which a sample is selected from a population (Johnson and Christensen, 2019). It involves studying the attributes of a subset, referred to as the sample, which is chosen from a larger collective known as the population, with the aim of understanding the characteristics of the population (Johnson & Christensen, 2019). Once researchers have established the attributes of the sample, by analysing the sample, they can make inferences about the entire population (Johnson & Christensen, 2019). Samples are typically much smaller in size compared to populations, making sampling a time and cost-efficient approach.

The sampling was obtained by using non-probability purposive sampling. A sample of 39 public companies listed on the JSE were chosen using a mixture of convenience and judgement sampling. Since data was collected in a panel for a period of 10 years, the sample of 39 companies resulted into 390 observations. According to Asteriou and Hall (2011), when the pooling assumption holds, panel data estimation will result in significant increase in sample size, leading to more precise estimates, and in certain cases, addresses the issue of omitted variables that can bias estimates in single-individual regressions. However, it is essential to recognise that panel estimation may face

challenges if the pooling assumption is incorrect (Asteriou & Hall, 2011). In such instances, the panel data estimator is anticipated to offer a representative average estimate of the individual parameters for what is known as a heterogeneous panel when parameters vary across (Asteriou & Hall, 2011). However, in this study, the pooling assumption held as the parameters are the same across all sampled firms.

The convenience sampling approach was used as it was simple to access consistent ESG data on the Revinitiv database. The following were the judgement standards:

1) A firm was required to have been listed on the JSE prior to 2012 and its ESG data should be collected by Revinitiv, as data was acquired from the Revinitiv database.
2) Firms without an ESG score or either of the three sub-scores (environmental score, social score, and governance score) and environmental innovation score were excluded in the sample because they did not have enough data for analysis.
3) Since delisted companies lack ESG disclosure scores, a firm that has been delisted anytime between 2013 to 2022 was excluded in the sample.

4.9 Data Collection and Research Instrument

Panel data was utilised in the study due to the availability of multiple observations on the same entities for a period of 10 years, which enabled the control of unobserved characteristics of different firms (Asteriou and Hall, 2011; Woodridge, 2015). Panel data sets include individual time series data for each entity within the dataset, and they can also be collected based on geographical distinctions (Asteriou & Hall, 2011). Additionally, panel data analysis is well-regarded for its ability to examine the significance of behavioural lags (Woodridge, 2015). Asteriou and Hall (2011) described that panel data analysis is founded on the assumption that individual relationships within the dataset share the same parameters. This assumption, known as the pooling assumption, treats all individuals as part of a unified dataset and imposes a common set of parameters across them (Asteriou & Hall, 2011).

4.9.1 Study Variables

The study considered sustainability as ESG, measured by the ESG score. By analysing information extracted from the companies' sustainability reports, the scores assessed the company's performance in relation to social, environmental, and governance aspects (Melinda & Wardhani, 2020). Therefore, the overall sustainability performance of the company was represented by the ESG score, which encompasses the combined

evaluation scores for each ESG component (Dicuonzo et al., 2022). The panel data collected for this study comprised of continuous data related to ESG and environmental innovation scores, and the environmental, social, and governance individual scores of firms and control variables. These scores were collected from the Refinitiv database. The Refinitiv database provided individual and collective ESG disclosure ratings that are standardised for JSE-listed corporations under examination (Refinitiv, 2022). Refinitiv is recognised for offering one of the industry's most complete ESG datasets, encompassing more than 630 diverse ESG metrics, including more than 85% of the global market capitalisation, since 2002 (Refinitiv, 2022). The objective of Refinitiv's ESG ratings is to openly and unbiasedly evaluate companies' sustainability's commitment, performance, and effectiveness, utilising data reported by the company such integrated reports, SCR reports, and business websites. The Refinitiv ESG categories are indicated as follows:

1) The ESG score assesses a company's environmental, social, and corporate governance performance using publicly available and verifiable data. It consists of 10 categories that combine to form three aspects scores: environmental, social, and corporate governance. Based on information that has been made publicly available, these category scores represent the company's dedication, efficacy, and overall ESG performance. The pillar scores are calculated by aggregating the category scores, with the weights of the environmental and social categories varying depending on the industry. The weights for the governance category, on the other hand, remain consistent across all industries.

2) The environmental score is composed of three categories, emissions, resource use and innovation.

3) The social score includes product responsibility, human rights, workforce categories and community.

4) The governance score is made up of CSR, management and shareholders categories.

5) The environmental innovation score is composed of capital expenditures (CapEX) R&D and green revenues.

4.9.2 Control Variables

Moreover, the model incorporated six control variables: corporate social responsibility committee (CSR committee), Global Reporting Initiative guidelines (GRI report guidelines), total assets and market capitalisation measuring company size, rate of return on assets (ROA), and the sector in which each company operates. These control variables

were considered because they may have correlations with both the independent and dependent variables, namely environmental innovation and corporate sustainability. Bono and McNamara (2011) recommend including a variable in the model as a control if it is highly correlated with the independent and dependent variables but is not the main focus of the study. Data for all the control variables was also collected from the Refinitiv database.

The value of a company can be influenced by its size, with larger companies having an advantage in accessing internal and external sources of funding. The size of a company is determined by its total assets and is seen as a reflection of its scale (Melinda & Wardhani, 2020). Market capitalisation denotes the total market value of a company's publicly traded shares (Dicuonzo et al., 2022; Drempetic et al., 2020). Investors are often attracted to larger companies due to their potential impact on value (Melinda & Wardhani, 2020). This study assessed company performance using the ROA. Return on Assets is commonly used as a benchmark for investment decisions and represents the rate of return on total assets listed in the balance sheet. It measures how effectively management can generate profits using the company's assets (Dicuonzo et al., 2022; Khaled et al., 2021). Return on assets is determined by dividing the net profit by the total asset size (Dicuonzo et al., 2022). The study considered the presence of a CSR committee and adherence to Global Reporting Initiative (GRI) reporting guidelines when reporting the integrated report (Dicuonzo et al., 2022; Drempetic et al., 2020; Shahbaz et al., 2020).

4.9.3 Data collection process

Data was collected from the Refinitiv database, which was accessed through the university Infor Central. The list of 352 public companies listed on the JSE as of 20 August 2023 was downloaded from the JSE website. Most of the companies listed on the JSE report on their sustainability data, however, most companies do not report on environmental innovation, thus, before downloading the required data, the 352 companies were examined on the Refinitiv database to check if they have the environmental innovation score data available. Of the 352 companies, only 60 companies had the environmental innovation score data. According to Corvino et al. (2020), there is an increasing number of firms reporting nonfinancial information, such as ESG data, however, only a small minority of these firms can successfully integrate this nonfinancial information with their financial data in a meaningful and coherent manner. Data collection for the 60 companies started on 25 August until 31 August 2023, where excel files of sustainability data, including ESG score, environmental score, social score, governance score and

environmental innovation score were downloaded for the each of the companies in the sample. Excel files with financial data for each company in the sample with the financial control variable were also downloaded.

Of the 60 companies, 20 had missing environmental innovation score data in some years during the study period, thus, data points for 20 companies were omitted from the sample. One company had been delisted during the study period and it was omitted from the sample, thus the final sample was 39 companies, resulting to 390 observations. ESG score, environmental score, social score, governance score, environmental innovation score, corporate social responsibility committee, Global Reporting Initiative guidelines and sector data for the period of 2013 - 2022 was extracted from the sustainability excel file for each company into an individual file that was used for analyses. Total assets, market capitalisation and rate of return on assets data was also extracted from the financial data excel file for each company into the individual file which was used for analysis covering the period of 2013 - 2022.

4.10 Data Analysis Approach

Data analyses was conducted with an aim to test four study hypotheses which were as follows:

1) H_1: There is a significant positive relationship between environmental innovation and corporate sustainability of companies in South Africa.

The three individual dimensions of ESG sub-hypotheses were:

2) H_{1a}: There is a significant positive relationship between environmental innovation and the environmental aspect of corporate sustainability of companies in South Africa.
3) H_{1b}: There is a significant positive relationship between environmental innovation and the social aspect of corporate sustainability of companies in South Africa.
4) H_{1c}: There is a significant positive relationship between environmental innovation and governance aspect of corporate sustainability of companies in South Africa.

To analyse the data, the generalized least squares (GLS) regression model was employed to determine how environmental innovation affects corporate sustainability of firms in South Africa. Cameron and Trivedi (2009) described that GLS estimators are suitable when there are violations of assumptions such as homoskedasticity and noncorrelation of regression errors. Bai et al. (2021) and Brooks (2008) suggested that to address potential

issues of heteroscedasticity and autocorrelation, the GLS regression model should be utilised. In order to handle collinearity and account for heterogeneity within sectors and companies, the GLS model was applied to cross-sectional and time-series data combined into a panel, as explained by Brooks (2008). Cameron and Trivedi (2009) asserted that GLS model estimates better than ordinary least squares (OLS), resulting in narrower confidence intervals, larger t-statistics and smaller standard errors. According to Brooks (2008), GLS is also referred to as weighted least squares (WLS) since it minimises a weighted sum of squared residuals. If the autocorrelation pattern is known, it is possible to employ a GLS procedure (Brooks, 2008).

To test for autocorrelation, the Durbin's h-test was employed. Additionally, the Hausman and Breusch Pagan tests were done to identify the most appropriate panel for the analysis. The analysis of numerical data in quantitative research is typically conducted using statistical procedures, often with the aid of software such as SPSS or Stata (Queirós et al., 2017). Therefore, to conduct data analysis, IBM SPSS version 29 was used, following standard procedures.

The research model was as follows:

$$ESG\_sc_{it} = \alpha + \beta_1 EI\_sc_{it\text{-}1} + \beta_2 CSR\_com_{it} + \beta_3 Gri\_guid_{it} + \beta_4 TA_{it} + \beta_5 ROA_{it} + \beta_6 MCAP_{it} + \beta_7 SECi_{it} + \varepsilon_t \qquad (1)$$

ESG_{it} indicates the ESG score of firm *i* at time *t*;

EI_sc $_{it\text{-}1}$ - indicates the Environmental Innovation score of firm *i* at time t;

CSR_com $_i$ – indicates if a firm have a CSR sustainability committee;

Gri_guid$_i$ – indicates if a firm CSR report is published in accordance with the GRI guidelines;

TA$_{it}$ - indicates the Size of firm measured by total assets *i* at time *t;*

ROA$_{it}$ - indicates the Return on Assets of firm *i* at time *t*;

MCAP$_{it}$ - indicates the Market capitalisation of firm *i* at time *t*;

SEC$_i$ - indicates the Sector in which firm i operates;

ε_t - indicates the error term.

The ESG aspects, including environmental, social, and governance, were analysed separately using equations 2, 3, and 4, respectively.

$$Env\_sc_{it} = \alpha + \beta_1 EI\_sc_{it\text{-}1} + \beta_2 CSR\_com_{it} + \beta_3 Gri\_guid_{it} + \beta_4 TA_{it} + \beta_5 ROA_{it} + \beta_6 MCAP_{it} +$$

$\beta_7 \text{SECi}_{it} + \varepsilon_t$ (2)

$Soc\_\text{sc}_{it} = \alpha + \beta_1 \text{EI\_sc}_{it-1} + \beta_2 \text{CSR\_com}_{it} + \beta_3 \text{Gri\_guid}_{it} + \beta_4 \text{TA}_{it} + \beta_5 \text{ROA}_{it} + \beta_6 \text{MCAP}_{it} +$
$\beta_7 \text{SECi}_{it} + \varepsilon_t$ *(3)*

$Gov\_\text{sc}_{it} = \alpha + \beta_1 \text{EI\_sc}_{it-1} + \beta_2 \text{CSR\_com}_{it} + \beta_3 \text{Gri\_guid}_{it} + \beta_4 \text{TA}_{it} + \beta_5 \text{ROA}_{it} + \beta_6 \text{MCAP}_{it} +$
$\beta_7 \text{SECi}_{it} + \varepsilon_t$ *(4)*

Env_sc_{it}: represents the ESG firm i at time t, from the Environmental pillar score;

Soc_sc_{it}: represents the ESG of firm i at time t, from the social pillar score;

Gov_sc_{it}: represent the ESG of firm i at time t, based on the Corporate Governance pillar score.

4.11 Research Quality

Mohajan (2020) noted that the selection of a research technique is crucial for evaluating a study's reliability and validity. Johnson and Christensen (2019) defined research reliability as the presence of consistent and repeatable results when a study is replicated, whereas validity pertains to the precision the conclusions taken from the study's findings. Reliability and validity are inherent concerns in any research endeavour, with quantitative research often being considered more reliable compared to other approaches (Mohajan, 2020). The rigor and robustness of quantitative methodology are assessed considering criteria like validity, reliability, and generalisability (Mohajan, 2020; Morris & Burkett, 2011). Validity is established when the results are derived from a randomised sample, ensuring that conflicts of interest have been minimised (Mohajan, 2020). Reliability is confirmed by employing an adequate sample size that allows for precise and accurate conclusions to be drawn (Mohajan, 2020; Mohajan, 2017). Generalisability is essential since it allows for the generalisation of results to the larger population (Mohajan, 2020; Morris & Burkett, 2011).

According to Bridgmon and Martin (2012) and Queirós et al. (2017) due to the typically large and representative nature of the samples used, the results of quantitative research are often treated as providing a full picture of the entire population. Objectivity is a key focus in quantitative research, particularly when quantifiable measures of variables can be collected, and conclusions can be derived from samples taken from the population (Queirós et al., 2017). The methodology employed in quantitative research aligns with the assumptions of an empiricist paradigm, emphasizing the objective and systematic

collection of data (Williams, 2007). In this type of research, the data served as an independent measure of reality, allowing for an objective assessment of the phenomena under investigation (Queirós et al., 2017; Williams, 2007).

Panel data was used in GLS as is well-regarded for its ability to examine the significance of behavioural lags (Woodridge, 2015). Additionally, six control variables were included in the model: corporate social responsibility committee, Global Reporting Initiative guidelines, total assets and market capitalization measuring company size, rate of return on assets, and the sector in which each company operates. These control variables were considered because they may have correlations with both the independent and dependent variables, namely environmental innovation and corporate sustainability. By including such control variables, the model yielded valid and reliable results.

4.12 Limitations

Quantitative research is widely recognised and robust; however, Mohajan (2020) noted that it is not without limitations. One limitation, as highlighted by Saunders and Lewis (2018), is that the definitions used in one dataset can change over time, potentially impacting the interpretation of data used in a study. Furthermore, when utilising secondary data, it can be challenging to ascertain the methodology and its effectiveness, which may influence the study's outcomes. Johnson and Onwuegbuzie (2004) added that the researcher's categories employed in analysing secondary data may not align with the understandings of local constituencies. Additionally, the knowledge generated through quantitative research can be too abstract and generalised to be directly applicable to certain local contexts (Creswell & Creswell, 2017; Johnson & Onwuegbuzie, 2004). Another potential pitfall is the risk of confirmation bias, where the researcher may focus more on theory analysis rather than theory development, potentially leading to overlooking important phenomena (Creswell & Creswell, 2017; Johnson & Onwuegbuzie, 2004).

There are several other limitations associated with secondary data including the availability of related secondary data which may be limited or not accessible (Mohajan, 2020). Additionally, the data obtained from secondary sources may not possess sufficient depth or comprehensiveness to effectively explain complex issues (Mohajan, 2020; Johnson & Onwuegbuzie, 2004). Moreover, relying solely on statistical relationships in secondary data may overlook broader themes and relationships that exist within the subject matter.

4.13 Ethical Considerations

This research study methodology was reviewed and clearance by the GIBS Research Ethics Committee, University of Pretoria, on 18 July 2023, before proceeding with data collection.

Chapter 5 – Study Results

5.1 Introduction

This chapter presents the analysis results of the study which was done using the methodology outlined in Chapter 4. Section 5.2 presents the sample profile and variables description of the companies analysed which offers insights into the profile of the companies included in the study, including a detailed description of the variables under consideration. Section 5.3 presents descriptive statistics providing a comprehensive overview of the descriptive statistics relevant to the analysis. Section 5.4 presents the correlation analysis which explores the relationships between the variables of interest. Section 5.5 presents the econometric analysis employing the generalised least squares regression model to examine and interpret the data, and lastly, Section 5.6 concludes the chapter with summary results of key results and findings derived from the analysis.

5.2 Sample Profile and Variables Description

The companies were categorised into sectors based on their classification in the Refinitiv database, which uses the Global Industry Classification standard to classify companies into sectors. Of the 352 companies listed on JSE, 39 companies had both ESG and environmental innovation data available, thus, 39 companies were the final research analysis sample size. The 39 companies with 390 observations were selected across seven sectors as presented in Table 2.

Table 2: Sectors of activity

Sector	Number of companies selected
Basic Materials	11
Consumer Cyclicals	3
Consumer Non – Cyclicals	4
Financial	9
Industrial	6
Real Estate	4
Technology	2

There were 10 variables used in this study as shown in Table 3. Since there are four hypotheses for the study four models conducted, each model had one dependent

variables, one independent variable and six control variables.

Table 3: Variables description

Variables	Variable Names	Variable code	Variable description
Dependent Variables	ESG	ESG_sc	ESG is the overall score that assesses a company's environmental, social, and corporate governance performance. It consists of 10 categories that combine to form three aspects scores: environmental, social, and corporate governance, representing the company's dedication, efficacy, and overall ESG performance. The score is ranked from 0 to 100.
	Environmental aspect	Env_sc	The environmental score is composed of three categories, emissions, resource use and innovation. The score is ranked from 0 to 100.
	Social aspect	Soc_sc	The social score includes product responsibility, human rights, workforce categories and community. The score is ranked from 0 to 100.
	Corporate Governance aspects	Gov_sc	The governance score is made up of CSR, management and shareholders categories. The score is ranked from 0 to 100.
Independent variable	Environmental innovation	EI_sc	The environmental innovation score is composed of capital expenditures (CapEX), R&D and green revenues.
Control Variables	Corporate Social Responsibility Committee	CSR_com	Indicates if the company have a CSR Sustainability Committee (Yes (1), if it has a committee, No (0), if it does not have)
	GRI Report Guidelines	GRI_guid	Indicates if the company's CSR report is published according the GRI guidelines (Yes (1) if CSR report is published in accordance with GRI guidelines, No (0), if not)
	Total Assets	TA	Total Assets represents the size of the company (ZAR)
	Rate of Return on Assets	ROA	Is the net profit divided by the total assets (%)
	Market capitalisation	MCAP	Total market value of a company's shares of stock (ZAR)
	Sector	Sec	Represents the sector in which a company operates (dummy variable)

The main aim of the study was to determine if environmental innovation has an impact on

sustainability, thus environmental was used as the independent variable across the four models conducted because Arshad et al. (2023) and Hu et al. (2021) posit that the incorporation of environmental innovation is considered essential for companies, as it serves as a valuable asset that drives them towards achieving sustainable growth and meeting the expectations and standards set by their stakeholders.

The six control variables (as indicated in Table 3, were included across the four models as they were assumed to be correlated with both the dependent and independent variables. Bono and McNamara (2011) suggested that variables assumed to be related to the study's main variables, yet are not the primary focus of the study, should be incorporated into the model as control variables.

5.3 Descriptive Statistics

The descriptive statistics are shown in Table 4, indicating the mean, maximum, minimum, standard deviation, and kurtosis.

Table 4: Descriptive Statistics Results

Variables	N	Minimum	Maximum	Mean	Std. Deviation	Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
ESG_sc	39	32.19	82.54	57.19	12.21	-0.48	0.74
Env_sc	39	14.41	92.84	55.98	19.21	-0.39	0.74
Soc_sc	39	23.00	91.49	60.64	14.98	0.05	0.74
Gov_sc	39	34.36	87.49	59.28	14.60	-0.87	0.74
EI_sc	39	14.02	93.34	51.20	20.59	-0.67	0.74
CSR_com	39	0.70	1.00	0.97	0.07	7.89	0.74
GRI_guid	38	0.44	1.00	0.99	0.09	38.00	0.75
TA	39	2247.41	2210040.90	274969.29	552241.13	4.79	0.74
ROA	39	-4.20	29.90	5.01	5.70	8.68	0.74
MCAP	39	694.21	284803.85	57842.06	76039.01	2.64	0.74
Sec	39	1	7	3.41	1.929	-1.17	0.74
Valid N (listwise)	38						

The mean represents a statistical measure used to determine a representative value for the sample, which is given as an average value for the distribution (Mishra et al., 2019). The standard deviation shows how spread out the values in a dataset are from the mean value, where a low standard deviation suggest that the data points are closely clustered

around the mean, while a high standard deviation suggests that the data points are widely spread from the mean (Mishra et al., 2019).The standard error is an estimate of the approximate difference between the sample mean and the population mean helping to show how much the sample mean might deviate from the true population mean. The Kurtosis is a statistical measure that indicate the shape of the probability distribution of a dataset, particularly how it deviates from a normal distribution.

The ESG score average performance of the 39 companies analysed was 57.19, with a minimum score of 32.19 and a maximum score of 82.54. This shows that the sustainability of companies being analysed between the period of 2013 to 2022 was slightly above the ESG average score. When analysing the individual aspects of ESG, the environmental aspect mean score was 55.98, with a minimum score of 14.41 and a maximum score of 92.84. The social aspect average score was 60.64, with a minimum score of 23.00 and a maximum score of 91.49. The corporate governance score average score was 59.28, with a minimum score of 34.36 and a maximum score 87.49.

The average of the environmental innovation score of companies analysed was 51.20, with a minimum score of 14.02 and a maximum score 93.34. During the period of analysis, about 97% companies in the sample had a CSR committee and about 99% of the companies analysed follow GRI guidelines when publishing their CSR reports. The average amount of total assets of the companies analysed was R274,969.28 million with a minimum amount of R2,247.41millions and a maximum amount of R2,210,040.90 million. The average market capitalisation of the companies in the sample was R57,842.06 million, with a minimum market capitalisation of R694.21 million and a maximum market capitalisation of R284,803.85 million. The average rate of return on assets of companies analysed was 5.01%.

To test the normality of the sample kurtosis was used and the results indicated that most of the variables were more spread out around the mean compared to a normal distribution and had few extreme values that had outliers than a normal distribution. This was corrected by the GLS model which was applied to combine the cross-sectional and time-series data into a panel, thereby, weighting the sample sum of squares.

5.4 Correlation analysis

To determine if there is a relationship between the variables, a correlation analysis using Pearson correlation was conducted. The Pearson correlation is a statistical metric that quantifies the magnitude and direction of a linear association between two random

variables (Schober et al., 2018). The study's main aim was to determine if environmental innovation has a relationship with corporate sustainability, therefore, the Pearson correlation was conducted to determine if variables used in the models have a linear relationship with each other. However, according to (Queirós et al., 2017) correlation does not imply causation because if two variables are correlated, it does not mean that one causes the other. As there might be unaccounted for variable influencing both, making it appear as if there is a direct cause-and-effect relationship between the two observed variables. Thus, to draw conclusions about the reliability and significance of the findings and make inferences about the broader population based on the data collected, hypotheses tests and confidence intervals were conducted to assess the statistical significance of the results obtained from a sample of data and to provide a means to estimate the strength of the relationship in the larger population (Schober et al., 2018).

Table 5 presents the Pearson Correlation matrix results.

Table 5: Pearson Correlation Matrix

Correlations		Sec	ESG_sc	El_sc	Env_sc	Soc_sc	Gov_sc	CSR_com	GRI_guide	LnTA	ROA	MACP
Sec	Pearson Correlation	1										
	Sig. (2-tailed)											
ESG_sc	Pearson Correlation	-0.263	1									
	Sig. (2-tailed)	0.106										
El_sc	Pearson Correlation	0.265	0.247	1								
	Sig. (2-tailed)	0.103	0.129									
Env_sc	Pearson Correlation	-0.022	0.749**	0.671**	1							
	Sig. (2-tailed)	0.893	0.000	0.000								
Soc_sc	Pearson Correlation	-0.173	0.869**	0.150	0.659**	1						
	Sig. (2-tailed)	0.292	0.000	0.362	0.000							
Gov_sc	Pearson Correlation	-0.397*	0.560**	-0.212	0.089	0.387*	1					
	Sig. (2-tailed)	0.012	0.000	0.195	0.590	0.015						
CSR_com	Pearson Correlation	0.104	-0.076	0.011	-0.034	-0.109	-0.237	1				
	Sig. (2-tailed)	0.529	0.646	0.945	0.835	0.511	0.147					
GRI_guide	Pearson Correlation	0.117	0.067	0.137	0.166	0.047	-0.092	0.672**	1			
	Sig. (2-tailed)	0.483	0.689	0.414	0.318	0.777	0.584	0.000				
TA	Pearson Correlation	0.158	0.126	0.283	0.414**	0.381*	-0.265	0.075	0.083	1		
	Sig. (2-tailed)	0.336	0.444	0.081	0.009	0.017	0.103	0.649	0.618			
ROA	Pearson Correlation	-0.334*	0.422**	-0.068	0.165	0.262	0.401*	-0.346*	-0.029	-0.288	1	
	Sig. (2-tailed)	0.038	0.007	0.681	0.316	0.107	0.011	0.031	0.861	.076		
MCAP	Pearson Correlation	0.110	0.341*	0.269	0.496**	0.432**	-0.054	-0.041	0.117	0.689**	0.085	1
	Sig. (2-tailed)	0.504	0.034	0.097	0.001	0.006	0.745	0.805	0.483	0.000	0.607	
	N	39	39	39	39	39	39	39	38	39	39	39

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

An *r* value with positive sign indicates a positive relationship and an *r* value with a negative sign indicates a negative relationship. A *p*-value ≤ 0.0 5 indicates a statistically significance. The ESG score have a statistically significant relation with two variables rate of return on assets and market capitalisation where the *p*-value < 0.05 indicated statistically significance. There is a positive statistically significant relationship between ESG and rate of return on assets (*r* = 0.4222, *p*-value = 0.007). This means that if rate of return on assets increases, ESG will also increase.

There is also a positive statistically significant relationship between ESG and market capitalisation (*r* = 0.341, *p*-value = 0.034). Between ESG and environmental innovation, GRI guidelines and total assets there was a positive relationship, however, it was not statistically significant as the *p*-value>0.05. The ESG score had a negative relationship with two variables, sector and CSR committee, however, it was not statistically significant as the *p*-value>0.05.

The environmental aspect had a statistically significant relationship with 3 variables, namely environmental innovation, total assets and market capitalisation. The environmental aspect had a strong positive statistically significant relationship with environmental innovation (*r* = 0.671, *p*-value = 0.000). The environmental aspect had a positive statistically significant relationship with total assets (*r* = 0.414, *p*-value = 0.009). The environmental aspect also had a positive statistically significant relationship with market capitalisation (*r* = 0.496, *p*-value = 0.001). The environmental aspect had a positive relationship with GRI guidelines and rate of return on assets which was not statistically significant as the *p*-value>0.05. The environmental aspect had a negative relationship with sector and CSR committee which was not statistically significant as the *p*-value>0.05.

The social aspect had a positive statistically significant relationship with total assets (*r* = 0.381, *p*-value = 0.017) and market capitalisation (*r* = 0.432, *p*-value = 0.006). The social aspect had a positive relationship with environmental innovation, GRI guidelines and rate of return on assets, however it was not statistically significant since the *p*-value>0.05. The social aspect had a negative relationship with sector and CSR committee; however, it was not statistically significant since the *p*-value>0.05.

The corporate governance aspect had a positive relationship with rate of return on assets (*r* = 0.401, *p*-value = 0.011), a negative relationship with sector (*r* = -0.397, *p*-value = 0.012), where both relationships were statistically significant. The corporate governance aspect had a negative relationship with environmental innovation, CSR committee, GRI guidelines, total assets, and market capitalisation which was not statistically significant

where the p-value>0.005.

5.5 Econometric Analysis

To test the 4 hypotheses of the study, the generalized least squares (GLS) regression model or weighted least squares regression was conducted on all hypothesis to determine how environmental innovation affects corporate sustainability of firms listed on the JSE and test how environmental innovation affects the 3 aspects of ESG, individually. The GLS regression model was applied to cross-sectional and time-series data combined into a panel to address potential issues of heteroscedasticity and autocorrelation among variables (Bai et al., 2021; Brooks, 2008) and to handle collinearity and account for heterogeneity within sectors and companies (Brooks, 2008).

a. H$_1$: There is a significant positive relationship between environmental innovation and corporate sustainability of companies.

To test the first hypothesis the below model was used:

$ESG\_sc_{it} = \alpha + \beta_1 EI\_sc_{it-1} + \beta_2 CSR\_com_{it} + \beta_3 Gri\_guid_{it} + \beta_4 TA_{it} + \beta_5 ROA_{it} + \beta_6 MCAP_{it} + \beta_7 SECi_{it} + \varepsilon_t$ *(1)*

Table 6 shows the model summary for the GLS regression model for the first hypothesis to predict corporate sustainability of companies.

Table 6: Model Summary for the GLS regression model for the first hypothesis

Model Summary[b,c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.955[a]	0.912	0.870	3.411	1.934

a. Predictors: (Constant), EI_sc, CSR_com, GRI_Guid, TA, ROA, MCAP, Sec=Technology, Sec=Real Estate, Sec=Industrials, Sec=Financials, Sec=Consumer Non-Cyclicals, Sec=Consumer Cyclicals

b. Dependent Variable: ESG Score

c. Weighted Least Squares Regression - Weighted by wESG

The R^2 was 0.912 indicating that the independent variables explain 91% of the variance in the dependent variable, ESG, therefore, the model was effective at explaining and predicting ESG scores based on the chosen independent variables. The Durban-Whatson value of 1.93 indicates that there is little or no autocorrelation in the data and the residuals or errors in a regression model are approximately normally distributed and independent, therefore, the model's assumptions are met, and the regression results are reliable.

Table 7 presents the GLS regression model results predicting the influence of

environmental innovation on corporate sustainability of companies. The coefficient for environmental innovation was 0.337, with p-value 0.000, indicating that there was a positive relationship between ESG and environmental innovation which is statistically significant at the 1% significance level, holding all other variables constant.

Table 7: GLS Regression Model Results – Overall ESG

Coefficients[a,b]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	-8.455	13.529		-0.625	0.538
EI_ Score	0.337***	0.074	2.639	4.576	0.000
CSR_com	94.399***	30.230	4.351	3.123	0.004
GRI_guid	-43.890**	18.751	-4.890	-2.341	0.028
TA	-9.191E-7	0.000	-0.040	-0.162	0.873
ROA	1.419***	.293	1.193	4.846	0.000
MCAP	2.968E-6	0.000	0.021	0.114	0.910
Sec=Consumer Cyclicals	-5.423	3.712	-1.074	-1.461	0.156
Sec=Consumer Non-Cyclicals	-13.619***	2.530	-2.314	-5.383	0.000
Sec=Financials	3.507	6.473	0.126	0.542	0.593
Sec=Industrials	-7.037	7.869	-0.054	-0.894	0.380
Sec=Real Estate	-16.256**	7.773	-0.127	-2.091	0.047
Sec=Technology	1.649	4.041	0.031	.0408	0.687

a. Dependent Variable: ESG Score

b. Weighted Least Squares Regression - Weighted by wESG

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively. SEC is a dummy using Basic Materials as treatment group and the other sectors as the control group. Robust standard errors are used.

The control variable CSR committee had a coefficient of 94.399 with p-value 0.004, indicating that there was a positive relationship between ESG and the presence of a

corporate social responsibility committee, which was statistically significant at the 1% significance level, holding all other variables constant. The control variable GRI guidelines coefficient was -43.890 with p-value 0.028. This indicates that there was a negative relationship between CSR reports published in accordance with GRI guidelines with ESG which was statistically significant at the 5% significance level, holding all other variables constant. The coefficient for rate of return on assets was 1.419, with p-value 0.000, indicating that there was a positive relationship between ESG and rate of return on assets, which was statistically significant at the 1% significance level, holding all other variables constant. Only two sectors had statistically significant relationship with ESG, Consumer Non-Cyclicals and Real Estate. The coefficient for Consumer Non-Cyclicals was -13.619 with p-value 0.000, indicating that Consumer Non-Cyclicals had a negative statistically significant relationship with corporate sustainability at 1% significance level, holding all other variables constant. The coefficient for Real Estate was -16.256 with p-value 0.047 indicating that Real Estate had a negative statistically significant relationship with corporate sustainability at 5 % significance level, holding all other variables constant.

The other control variables did not have a statistically significant relationship with ESG, holding other factors constant.

Therefore, the null hypothesis that there is a positive relationship between environmental innovation and companies' sustainability was accepted at a 1% significance level.

b. **H_{1a}: There is a significant positive relationship between environmental innovation and the environmental aspect of corporate sustainability of companies.**

To test the second hypothesis the below model was used:

$ENV\_sc_{it} = \alpha + \beta_1 EI\_sc_{it-1} + \beta_2 CSR\_com_{it} + \beta_3 Gri\_guid_{it} + \beta_4 TA_{it} + \beta_5 ROA_{it} + \beta_6 MCAP_{it} + \beta_7 SECi_{it} + \varepsilon_t$

Table 8 shows the model summary for the GLS regression model for the second hypothesis to predict the environmental aspect of corporate sustainability of companies. The R^2 was 0.945 indicating that the independent variables explain 95% of the variance in the dependent variable, ESG, therefore, the model was effective at explaining and predicting ESG scores based on the chosen independent variables.

Table 8: Model Summary for the GLS regression model for the second Hypothesis

Model Summaryb,c

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.972a	0.945	0.919	1.224	2.112

a. Predictors: (Constant), EI_sc, CSR_com, GRI_Guid, TA, ROA, MCAP, Sec=Technology, Sec=Real Estate, Sec=Industrials, Sec=Financials, Sec=Consumer Non-Cyclicals, Sec=Consumer Cyclicals

b. Dependent Variable: Enviromental Aspect Score

c. Weighted Least Squares Regression - Weighted by wighted ENV

The Durban-Whatson value of 2.11 indicates that there is little autocorrelation in the data and the residuals or errors in a regression model are approximately normally distributed and independent, therefore, the model's assumptions are met, and the regression results are reliable.

Table 9 presents the GLS Regression Model results predicting the influence of environmental innovation on the environmental aspect of corporate sustainability of companies. Results show that only two variables had a statistically significant relationship with the environmental aspect of corporate sustainability of companies. The environmental innovation coefficient was 0.691 with p-value 0.000, indicating that environmental innovation had a positive statistically significant relationship with the environmental aspect of corporate sustainability of companies at the 1% significance level, holding all other variables constant. The control variable rate of return on assets coefficient was 0.979 with p-value 0.022, indicating that rate of return on assets had a positive statistically significant relationship with the environmental aspect of corporate sustainability of companies at the 5% significance level, holding all other variables constant.

Table 9: GLS Regression Model Results – Environmental Aspect

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	25.573	23.836		1.073	0.294
	EI_ Score	0.691***	0.075	0.654	9.224	0.000
	CSR_Com	2.558	36.428	0.022	0.070	0.945
	GRI_Guid	-12.672	27.651	-0.231	-0.458	0.651
	TA	6.960E-7	0.000	0.025	0.138	0.891
	ROA	0.979**	0.400	0.211	2.450	0.022
	MCAP	2.744E-5	0.000	0.091	0.667	0.511
	Sec=Consumer Cyclicals	-14.578	10.738	-0.473	-1.358	0.187
	Sec=Consumer Non-Cyclicals	-11.343	7.294	-0.084	-1.555	0.132
	Sec=Financials	7.842	6.633	0.200	1.182	0.248
	Sec=Industrials	-1.454	6.649	-0.013	-0.219	0.829
	Sec=Real Estate	-13.761	8.164	-0.093	-1.686	0.104
	Sec=Technology	5.326	10.609	0.027	0.502	0.620

a. Dependent Variable: Enviromental Aspect Score

b.Weighted Least Squares Regression - Weighted by wighted ENV

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively. SEC is a dummy using Basic Materials as treatment group and the other sectors as the control group. Robust standard errors are used.

Therefore, the null hypothesis that there is a significant positive relationship between environmental innovation and the environmental aspect of corporate sustainability of companies was accepted at the 1% level of significance.

c. **H_{1b}: There is a significant positive relationship between environmental innovation and the social aspect of corporate sustainability of companies.**

To test the third hypothesis the below model was used:

$SOC\_sc_{it} = \alpha + \beta_1 EI\_sc_{it-1} + \beta_2 CSR\_com_{it} + \beta_3 Gri\_guid_{it} + \beta_4 TA_{it} + \beta_5 ROA_{it} + \beta_6 MCAP_{it} + \beta_7 SECi_{it} + \varepsilon_t$

Table 10 shows the model summary for the GLS regression model for the third hypothesis to predict the social aspect of corporate sustainability of companies. The R^2 was 0.990 indicating that the independent variables explain 99% of the variance in the dependent variable, ESG, therefore, the model was effective at explaining and predicting ESG scores based on the chosen independent variables. The Durbin-Watson value of 1.98 suggests minimal or no autocorrelation in the data, and the residuals in the regression model are relatively close to being normally distributed and independent. Thus, this indicates that the model's assumptions are satisfied and the regression results are reliability.

Table 10: Model Summary for the GLS regression model for the third Hypothesis

Model Summaryb,c

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.995a	0.990	0.986	1.383	1.981

a. Predictors: (Constant), EI_sc, CSR_com, GRI_Guid, TA, ROA, MCAP, Sec=Technology, Sec=Real Estate, Sec=Industrials, Sec=Financials, Sec=Consumer Non-Cyclicals, Sec=Consumer Cyclicals

b. Dependent Variable: Social Aspect Score

c. Weighted Least Squares Regression - Weighted by wieghtSOC

Table 11 presents the GLS regression model results to predict the influence of environmental innovation on the social aspect of corporate sustainability of companies. The results indicate environmental innovation had a coefficient of 0.094 with p-value 0.353, meaning that environmental innovation had a positive relationship with the social aspect of corporate sustainability of companies, however, it was not statistically significant. Control variable rate of return on assets had a coefficient of 0.822 with p-value 0.025, indicating that rate of return on assets had a positive statistically significant relationship with the social aspect of corporate sustainability of companies at the 5% significance level, holding all other variables constant. The other control variables did not have a statistically significant relationship with the social aspect of corporate sustainability of companies.

Table 11: GLS Regression Model Results – Social Aspect

Coefficients[a,b]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	53.399	25.810		2.069	0.049
EI_ Score	0.094	0.100	0.076	0.947	0.353
CSR_Com	-3.936	37.723	-0.018	-0.104	0.918
GRI_Guid	1.618	30.002	0.038	0.054	0.957
TA	1.347E-5	0.000	0.094	1.474	0.153
ROA	0.822**	0.346	0.765	2.378	0.025
MCAP	1.514E-6	0.000	0.008	0.033	0.974
Sec=Consumer Cyclicals	-2.562	12.083	-0.108	-0.212	0.834
Sec=Consumer Non-Cyclicals	-5.617	6.475	-0.023	-0.868	0.394
Sec=Financials	-6.630	7.956	-0.037	-0.833	0.413
Sec=Industrials	-1.156	7.333	-0.004	-0.158	0.876
Sec=Real Estate	-1.834	6.331	-0.008	-0.290	0.774
Sec=Technology	-0.179	9.616	-0.002	-0.019	0.985

a. Dependent Variable: Social Aspect Score

b. Weighted Least Squares Regression - Weighted by wieghtSOC

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively. SEC is a dummy using Basic Materials as treatment group and the other sectors as the control group. Robust standard errors are used.

Therefore, the null hypothesis that there is a significant positive relationship between environmental innovation and the social aspect of corporate sustainability of companies was not supported.

d. **H_{1c}: There is a significant positive relationship between environmental innovation and the governance aspect of corporate sustainability of companies.**

To test the fourth hypothesis, the below model was used:

$GOV\_sc_{it} = \alpha + \beta_1EI\_sc_{it-1} + \beta_2CSR\_com_{it} + \beta_3Gri\_guid_{it} + \beta_4TA_{it} + \beta_5ROA_{it} + \beta_6MCAP_{it} + \beta_7SECi_{it} + \varepsilon_t$

Table 12 shows the model summary for the GLS regression model for the fourth hypothesis to predict the governance aspect of corporate sustainability of companies. The R^2 was 0.789 indicating that the independent variables explain 79% of the variance in the dependent variable, ESG, therefore, the model was effective at explaining and predicting ESG scores based on the chosen independent variables. The Durbin-Watson value of 1.81 indicates that there is minimal or no autocorrelation in the data, and the residuals in the regression model are relatively close to being normally distributed and independent. Thus, this suggest that the model's assumptions are satisfied and the regression results are reliability.

Table 12: Model Summary for the GLS regression model for the fourth Hypothesis

Model Summary[b,c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.888[a]	0.789	0.688	1.24	1.81

a. Predictors: (Constant), EI_sc, CSR_com, GRI_Guid, TA, ROA, MCAP, Sec=Technology, Sec=Real Estate, Sec=Industrials, Sec=Financials, Sec=Consumer Non-Cyclicals, Sec=Consumer Cyclicals

b. Dependent Variable: Goverment Aspect Score

c. Weighted Least Squares Regression - Weighted by wieghtGOV

Table 13 presents the GLS regression model results predicting the influence of environmental innovation on the governance aspect of corporate sustainability of companies. The environmental innovation coefficient was 0.029 with p-value 0.812, indicating a positive relationship between environmental innovation the governance aspect of corporate sustainability of companies, however, it was not statistically significant. None of the control variables had a statistically significant relationship with the governance aspect of corporate sustainability of companies.

Table 13: GLS Regression Model Results - Corporate Governances Aspect

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	74.326	30.067		2.472	0.021
	EI_ Score	0.029	0.121	0.046	0.241	0.812
	CSR_Com	-40.204	50.075	-0.647	-.0803	0.430
	GRI_Guid	26.535	35.041	0.865	0.757	0.456
	TA	-8.197E-6	0.000	-0.490	-1.492	0.148
	ROA	0.628	0.535	0.187	1.173	0.252
	MCAP	1.321E-5	0.000	0.153	0.484	0.633
	Sec=Consumer Cyclicals	4.964	11.562	0.288	0.429	0.671
	Sec=Consumer Non-Cyclicals	-9.507	7.991	-0.125	-1.190	0.245
	Sec=Financials	-7.365	8.359	-.0287	-0.881	0.387
	Sec=Industrials	-0.717	7.785	-0.011	-0.092	0.927
	Sec=Real Estate	-16.200	10.037	-0.178	-1.614	0.119
	Sec=Technology	-10.425	8.039	-.0277	-1.297	0.207

a. Dependent Variable: Gov_sc

b. Weighted Least Squares Regression - Weighted by wieghtGOV

Note: ***, ** and * denote significance at 1%, 5% and 10% respectively. SEC is a dummy using Basic Materials as treatment group and the other sectors as the control group. Robust standard errors are used.

Therefore, the null hypothesis that there is a significant positive relationship between environmental innovation and the governance aspect of corporate sustainability of companies was not supported.

5.6 Results Summary

The descriptive statistics provided an overview of the characteristics of the variable used

in the study. The Pearson coefficient analysis indicated that there was sufficient relationship between the variables used in the study. The GLS regression analysis indicated that there is a positive statistically significant relationship between environmental innovation and corporate sustainability of companies. The individual aspects analysis indicated that environmental innovation had a positive statistically significance relationship only with the environmental aspect of sustainability of companies. Table 13 presents the summary results.

Table 14: Summary results

Hypothesis	Results	Relationship
H_1: There is a significant positive relationship between environmental innovation and corporate sustainability of companies.	Null hypothesis accepted	Positive significant relationship
H_{1a}: There is a significant positive relationship between environmental innovation and the environmental aspect of corporate sustainability of companies.	Null hypothesis accepted	Positive significant relationship
H_{1b}: There is a significant positive relationship between environmental innovation and the social aspect of corporate sustainability of companies.	Null hypothesis rejected	No significant relationship
H_{1c}: There is a significant positive relationship between environmental innovation and governance aspect of corporate sustainability of companies.	Null hypothesis rejected	No significant relationship

Study results will be discussed in detail in the preceding chapter which will integrate the concepts used in this study, connect study results to literature and answer the research questions.

Chapter 6 – Discussion of Results

6.1 Introduction

There is a global shift in the evaluation of companies' long-term sustainability, with investors now considering climate change as a crucial factor (Bender et al., 2019), and arising resource scarcity concerns across various sectors, therefore, companies need to possess the ability to allocate their available resources among different alternatives (Albort-Morant et al., 2016). Companies will need to adapt competitively to attain competitiveness by optimising the utilisation of their capabilities and limited resources and adjusting their operations to gain legitimacy and align with the expectations of the society in which they operate in (Leal-Rodríguez et al., 2018). Companies also need to cultivate dynamic capabilities to progress, thrive, expand, adapt, and ensure their long-term viability (Albort-Morant et al., 2016). Dynamic capabilities are associated with the transformation of regular capabilities, leading to modifications in the firm's production methods, products, or the creation of better capabilities (Albort-Morant et al., 2016).

Since the primary aim of any business is to generate profits and ensure its survival in the market (Chan et al., 2016), to thrive in today's turbulent and hypercompetitive environments, Leal-Rodríguez et al. (2018) recommended that companies must foster innovation. Albort-Morant et al. (2016) stated that this will enable them to adapt swiftly and effectively to the changing external environment. According to Zhang et al. (2019), technological progress, driven by environmental innovation, plays a crucial role in enabling companies to achieve sustainability while experiencing growth. Therefore, Saunila et al. (2018) suggested that prioritising the enhancement of environmental innovation should be a key focus for companies, as innovation requires significant investments (Zhang et al., 2019).

Given that sustainability is an institutionalised value today and that many businesses have adapted their business models to meet new social needs, focused on economic effectiveness, human rights and environmental preservation, this study examined if businesses in South Africa, in response to social pressures and environmental regulations, recognise environmental innovation as a key to enhance their ESG implementation (Dicuonzo et al., 2022). To achieve sustainable growth, companies must embrace environmental innovation that enhances productivity by minimising the use of natural resources and utilising cleaner alternatives (Zhang et al., 2019).

Therefore, this chapter presents a discussion on key findings of the study, which were

outlined on Chapter 5, by providing interpretation and analysis of the results. It further provides the implications and meaning of the study results by examining and discussing the significance of findings in the context of existing literature and theoretical frameworks that were presented in Chapter 2. Section 6.2 provides the demographic discussion of public companies in South Africa that were studied in this research. Section 6.3 discusses the correlation analysis. Section 6.4 provides answers to the research questions by explaining the significance of the results, their implications, and how they relate to the research questions and hypotheses and link them to existing literature and theoretical frameworks. Lastly Section 6.5 provides the summary of the study findings.

6.2 Discussion of Demographic Profile of Companies

The ESG score average performance of the 39 companies analysed was 57.19 out of 100.00 showing that the sustainability of South African companies being analysed between the period of 2013 to 2022 was slightly above the average ESG score. According to Johnson (2020), after the integrated reporting was adopted, companies began to provide more information regarding environmental practices as a result of a growing awareness among them. However, it appeared as though this encouraging trend is moving slowly, despite a positive rise in the disclosure of sustainability practices. Johnson (2020) found that public firms' total ESG disclosure score remained below 40 out of a potential 100 when 68 JSE firms were studied considering 2011 to 2018 period. In comparison to Johnson's (2020) findings, the average of 57.19 indicates that public companies in South Africa are making incremental improvements in implementing sustainable practices since the integrated reporting rules were adopted in South Africa in 2011. This ESG score is in line with Chininga et al. (2023) who found that South Africa is putting efforts to implement sustainable environmental practices which is shown by the dedication demonstrated by the country's formal pledge to achieve Net Zero emissions by the year 2050 demonstrating its attention to solving climate change and maintaining a sustainable environment.

Therefore, as public companies listed on the JSE are required to disclose their sustainability practices, the average sustainability score of 57.19 shows that South African companies selected for the study are committed to sustainable practices. More interestingly, is the maximum sustainability score of 82.54 indicating that some companies are not only committed but are actively addressing and excelling in sustainability initiatives. Amin and Tauseef (2022) suggested that companies excelling in ESG not only demonstrate their commitment to stakeholders but also enjoy benefits like reduced

financial constraints and improved reputation. Therefore, these companies usually to attract more media attention and investments. On the contrary, companies with below-average ESG performance may face higher costs when seeking bank loans (Amin & Tauseef, 2022). Although Johnson et al. (2019) observed ESG disclosure ratings taken into account when calculating the ESG score may not always represent the actual ESG practices of companies.

The environmental aspect average score of companies in South Africa was 55.98 out of 100.00, with a minimum score of 14.41 and a maximum score of 92.84. Though the environmental aspect score was above the environmental aspect average score of 50.00, the minimum and maximum scores show a large dispersion. The environmental score represents resource use, emissions and innovation. The maximum score of 92.84 indicates that some public companies South Africa are committed to implement environmental practices to minimise their resource use, reduce emissions and be innovative, whereas the minimum score of 14.41 indicates that some South African companies are not performing well in terms of environmental sustainability, implying that there is room for improvement on the environmental aspect, regarding reducing emissions, minimising resource use and being innovative. This difference in environmental performance emphasises the need for more consistent and extensive efforts from all companies to address environmental challenges in South African. Specific environmental issues pose significant risks and challenges to companies in South Africa include, water shortage, climate change, pollution, overfishing and destruction of natural habitats (Johnson et al., 2019; Hebb et al., 20165). Among these concerns, climate change is expected to have an increasingly significant impact on the way companies operate, their financial performance, and their revenues and costs in the future (Johnson et al., 2019; Girdwood, 2013).

The social aspect average score was 60.64 out of 100.00, with a minimum score of 23.00 and a maximum score of 91.49. The average social score of the public companies in the sample was higher than the environmental and governance average scores. The social aspect score includes human rights, workforce, product responsibility and community. The social aspect average score indicates that public companies in South Africa are putting an effort to address social issues like respect of human rights at the workplace, health and safety of their employees, are engaged in corporate responsibilities to improve the communities they operate in and also responsible their customers' health and safety. According to Johnson (2020), South Africa is facing a number of social issues which

multifaceted which include poverty, inequality and unemployment; therefore, local companies should take proactive measures like implementing initiatives like health-related policies and support and contribute not only to their employees' well-being but also to broader social and economic development in South Africa.

The corporate governance score average score was 59.28 out of 100.00, with a minimum score of 34.36 and a maximum score 87.49. The governance score represents shareholders, management, and corporate social responsibility strategy. The average of 59.28 indicates that public companies in South Africa in the sample are doing well in terms of board diversity and skills, conducting independent audits, implementing shareholders rights policy, public availability corporate statutes, stakeholder engagement, CSR sustainability and reporting global compact signatory. South Africa has a comprehensive framework for corporate governance for companies as stipulated by the King reports (Johnson, 2020). Corvino et al. (2020) and Waweru (2020) alluded that corporate governance has seen substantial expansion and attention over the years, which may be attributed to notable occurrences including business failures, instances of corporate fraud, and a fall in investor confidence. In response to these problems, firms are changing how they approach corporate governance and developing ethical codes to create a more morally and environmentally sound business model (Corvino et al., 2020).

The average of the environmental innovation score, representing the main independence variable of the study, of companies analysed was 51.20 out of 100.00, with a minimum score of 14.02 and a maximum score 93.34. The environmental innovation score represents initiatives implemented by companies to minimise their environmental impact which include environmental assets under management, environmental products, equator principles, and renewable or clean energy products. According to Udeagha and Muchapondwa (2023), environmental innovation in South Africa involves adopting environmentally friendly technological advancements, which play a major part in reducing GHG emissions, making it an eco-friendly form of technical progress. Environmental innovation that focuses on enhancing energy efficiency and increasing the availability of renewable energy sources, both of which contribute to lowering carbon emissions in South Africa (Udeagha & Muchapondwa, 2023). The 51.20 out of 100 score indicates that companies in South African can utilise environmental innovation to improve their sustainability practices.

Concerning the control variables, during the period of analysis, about 97% companies in the sample had a CSR committee and about 99% of the companies analysed follow GRI

guidelines when publishing their CSR report. These results show that most of the public company in the sample have a CSR committee and almost all public companies adhere to the GRI guidelines when disclosing their CSR reports. This might be attributed to that South African listed firms are mandated to used integrated reporting and publish their CSR reports (Corvino et al., 2020). The average amount of total assets of the companies analysed was R274,969.28 million with a minimum amount of R2,247.41millions and a maximum amount of R2,210,040.90 million. The average market capitalisation of the companies in the sample was R57,842.06 million, with a minimum market capitalisation of R694.21 million and a maximum market capitalisation of R284,803.85 million. The total asset and market capitalisation indicates a reflection of the size of companies in the sample. Melinda and Wardhani (2020) affirmed that investors are often attracted to larger companies due to their potential impact on value. The average rate of return on assets of companies analysed was 5.01%. Dicuonzo et al. (2022) and Khaled et al. (2021) described that the rate of return on assets measures how effectively management can generate profits using the company's assets.

6.3 Discussion of the Pearson Correlation

The Pearson correlation tested linear relationship between the study variables. The ESG score have a statistically significant relationship with the three elements of sustainability which are environmental, social and governance scores. This was expected as they all form part of ESG. The social score had the strongest positive relationship with ESG score where (r = 0.869), whereas in the environmental score (r = 0.749) and the governance score (r = 0.560), showing the least relationship with ESG. This association was consistent with Araújo et al. (2022) who found that ESG was positively correlated with each of three aspects individually. This suggests that companies committed to sustainable practices exhibit an environmental consciousness, prioritise employee relations and societal well-being, and adhere to corporate governance principles aimed at transparency, responsibility, and protecting the rights of stakeholders.

6.4 Research Questions Discussion

6.4.1 Introduction

It is crucial for companies to understand how they can create a competitive edge by deploying resources and skills when they interact with the natural environment and contribute to social well-being (Khanra et al., 2022). Thus, in the literature review, the

study used the RBV to understand how companies can combine their valuable and limited resources to achieve sustainable competitive advantages. Barney et al. (2011) and Hart (1995) suggested that the limitations and difficulties placed on businesses by the natural environment should be included in business models of sustainable competitive advantage. Therefore, the RBV offered insights into how environmental innovation may possibly address the balance between resource utilisation and resource conservation (Khanra et al., 2022). The literature review revealed that as firms are faced with resource scarcity, and environmental concerns, they need to develop dynamic capabilities which will help them to be sustainable. Therefore, they must efficiently allocate their resources among competing needs to adapt to the complex and ever-changing business landscape. A firm's ability to quickly and effectively realign its resources, encompassing its business model, with the dynamic business environment, is contingent on the strength of its dynamic capabilities (Teece, 2018).

According to Arshad et al. (2023), a company's strategic capabilities, such as its ability to adapt, create, and react to market changes are essential for gaining a competitive advantage and achieving superior performance through innovation, therefore, businesses equipped with green dynamic capabilities have the potential to not only outperform their competitors but also positively impact the environment and society by promoting sustainable practices and solutions for the long term. This adaptability enables businesses to incorporate environmental innovation into their products and processes, promoting sustainability. Environmental innovation was identified as a method to achieve a cleaner and greener business environment (Arshad et al., 2023; Dicuonzo et al., 2022).

Thus, the study aimed to find answers if environmental innovation has an impact on corporate sustainability of companies in South Africa. This section provides an analysis of the study's findings presented in Chapter 5 and provide insights into how they answer the research questions. The results discussion connects these findings to the previous studies discussed in the literature review chapter and additional recent studies. The first question sought to find how environmental innovation influences corporate sustainability of companies in South Africa.

6.4.1 Research Question 1

The first research question sought to investigate the impact of environmental innovation on the corporate sustainability of South African companies, underpinned by the following hypothesis:

H$_1$: There is a significant positive relationship between environmental innovation and corporate sustainability of companies in South Africa.

The coefficient for environmental innovation was 0.337, with p-value 0.000, indicating that there was a positive relationship between ESG and environmental innovation which is statistically significant at the 1% significance level, holding all other variables constant. The positive coefficient reveals that a 1% increase in environmental innovation investments, can results to a 33.7% increase on sustainability, when all other factors that affect corporate sustainability are held constant. These results are in line with Dicuonzo et al. (2022) who found that companies that invest more in innovation as shown by their investments in R&D and the number of patents they hold typically outperform less innovative companies in terms of sustainability, meaning that innovation and adherence to ESG principles seem to have a good impact on company. Araújo et al. (2022) also revealed that environmental innovation improves corporate sustainability indicating that companies with the ability to innovate in environmentally friendly ways can deliver greater value to their customers and achieve sustainability. Zhang and Chen (2023) found that ESG increases with increasing amount and quality of environmental innovation output.

The positive influence environmental innovation has on a company's sustainability suggests companies need to understand the need of investing in environmental innovation as a means of attaining sustainable development and guaranteeing long-term profitability. Since sustainability and competitiveness are strongly related, it is essential for businesses to align the two and recognise that environmental innovation could be adopted as a dynamic strategy for achieving both business success and sustainability goals (Dicuonzo et al., 2022).

Chouaibi et al. (2022) established a connection between enhanced financial performance and companies that focus on ESG factors, particularly those emphasising on environmental innovation. This improvement likely occurs because these companies can enhance their financial results by both reducing costs and differentiating their products or services through environmental innovation (Chouaibi et al., 2022). In this context, environmental innovation was seen to attain sustainable growth and, consequently, achieve improved financial outcomes for ESG-oriented companies.

Khanra et al. (2022) also observed that environmental innovation has the capacity to serve as a valuable resource for organisations, enabling them to gain a competitive edge while also promoting sustainable development, as it offers means to ensure the preservation of resources for future generations while reconciling the use of available resources. Thus,

environmental innovation is a proactive for firms aiming to be at the forefront of innovation and positive change, as it allows them to address environmental challenges, reduce their carbon footprint, and offer sustainable solutions for the benefit of society and the planet, through developing and offering eco-friendly products and adopting sustainable processes and business strategies (Arshad et al., 2023; Chouaibi et al., 2022; Lin et al., 2021).

Therefore, the null hypothesis that there is a positive relationship between environmental innovation and companies' sustainability was accepted at a 1% significance level.

6.4.2 Research Question 2

The second research question sought to investigate the impact of environmental innovation on the environmental element of corporate sustainability of South African companies, underpinned by the following hypothesis:

H_{1a}: There is a significant positive relationship between environmental innovation and the environmental aspect of corporate sustainability of companies in South Africa.

Over the past few decades, the environmental dimension has demonstrated the consequences of human-driven economic development, a growing population, overexploitation of natural resources, and an overestimation of technological advancements without acknowledging their limitations. This is evident through environmental degradation and climate change (Cancino et al., 2018). Therefore, in the environmental dimension, companies should adopt practices and strategies that are environmentally friendly and aim to minimise their negative impact on the environment.

The environmental dimension pertains to a firm's capacity to minimise its GHG emissions in its operations through utilisation of natural resources effectively Dicuonzo et al. (2022). Cancino et al. (2018) explained that environmental aspect encompasses minimal emissions, renewable resources, waste reduction, pollution prevention and biodiversity conservation. By embracing the environmental dimension, companies can effectively utilise resources in a balanced approach and prioritise the long-term value of the organisation (Melinda & Wardhani, 2020).

The study results showed that the environmental innovation coefficient was 0.691 with p-value 0.000, indicating that environmental innovation had a positive statistically significant relationship with the environmental aspect of corporate sustainability of companies at the 1% significance level, holding all other variables constant. The coefficient shows that a

1% increase in environmental innovation will result to 69.1% increase in the environmental performance of companies, when holding constant all other factors that may affect the environmental performance. This indicates that investments in environmental innovation will results to efficient use of resources, reduction in emissions and increase in innovation. According Chouaibi et al. (2022) and Harel et al. (2020), environmental innovation aims to address environmental challenges by reducing pollution, improving energy efficiency, minimising waste, utilising sustainable resources, and promoting recycling. It does not only enhance a company's environmental performance but also provides a competitive edge.

Fernando and Wah (2017) found that when product innovation, service innovation and process innovation are core in environmental innovation, environmental innovation had a positive impact on environmental performance. Moreover, when environmental innovation is applied to different business sectors that produce services and goods and service, environmental innovation becomes a crucial component for the achievement of a green strategy's success in enhancing environmental performance (Fernando & Wah, 2017). This is because firms that normally adjust modern technology as part of environmental innovation to attain sustainability and establish a competitive edge. Thus, environmental innovation is crucial for firms aiming to be at the forefront of innovation and positive change, as it allows them to address environmental challenges, reduce their carbon footprint, and offer sustainable solutions for the benefit of society and the planet, through developing and offering eco-friendly products and adopting sustainable processes and business strategies (Arshad et al., 2023; Lin et al., 2019).

Similar to Zhang and Chen (2023), the study revealed that revealed that environmental innovation has the greatest influence on the environmental aspect as compared to its influence on the social and governance aspects. However, Araújo et al. (2022) found that environmental innovation did not have a significant influence on the environmental aspect.

Therefore, the null hypothesis that there is a significant positive relationship between environmental innovation and the environmental aspect of corporate sustainability of companies was accepted at the 1% level of significance.

6.4.3   Research Question 3

The third research question sought to investigate the impact of environmental innovation on the social element of corporate sustainability of South African companies, underpinned by the following hypothesis:

H$_{1b}$: There is a significant positive relationship between environmental innovation and the social aspect of corporate sustainability of companies in South Africa.

The study results showed that environmental innovation have a coefficient of 0.094 with p-value 0.353, meaning that environmental innovation had a positive relationship with the social aspect of corporate sustainability of companies, however, it was not statistically significant. Araújo et al. (2022) and Zhao et al. (2023) also found that environmental innovation did not have a significant impact on the social aspect. The social aspect evaluates a firm's ability to establish trust among its employees and uphold ethical values, while also emphasising the importance of respecting human rights (Dicuonzo et al., 2022). It aims to ensure human and labour rights, social development, equity, justice and social support and focuses on fostering a fair and inclusive society where the needs and rights of individuals and communities are respected and upheld (Abbas & Sağsan, 2019). According to Cancino et al. (2018), the social aspect includes well-being, diversity, and equality, ensuring secure livelihoods, community development, maintaining health and safety measures, and adhering to labour standards. The study results indicate that companies in South Africa can invest in environmental innovation without concerns that those investments will affect social aspects initiatives like addressing human rights, giving back to communities, product responsibility and workforce initiatives.

Since the study found that the relationship between environmental innovation and the social aspect was not statistically significant, the null hypothesis that there is a significant positive relationship between environmental innovation and the social aspect of corporate sustainability of companies was rejected.

6.4.4 Research Question 4

The fourth research question sought to investigate the impact of environmental innovation on the governance aspect of corporate sustainability of South African companies, underpinned by the following hypothesis:

H$_{1c}$: There is a significant positive relationship between environmental innovation and governance aspect of corporate sustainability of companies in South Africa.

The field of corporate governance has experienced significant growth and attention in recent decades, due to heightened interest is a response to notable events like corporate fraud, and a decline in investor trust (Corvino et al., 2020). As a result, there has been a shift towards the development of ethical codes and a movement among companies toward

adopting a more sustainable approach to corporate governance (Corvino et al., 2020).

The study results showed that environmental innovation coefficient was 0.029 with p-value 0.812, indicating a positive relationship between environmental innovation the governance aspect of corporate sustainability of companies, however, it was not statistically significant. The governance aspect examines a company's implementation of effective procedures and efficient corporate management practices that prioritise the interests of its shareholders (Dicuonzo et al., 2022). Dicuonzo et al. (2022) stated that the governance aspect pertains to a firm's ability to prioritise shareholders' interests by implementing effective processes and efficient corporate management systems. The study results indicates that investments in environmental innovation does not affect corporates initiatives of companies in South Africa like board diversity and skills, conducting independent audits, implementing shareholders rights policy, public availability corporate statutes, stakeholder engagement, CSR sustainability and reporting global compact signatory. Eberhardt-Toth (2017) found that companies with a CSR committee resort to positive corporate governance especially when the CSR committee consists of non-membership of the chief executive officer, female chair, higher average age of directors, larger proportion of in- dependent directors and smaller size. In the governance dimension, while being socially responsible and environmentally friendly, companies must also strive to create value and generate profit for their shareholders. This means balancing financial success with social and environmental objectives.

In contrast to the study findings, Araújo et al. (2022) and Zhao et al. (2023) found that the governance aspect was positively influenced by environmental innovation, which indicate that the capability to lower costs and establish new market through environmental innovation may be because corporate governance encompasses elements like transparency, resource allocation, responsibility, sustainability, stakeholder rights protection and strategic management, all which are closely tied to environmental innovation. Similar to the study findings, Zhang and Chen (2023) also established that environmental innovation had the least influence on the governance aspect compared to its influence on the environmental and social aspects. Zhang and Chen (2023) attribute this difference to environmental innovation initiatives tend to consume the company's available resources and may be in conflict with its immediate financial performance goals.

South Africa have a comprehensive corporate governance framework for publicly traded companies which has kept governance scores consistently high and stable, indicating that

companies that disclose their governance practices effectively tend to make wise choices in allocating capital and receive favourable market recognition, resulting in higher stock valuations (Muzanya, 2022). According to Ahmed et al. (2021), more companies are embracing corporate sustainability rather than avoiding it as management has recognised that adopting corporate sustainability can lead to increased efficiency and productivity, prompting a shift towards integrating sustainable practices into their operations. This outcome might be explained by the closely link between corporate governance and the values of market openness, accountability, resource allocation, corporate sustainability, strategic management, and stakeholder rights protection, where these aspects within the governance aspect are open and responsive to environmental innovation to enhance environmental performance and open up new market opportunities (Araújo et al., 2022).

Since the study findings showed that environmental innovation did not have a significant relationship with the governance aspect of corporate sustainability of companies in South Africa, the null hypothesis that there is a significant positive relationship between environmental innovation and the governance aspect of corporate sustainability of companies was rejected.

6.5 Summary of Findings

The primary goal of the study was to understand how environmental innovation influences corporate sustainability of public companies in South Africa, drawing upon public companies listed on the Johannesburg Stock Exchange (JSE). Figure 2 shows a visual presentation of the relationships of constructs used in the study and the results of the four hypotheses that the study investigated. In the literature review, the RBV theory explained how firms utilise their internal resources to gain a competitive advantage, highlighting the importance of leveraging unique capabilities for sustainable practices.

Dynamic capabilities emphasised the need for adaptability and flexibility in responding to changing market conditions, fostering sustainability within firms. The concept of innovation is driving sustainable practices, with a particular focus on environmental innovation aimed at reducing environmental impact. Lastly, the concept of sustainability provided a holistic perspective, encompassing environmental, social, and governance dimensions.
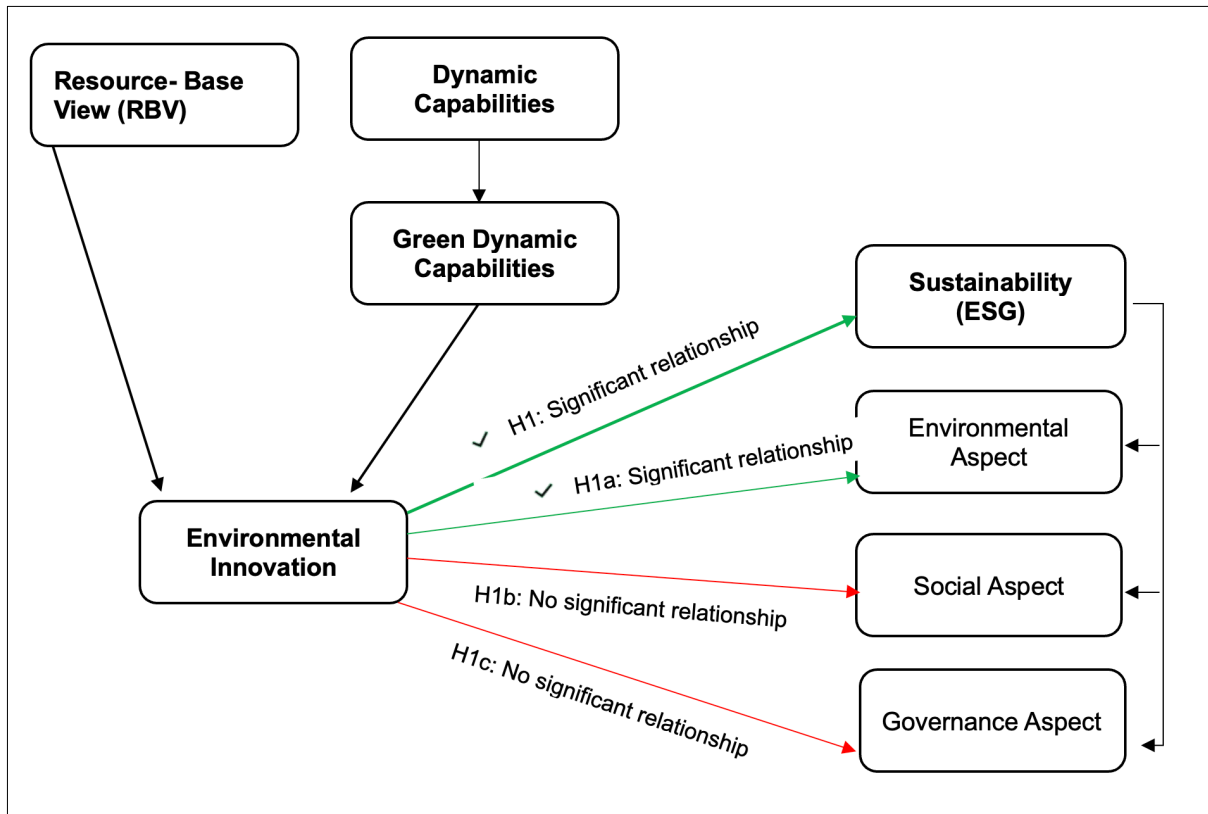
Figure 2: *Findings summary*
Source: *Author's construct (2023)*

The secondary objectives of the study were to understand at what extent does environmental innovation influences the environmental, social and governance elements of corporate sustainability. Figure 2 illustrates a significant positive relationship between environmental innovation and corporate sustainability of public companies in South Africa showing that, environmental innovation has a significant positive relationship with the environmental aspect of corporate sustainability of companies only. There was no significant relationship between environmental innovation and the social and governance aspect of corporate sustainability of companies. Chapter 7 provides the implications of the research findings.

Chapter 7 - Conclusions and Recommendations

7.1 Introduction

As there are heightened concerns about climate change and resource scarcity which affect multiple industries, companies must demonstrate the capacity to effectively allocate their resources among various options, particularly in response to the increasing societal demands for integrating sustainability considerations into their daily operations (Albort-Morant et al., 2016). However, embracing sustainability requires significant investments in innovation and R&D (Dicuonzo et al., 2022; Fernandez et al., 2021; Buallay, 2019). Thus, companies typically exercise caution when considering investments in environmental sustainability initiatives due to concerns that such investments could potentially increase operational costs and undermine their competitiveness (Khanra et al., 2022). Stucki (2019) highlights that companies tend to invest in environmental innovation if it leads to improved firm performance. Therefore, Zhang et al. (2019) suggest that to achieve sustainable growth, companies must embrace environmental innovation that enhances productivity by reducing the consumption of natural resources and utilising cleaner alternatives. This means that companies must adapt competitively to attain competitiveness by optimising the utilisation its capabilities and limited resources and adjust their operations to gain legitimacy and align with the expectations of the society in which they operate in (Leal-Rodríguez et al., 2018).

Therefore, in Chapter 1, the study presented the research problem that the study aimed to address the problem on how companies can strike a balance between society and the environment, to achieve sustainable competitive positioning for long-term success for firms because to promote sustainable growth, businesses need to consider the co-creation of profits, environmental and social benefits, while maintaining a compromise among them. Chapter 2 took a theoretical approach as a foundation for the study to build upon relevant frameworks and constructs, provide references and evidence that support the study's arguments, and identify gaps in existing literature. The theoretical approach explored the RBV, dynamic capabilities, green dynamic capabilities, environmental innovation, and lastly, the sustainability concept. Each of these theories provided unique insights into the relationship between innovation and corporate sustainability. The RBV theory explained how organisations utilise their internal resources to gain a competitive advantage, highlighting the importance of leveraging unique capabilities for sustainable practices. Dynamic capabilities emphasised the need for adaptability and flexibility in responding to changing market conditions, fostering sustainability within firms. The

concept of innovation is driving sustainable practices, with a particular focus on environmental innovation aimed at reducing environmental impact. Lastly, the concept of sustainability provided a holistic perspective, encompassing environmental, social, and governance dimensions.

Therefore, from these theories, in Chapter 3, four research hypotheses were formulated where the primary research hypotheses proposed that there is a significant positive relationship between environmental innovation and corporate sustainability of public companies in South Africa, and the secondary hypotheses proposed that there is a significant positive relationship between environmental innovation and the three aspects of corporate sustainability of companies in South Africa, individually. A methodology that was selected to test the study hypotheses, was presented in Chapter 4, where the study employed a positivism approach that utilised structured methods to enable generalisation and replication. Secondary data was collected from the Refinitiv Database. The study employed a longitudinal design, collecting panel data spanning from 2013 to 2022. A sample of 39 public companies listed on the JSE were chosen using a combination of convenience and judgement sampling, with resulted to 390 observations.

The collected secondary data was analysed using the generalized least squares (GLS) regression model to determine how environmental innovation affects corporate sustainability of public companies in South Africa, and study results were presented in Chapter 5. The descriptive statistics revealed that the mean ESG score of the 39 companies analysed was 57.19 out of 100.00 showing that the sustainability of South African companies being analysed between the period of 2013 to 2022 is slightly above the average ESG score. The average of the environmental innovation score, representing the main independence variable of the study, of companies analysed was 51.20 out of 100.00, representing the level of initiatives implemented by companies to minimise their environmental impact which include environmental assets under management, environmental products, equator principles, and renewable or clean energy products.

Chapter 6 provided answers to the research questions that were outlined in Chapter 3. The first research question sought to investigate the impact of environmental innovation on the corporate sustainability of South African companies. Study findings indicated that there was a positive relationship between ESG and environmental innovation. The positive influence environmental innovation has on a company's sustainability suggests companies need to understand the need of investing in environmental innovation as a means of attaining sustainable development and guaranteeing long-term profitability.

Since sustainability and competitiveness are strongly related, it is essential for businesses to align the two and recognise that environmental innovation could be adopted as a dynamic strategy for achieving both business success and sustainability goals (Dicuonzo et al., 2022). Therefore, the null hypothesis that there is a positive relationship between environmental innovation and companies' sustainability was accepted at a 1% significance level.

The second research question sought to investigate the impact of environmental innovation on the environmental element of corporate sustainability of South African companies. The study results showed that the environmental innovation has a positive statistically significant relationship with the environmental aspect of corporate sustainability. This indicates that investments in environmental innovation will results to efficient use of resources, reduction in emissions and increase in innovation. According Chouaibi et al. (2022) and Harel et al. (2020), environmental innovation aims to address environmental challenges by reducing pollution, improving energy efficiency, minimising waste, utilising sustainable resources, and promoting recycling. Therefore, the null hypothesis that there is a significant positive relationship between environmental innovation and the environmental aspect of corporate sustainability of companies was accepted at the 1% level of significance.

The third research question sought to investigate the impact of environmental innovation on the social element of corporate sustainability of South African companies. The study results showed that environmental innovation does not have a statically significant relationship with the social aspect of corporate sustainability of companies. The social aspect evaluates a firm's ability to establish trust among its employees and uphold ethical values, while also emphasising the importance of respecting human rights (Dicuonzo et al., 2022). The study results indicate that companies in South Africa can invest in environmental innovation without concerns that those investments will affect social aspects initiatives like addressing human rights, giving back to communities, product responsibility and workforce initiatives. Therefore, the null hypothesis that there is a significant positive relationship between environmental innovation and the social aspect of corporate sustainability of companies was rejected.

The fourth research question sought to investigate the impact of environmental innovation on the governance aspect of corporate sustainability of South African companies. The study findings showed that environmental innovation does not have a statistically

significant governance aspect of corporate sustainability of companies, however, it was not statistically significant. The governance aspect examines a company's implementation of effective procedures and efficient corporate management practices that prioritise the interests of its shareholders (Dicuonzo et al., 2022). The study results indicated that investments in environmental innovation does not affect corporates initiatives of companies in South Africa like board diversity and skills, conducting independent audits, implementing shareholders rights policy, public availability corporate statutes, stakeholder engagement, CSR sustainability and reporting global compact signatory. Therefore, the null hypothesis that there is a significant positive relationship between environmental innovation and the governance aspect of corporate sustainability of companies was rejected.

7.2 Study implications

7.2.1 Theoretical implications

The study found that environmental innovation has an influence on corporate sustainability of public companies in South Africa. According to Abbas and Sağsan (2019) and Albort-Morant et al. (2016), companies that lead in environmental innovation have a higher likelihood of gaining several competitive advantages which include factors like earning the trust and loyalty of customers and experiencing improved profitability. Therefore, the positive relationship between environmental innovation and ESG indicates that environmental innovation is crucial for firms aiming to be at the forefront of innovation and bringing positive change, as it allows them to address environmental challenges, reduce their carbon footprint, and offers sustainable solutions for the benefit of society and the planet, through developing and offering eco-friendly products and adopting sustainable processes and business strategies (Arshad et al., 2023; Lin et al., 2019).

According to dynamic capability theory, a company's strategic capabilities, such as its capability to change, innovate, and respond to changes in the market, are essential for establishing a competitive edge and achieving better performance through innovation, therefore, businesses equipped with environmental innovation capabilities have the potential to not only outperform their competitors but also positively impact the environment and society by promoting sustainable practices and solutions for the long term (Arshad et al., 2023). The RBV of the firm considered dynamic capabilities and explored how firms integrate environmental sustainability into their pursuit of competitive advantage (Barney et al., 2011; Hart & Dowell, 2011). Therefore, by developing

environmental innovation capabilities, companies are better equipped to adopt and implement environmental innovation successful, thereby improving its overall sustainability implementation, especially with regards to environmental and societal impact (Arshad et al., 2023). However, this study found that environmental innovation does not influence the social aspect of sustainability.

Ferreira et al. (2018) highlighted the significance of the RBV in understanding how companies combine their valuable and limited resources to achieve sustainable competitive advantages. Therefore, the findings of the study provided insights into how environmental innovation may possibly address the balance between resource utilisation and resource conservation (Khanra et al., 2022). This was indicated by the positive significant relationship between environmental innovation and the environmental aspect of corporate sustainability of companies, suggesting that investments in environmental innovation will results to emissions reduction, efficient use of resources, and increase in innovation. As there are environmental concerns, the study showed that environmental innovation can play a crucial role in helping companies to integrate sustainable concepts into their business operations to help address environmental concerns. Albort-Morant et al. (2016) stated that effective implementation of environmental innovation initiatives not only allows companies to improve their operational efficiency but also enables them to develop and reinforce their core capabilities while enhancing their environmentally responsible reputation, which can ultimately lead to better output and boosted profitability.

7.2.2 Practical implications

Since companies typically exercise caution when considering investments in environmental sustainability initiatives due to concerns that such investments could potentially increase operational costs and undermine their competitiveness, this research provides motivation for managers to invest in environmental innovation to spur corporate sustainability of their companies. Chouaibi et al. (2022) underscored that environmental innovation can be applied to implement sustainability related strategies to support firms' sustainability and financial performance. Chouaibi et al. (2022) argued that resource allocation on environmental innovation implementation does not only results to improved financial performance, but it also creates value, which gives a firm a competitive advantage. Therefore, environmental innovation is instrumental in attaining sustainability. To achieve sustainable growth, companies must embrace environmental innovation that enhances productivity by reducing the consumption of natural resources and utilising cleaner alternatives (Zhang et al., 2019). This is important because environmental

innovation contributes to the growth and success of businesses. By fostering innovation, organisations can enhance their ESG practices by creating business models that promote corporate sustainability and facilitate the adoption of sustainable measures (Forcadell et al., 2019; Albort-Morant et al., 2016). Environmental innovation offers companies the potential to carry sustainable practices in their operations, thus enhancing their competitiveness (Albort-Morant et al., 2016).

The positive relationship found between environmental innovation and the environmental aspect of sustainability, indicates that when environmental innovation is integrated into a business strategy it can enhance a firm's abilities and minimise the adverse effects on the environment (Fernando & Wah, 2017). Cost-effective production of products and services be leveraged through environmental innovation to help firms meet environmental regulations and fulfil their societal responsibilities (Fernando & Wah, 2017). Thus, managers can integrate environmental innovation as a competitive strategy in business strategies to enhance their products and services, and streamline their internal processes, resulting in lower operational costs (Chouaibi et al., 2022). Understanding how companies can enhance the environmental sustainability of their products and services through environmental innovation is essential for competitiveness.

7.3 Research Limitations

The research limitation for the study was the missing data on environmental innovation from public companies in South Africa. The availability of data for more companies could have provided a better understanding of how environmental innovation affect corporate sustainability. Applying the research findings of the influence of environmental innovation on corporate sustainability to create standardised models for firms, especially in a country like South Africa, is challenging because companies are different from each other. This study focused on publicly listed companies in South Africa, not a sectoral study, which raises issues because each industry and company has unique traits and circumstances. While some companies with strong ESG practices can serve as examples for exploring environmental innovation pathways, the impact of environmental innovation on their outcomes can vary significantly depending on their specific ESG practices and the industry in which they operate, therefore, there is no one-size-fits-all approach. Additionally, the effectiveness of environmental innovation is shaped by individual company characteristics and the broader business environment. When collecting the data, most companies had ESG data, unfortunately most of them were missing the environmental innovation data

which resulted in a low sample size.

7.4 Recommendations for Future Research

In future research, it is advisable to acknowledge and tackle the limitations identified in this study. One approach could involve conducting more focused and in-depth investigations within specific sectors, looking at the types of environmental innovations employed by the different sectors. The study did not investigate the factors that drive companies to invest in environmental innovation, therefore it is also crucial to understand the perspective of managers on how they implement sustainable practices. A qualitative study can provide insights at what influences managers to implement environmental innovation and the challenges they face as they implement sustainable practices. Future research could investigate what motivates firms to enhance their environmental innovation capabilities. It could examine whether environmental regulations, consumer demand for ESG-compliant products, or the desire to boost competitiveness are the driving forces behind firms' increased focus on environmental innovation. The other limitation of the study was the unavailability of data on environmental innovation; therefore, future studies can investigate how South African companies measure and report environmental innovation initiatives. Furthermore, for future research to produce more accurate results and help improve the robustness and reliability of the findings it is recommended to collect primary data from companies and include a larger sample for the study.

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