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IFRS DISCLOSURES AND THE DYNAMICS OF CLIMATE CHANGE: ANALYSIS OF SOUTH AFRICAN MANUFACTURING COMPANIES

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Abstract:
The planet is gradually deteriorating due to climate change. Climate change is created by shifts in temperatures and weather patterns. Changes in temperatures might be natural, however, since the nineteenth century, human beings have made a significant contribution to climate change by not being environmentally conscious when burning fossil fuels, deforestation, using fertilisers and using fluorinated gases. Consequently, adding vast quantities of greenhouse gases to those naturally occurring in the atmosphere results in a rise in the greenhouse effect and global warming. Climate change affects not only human and natural systems but also the transparency of companies in making their financial disclosure during such climate conditions. The companies can be transparent by using the climate accounting tool to measure and report on the organisation's climate impact through direct and indirect emissions. Given the non-disclosures of many companies, the study explored International Financial Reporting Standard (IFRS) disclosures and the dynamics of climate change. This disclosure motivates investors by informing them about climate solutions and how the company is building its resilience against climate impacts so that they can make informed investment decisions. The data is collected from JSE-listed manufacturing companies using Refinitiv Eikon, using a historical period from 2005 to 2022. The analysis uses descriptive statistics involving dissimilar econometric techniques such as the panel data dependence technique, pooled multivariate regression, Generalised Method of Moments (GMM), feasible generalised least squares and Pooled Fixed and Random effects. The study found a cross-sectional dependence among the identified dynamics.

Keywords: Climate Change, Financial Reporting, IFRS Disclosures, Sustainability

INTRODUCTION

The market has recently been driven by reduced product life cycles and more individualisation of products. Hence, pressure is placed on resource efficiency to meet customer demand. On the other hand, lean manufacturing is essential to increase financial performance because it reduces wastage and raises productivity (Yadav et al., 2020). The change in weather conditions has been causing widespread destruction across the globe, especially in KwaZulu-Natal, South Africa (Engelbrecht et al., 2022). As a result of this change, heavy rains caused massive floods which killed approximately 500 people, damaged infrastructure (roads & bridges), destroyed about 4,000 properties and displaced close to 40,000 residents in just 48 hours (Engelbrecht et al., 2022). DeFries et al. (2019) mention that the natural disaster not only created problems for the communities in this part of the province but also caused an acceleration in the financial losses for most businesses. Therefore, in addition to environmental, social and governance financial aspects, climate change effects are crucial for the investigation.

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Clover, Albany, and motor vehicle businesses (Toyota), among other top manufacturing companies, had to stop transporting their goods because of the bad weather conditions and damage to infrastructure (Smith, 2022). As a result, they were not able to produce maximum units of production to maximise their profits. Instead, their focus was on total profits that could be made, resulting in lost contribution. According to Smith (2022), it took 25 weeks for Toyota to be fully operational after the effects of climate change. On the other hand, if their production was maximised during this period, the companies could have had more stock on hand. Having more stock can lead to increased storage costs and greater chances of the goods being damaged, scrapped, stolen, or expired. Bopape et al. (2021) agree that a similar incident of this nature transpired in 2019 and resulted in over 70 claims of human lives. Hence, the disaster is not a new revelation in this province but a historic one that cannot be forgotten. The disaster has also taken away some of the basic needs of people. This implies that there is a great probability of the recurrence of this natural disaster. Climate change is not controllable, but individuals and businesses can learn how to respond to it by planning and adapting to the changes. The disaster depicted in Figure 1 shows the recorded severe climate events in South Africa, with floods being the highest (32.4%) (Letsatsi & Kruger, 2022). Furthermore, some locations in the south of KwaZulu-Natal (KZN), like Amanzimtoti and Port Shepstone, had greater than 55 mm of rain in 48 hours.

Climate change is uncontrollable, but individuals and businesses can learn how to respond to it by planning and adapting to the changes. Hence, climate accounting should be used for non-financial factors like floods caused by climate change. According to CDSB (2022), the International Sustainability Standards Board (ISSB) and the International Standards Board (ISB) are collaborating to address environmental-related issues. A variety of international financial reporting standards, like IFRS-16 and IFRS-15, need to be considered by manufacturing companies in their financial statements prepared, as they could facilitate and change their disclosures to account for climate change (KPMG, 2022). Furthermore, manufacturing companies should build a sustainable model of operating and practice climate accounting so that they become more resistant to environmental risks created by climate change.

The importance of manufacturing companies to the economy has been verified by countless studies, such as Okorie et al. (2023), who affirm that manufacturing companies contribute significantly to economic growth by producing goods essential for consumption and investment. In addition, it drives productivity gains, innovation, and technological advancement, which are vital for a thriving economy. Okorie et al. (2023) agree that manufacturing companies create a demand for raw materials, components, and services, thereby stimulating growth in related industries. This interconnectedness within the supply chain can have multiplier effects on the economy. So, manufacturing businesses anchor regional development, particularly in rural areas or regions with limited economic opportunities. Also, it can attract investment, support local businesses, and improve living standards (Lee et al., 2023). Therefore, manufacturing companies are necessary to drive economic growth, foster innovation, ensure supply chain stability, create jobs, and enhance national security. This can be improved by enforcing sustainable financial reporting so that previous mistakes are not carried forward in the following years. However, the importance of manufacturing companies extends beyond individual businesses to encompass the prosperity and well-being of societies worldwide. Therefore, this study suggests that in the context of South Africa's shift towards sustainable goals within the basis of climate accounting and disclosure, it is imperative to analyse the impact of climate change effects and IFRS disclosures on the JSE listed companies in South Africa.

The primary contributions of this study are: climate change poses long-term risks to the sustainability of manufacturing operations. This research will help manufacturing companies

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develop sustainable business practices that not only mitigate environmental impacts but also contribute to long-term profitability and viability. The research findings in this field can be utilized by manufacturing companies to drive organizational learning and improvement by examining case studies and applying best practices. Thirdly, the study may be useful to those companies that wish to change their operational models. Consequently, the results of this study will bring awareness to stakeholders of manufacturing companies to comprehend climate accounting and the sustainability of financial reporting. This awareness can contribute to attracting environmentally conscious consumers and investors which can lead to increased market share for the manufacturers and profitability. Al-Shaer (2020) conducted a similar study in the United Kingdom, focusing on firms which do not specify which firms were being investigated. Therefore, to date, according to the researchers' knowledge, climate accounting as well as the issue of non-disclosure have not been looked at in the manufacturing context in South Africa.

International Financial Reporting Standard (IFRS) disclosures and the climate related factors. Anderson (2019) mentions that climate change is a subject that habitually interests investors. Also, other stakeholders are questioning the International Accounting Standard Board as to why climate change is not explicitly mentioned in the IFRS. As far as the Australian Accounting Standards Board (AASB) and the Audit and Assurance Board (AUASB) are concerned, the board is doing an update in non-mandatory supervision on the management review. Where companies would be expected to deal with material environmental and social issues. Thereafter, using that information to complement it in the financial statements. Principal users expect manufacturers to include materiality judgments when preparing their financial reports. On the other hand, the standards set by IFRS require manufacturers to make materiality judgements in decisions made. The judgments to be made should pertain to presentation and disclosure, measurements, and recognition. Having too much information on the financial statements leads to disclosure issues as some information contained would be irrelevant. A study conducted by (Toth et al., 2022) aimed at determining the interrelation between climate-related sustainability and financial reporting disclosures highpoints that there is no obligation to have sustainable reports as there is no standardised reporting requirement. Furthermore, the authors found that there is no connection between sustainability and financial reporting. Nevertheless, climate risks must be included in the financial statements so that companies can consider such risks in the context of financial reporting rather than isolating the matter as corporate, social responsibility reporting. Manufacturing companies may have assets that are potentially at risk of climate change. So, by providing information on the financial statements, explanations can be given to the users without them having to dig further for clarity. For example, an explanation stating why a carrying amount of an asset is not attached to climate risk. Notes are not just recorded anywhere in the financial statements but are recorded under notes as per IAS 1 requirements. So, the recording of information that could influence the decision-makers is crucial. To assess the materiality of information, qualitative factors should also be considered, like the size and nature of the manufacturing business. In conclusion, the requirement for judgment on materiality is inescapable towards the initial reports. As a result, if the financial statements are omitted or materially modified, then that material information could impact the investors' decision-making.

How climate change factors influence IFRS 15 – Revenue. The sustainability index and financial statements are vital elements in the economic unit, and information about the revenue generated is very important. According to Hameed et al. (2019), stakeholders depend on the financial performance of the organisation to make economic decisions. In addition, it is the amount of revenue that the company has that will determine if the organization has performed well financially.

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Consequently, the economic decisions made by stakeholders can also be influenced by recognition timing and disclosure measurement. Usurelu and Dutescu (2018) agree that revenue cannot just be looked at briefly, especially during harsh climate situations. Manufacturers need to provide accurate revenue information in their financial statements with the considering climate effects. On the other hand, long-term arrangements can affect revenue recognition throughout the contract (Haggenmüller, 2019). So, the financial performance statement produced by manufacturing companies during floods might be inaccurate. With that being said, the financial statements should include revenue that would be probable and not revenue that is uncertain. Climate change creates uncertainty as the magnitude and timeframe of the climate risks are complex and cannot be predetermined. Substantial diversity is widespread in revenue recognition practices since the latest standards have low support on topics like accounting for climate change (Tong, 2014). Climate change can cause the total cost of the contract to change on cost estimates. Therefore, percentages will change, and this creates dishonesty in the disclosure to conceal the real financial indicators from the investors. Besides, if the total estimated revenue cost is lower than the anticipated cost to deliver that contract, it makes it unnecessary for the company to continue with the business relationship with suppliers or investors. Auditors need to correct the inconsistencies by using their expertise and provide an independent opinion that will challenge any irregularities, non-disclosures, recognition, and measurements on the financial reporting to help cut down the climate-related issues of improper financial reporting (Grigoroi, 2017). Some material information regarding revenue can go under notes in their financial statements – audited financial statements.

How climate change factors influence FRS 16 – Leases. Many manufacturing companies lease assets (long-term) and these assets are likely to be affected by climate risk factors like floods, which in turn affects the financial statements like impairment of fixed assets. In addition, this can cause a major increase in the depreciation of the assets before the end of their useful life (Hladika & Valenta, 2018). It is difficult for businesses to lease a different building because some contracts bind the companies to finish the term. The companies are then forced to stick to the leased building until the end of the term and not renew the contract. This should now be material to the manufacturers for disclosure in their financial statements, but they choose not to because of investment opportunities. According to Matos (2021), operating leases are usually recorded using previous leases recognised in the balance sheet rather than recognising it as an expense; this impacts the manufacturer's financial statements as decisions are dependent on many factors. Furthermore, the companies are expected to decrease the level of impact that IFRS 16 has on their leverage by making sound decisions, especially during harsh climate conditions. The implementation of this standard was designed to raise reliability and provide sustainable reporting to assist investors in their decision-making. When a standard has a substitute treatment, the manufacturing company would rather go for the alternative that capitalizes lesser lease operation. As a result, the operation cost will be lower. The fact that some leases are not disclosed on the balance sheet during climate change means that the company will face a challenge when the financial statements and financial ratios are being compared from one manufacturing company to the next for that period (Morales Díaz & Zamora Ramírez, 2018). In the case of a lessee, many companies do not separate the lease and non-lease components but after the introduction of IFRS 16, these companies are bound to separate them if this was not done previously. Consequently, aggregating the amounts under one transaction conceals other items that should be recorded. Resulting in an unfair presentation to stakeholders and users. Fuad et al. (2022) argue that manufacturing companies with a low level of corruption are a result of them implementing IFRS 16. In addition, in a strong legal environment, the

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implementation of IFRS would cost less as opposed to a low legal environment. In a low legal environment, manipulating financial statements would be easier.

How climate change factors influence IFRS 19 – Employee benefits. Manufacturing companies that are affected by climate change effects have the option to reorganize their business or make a complete shutdown. When the organization terminates or restructures, the decisions made have a great influence on employee benefits (KPMG, 2022). Resulting in early disbursements of funds to a lot of staff. During this period, the manufacturer may reshuffle staff (fewer working hours) or make climate-related performance criteria for employee incentives. Redundancies usually occur when the restructuring takes place and creates an expense for the early termination of employee contracts (Iatridis & Rouvolis, 2010). What is an issue here is that most manufacturers make provisions once they have discovered that they have enough funds in alignment with their plans. Therefore, creating disclosure issues like not being precise whether the benefit is a termination or post-employment. The difference between the two benefits is that post-employment benefits should be qualified after the period of service. The termination benefit should be qualified the moment liability arises and recognised in full. According to Horton et al. (2013), manufacturing companies must make actual assumptions that have been used in determining employee benefits. In addition, proper disclosure in the financial statements needs to be disclosed whether the expected value benefit is short or long-term in nature. So, the company must have incentive plans made regarding climate performance measures. On the other hand, plan assets like stocks, bonds and investments need to be measured while considering how climate change might impact those assets which agree (Ben-Amar et al., 2022). So, employers must provide enough information on the type of planned assets. In most cases, the fair value of plan assets is not aggregated under IAS 19. Updating the disaggregation disclosure in the financial statements will provide users with an indication of the climate-related risks associated with those assets. In addition, employees need to be aware of what climate risk factors they would be exposed to. (KPMG, 2022) states that management should include climate risk factors under demographic and financial assumptions. Thus, management must make scrutiny of the measurement and disclosure of plan assets if they are significantly influenced by climate-related risks. This research has noted scarcity in the literature that points out the relationship between IFRS disclosures and the dynamics of climate change in the JSE listed manufacturing companies' context. The study aims to address this gap by integrating IFRS disclosures with climate change effects into a single framework.

Firm size moderated by disclosures of climate change. The influence of firm size on climate change disclosures has been widely studied. Hardiyansah et al. (2021) state that bigger companies tend to disclose more climate-related information than smaller ones. Even though smaller counterparts may also engage in climate disclosures, they encounter challenges of limited resources for data collection and reporting. The relevancy of firm size is associated with sustainability disclosures and the company's financial wealth (Abdi et al., 2022). Climate disclosures are voluntary but some small companies are starting to disclose climate-related matters. Furthermore, the disclosure is more valuable to investors regarding the size of the company. Hapsoro and Falih (2020) determined that climate disclosures positively influence equity value and this is caused by the level of emissions usually made by larger firms. This indicates that larger companies have a greater responsibility to disclose their climate-related matters as some of their operations interfere with environmental surroundings, which is a conservational matter that must be carefully managed. Hence, there is more pressure for bigger companies to address social responsibility and environmental issues (Hapsoro & Falih, 2020). The issue of climate change is constantly attracting attention on a global scale. According to Gahramanova and Kutlu Furtuna (2023), it becomes hard

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for investors to analyse a small company's future outlook since disclosure of climate change is voluntary. As a result of inconsistency, there is a lack of comparability between larger companies and smaller companies for stakeholder evaluation on the influence of climate change matters. Therefore, investors would rather compare disclosed information among larger companies and exclude smaller ones. Saraswati et al. (2021) agree that to determine the profitability of a company, investors are interested in the size of the company. Investors are on the opinion that since the company has a large profile, the resources used ought to be higher, therefore a broader climate disclosure will be required. Consequently, larger companies are being monitored on the extent they consider climate change during and after the production of their products. (Assaf et al., 2024) state that to reduce information disproportionateness, manufacturing companies should look at stock risk and sales growth so that climate change disclosure of good quality can be provided. In addition, countries like the United States with a higher GDP are highly leveraged and are associated with low quality on climate change disclosure. Consequently, low-quality climate disclosure comes with greater scrutiny and regulatory pressure on high-quality disclosure to remain profitable (Widianto & Sari, 2020). Abdi et al. (2022) suggest that more manufacturing companies should invest in sustainability projects regardless of the company size. However, larger companies have an advantage due to the unlimited resources they have. As a result, larger companies will have a well-structured strategy to enable them to monitor their business objectives while handling sustainability projects. Furthermore, companies conducting such sustainability projects stand out from other counterparts because of their company image portrayed to investors and society. On this basis, companies that do not engage in sustainability projects focus more on improving their financial wealth. So, new entrants in the market must be familiarized with sustainability engagements and related initiatives as this attracts stakeholders without company size comparison.

Board size moderated by disclosures of climate change. Alodat et al. (2024) state that disclosure of climate change has come out to be an important matter that needs to be critically studied by policymakers, researchers and scholars in recent times. This matter is prominent to some businesses that can be regarded as being environmentally sensitive. Studies like (Nasih et al., 2019) found that climate change disclosure practices of some companies are influenced by the size of the company's board of directors. In addition, the board size has directors who have dissimilar expertise regarding sustainability and climate change disclosure. The varied expertise helps with accountability and financial reporting transparency. Bigger boards are likely to apportion vital financial resources to pursue more conservational initiatives. Therefore, due to the size of smaller firms, the board may have few members who have the right expertise, as this slows down improvements in sustainability practices and climate change disclosures. According to Saha and Khan (2024), to ensure that an organization is legitimate via climate disclosures, companies should consist of board members who have frequent meetings. The meetings are more meaningful if the board has gender diversity. Moreover, a larger female population on board tends to enhance climate change initiatives. Hence, an organisation needs to practice board diversity in connection to gender. Kutlu Furtuna and Sonmez (2024) agree that corporate innovation is higher when there are more than two women on the board than when there are fewer than two women on the board. Consequently, female directors can put pressure on managers to align their business goals with sustainability. Thus contributing to board meetings by generating ideas to increase environmental disclosure practices. On the contrary, Saha & Khan, 2024) highlight that larger companies with an increased number of independent boards can become ineffective due to a lack of communication and coordination. This means that managing a large board is not as easy as managing a smaller board. Disclosure and sustainability goals might be important in a larger company, but managing

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the board is also vital so that there will be consistency and a well-structured company to commit to climate-friendly initiatives. Zhu et al. (2024) indicate that a wider range of board members can affect the integrity of decisions made in the organisation. Furthermore, a board consisting of females may enhance the board's effectiveness, which can result in climate disclosure of crucial information. Companies with more female board members enjoy long-term benefits aimed at promoting environmental disclosure. Moreover, different insights and perspectives can be made by a diverse board of directors and this enhances ecological disclosures. However, in some instances, as the board size increases, it causes a downward shift in the direction of sustainability (Nguyen & Thanh, 2022). Nevertheless, for better organisational performance, the size should not be too large to operate effectively.

Non-disclosure of climate change information in manufacturing companies. Climate change disclosure has been a prevalent matter for manufacturing companies. Yet, manufacturing companies are not compelled to disclose this as it is not a requirement to bind them by law (Attenborough, 2022). Failing to disclose climate-related risks, policies, and mitigation strategies has consequences. The lack of transparency within the organisation can have significant effects since parties like stakeholders are interested in the company's strategic objectives regarding sustainability. There is a high possibility that climate change impacts can emerge in the long run for companies in different industries (Alpert et al., 2022). Therefore, the timing of these impacts cannot be fully understood, as the event remains uncertain. Consequently, manufacturing companies need a strategic plan to lower the challenges that uncertainty brings along with the effects of climate change. This means that the company should consider the potential risks that could come under different weather conditions to incorporate those risks in alignment with its strategic objectives. According to Wasim (2019), manufacturing companies are bound to encounter risks considered to be unique, which may accumulate over the years. Importantly, the climate change risks do not target specific companies. As a result, the impact goes deep to the point that the country's economy. Wasim (2019) explains further that some companies fail to disclose climate-related information because the law does not require them to make it a standard requirement. However, this affects investors as they need to take into account the environmental challenges faced by the organisation. This results in a negative reputation as sustainability ratings will be lower for non-disclosing companies than companies that are making climate change disclosures. A lot of manufacturing companies lose long-term investment opportunities since investors would rather select an option with certainty than an option where the organisation has little or no climate change knowledge of its company to raise awareness among stakeholders (Tang, 2022). In addition, it is observed that most non-disclosing companies are service offerings. They consider themselves less vulnerable to climate risks due to the type of business they conduct. Yet, some do not disclose for confidentiality reasons (Tang, 2022). This could mean that due to how sensitive some companies' information is, they would rather give up an opportunity than give away their delicate information. Bhaduri (2021) reports that fraud is likely committed by manufacturing companies that do not adequately disclose their climate-related risks. Consequently, vital information fails to reach investors, misleading them into making decisions without awareness of potential climate risks. According to Megeid (2024), climate change is resulting in more frequent and severe events and disasters. This necessitates that governments, businesses, and other organisations collaborate to respond effectively. Users of financial statements expect fair reporting by manufacturing companies. Therefore, manufacturers must consider IAS 1 to meet users' expectations. If economic judgments rely on choices made by users, then disclosures regarding climate risk should be regarded as significant for transparency.

Conceptual framework.

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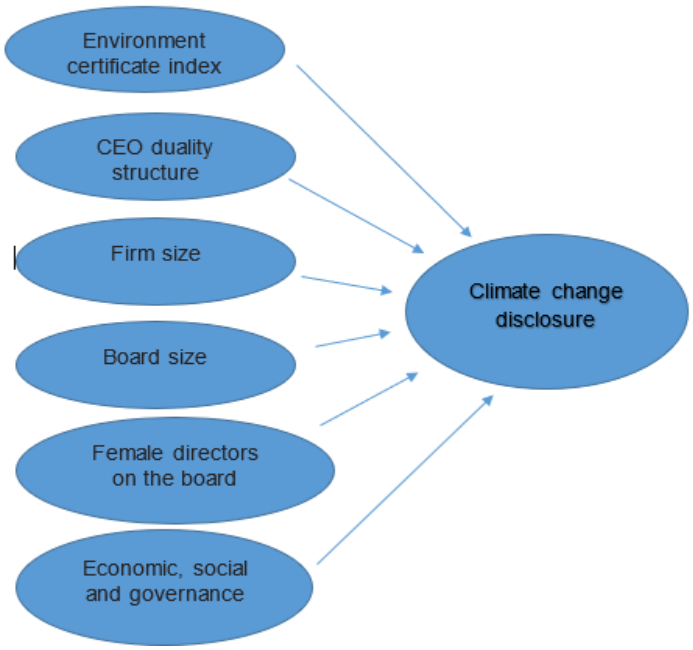

Source: Author's design (2025).

Figure 1. Conceptual framework

Figure 1 shows the relationship between IFRS disclosures and the dynamics of climate change towards sustainable financial reporting among manufacturing companies in South Africa. The environment certificate index, CEO duality structure, firm size, board size, proportion of female directors on the board, economic, social and governance are independent IFRS disclosure variables while climate change disclosure is the dependent variable. Hence, this framework outlines the summary of the study's objective.

Corporate Sustainability Theory. Corporate Sustainability Theory traces its origins to the Triple Bottom Line framework propounded by John Elkington (1997) and the 1987 Brundtland Report. This theory has been presented to provide manufacturing organisations with proper supervision to sustain and advance the company's profitability while enhancing environmental and social performance. Ashrafi et al. (2018) mention that the corporate sustainability theory exposes corporate obligations to better performance. As a result, this theory can be seen as satisfying stakeholders and not compromising the future production needs and goals of manufacturing companies around KZN. Strategies made under corporate sustainability show how problems that are encountered with sustainability will be resolved in practice (Baumgartner & Rauter, 2017). This strategy is useful to manufacturers so that a competitive advantage can be obtained as well as in most profit-oriented organizations. Furthermore, strategizing is not the only requirement for the progression of manufacturing companies. Corporate sustainability management is required to make changes and continuous learning progressions, as it will attain the manufacturer's objectives resourcefully. Adubor et al. (2022) state that human beings assist the business in many ways, shaping business practices and ensuring the initiative success of corporate sustainability. Furthermore, maintaining corporate sustainability will yield improved employee productivity while lowering operational risks. In other words, corporate sustainability deals with individuals within an organisation who aim to find solutions to environmental challenges encountered by the company. Corporate sustainable development does not only cover economic factor evaluations and protection of the environment but also social responsibility (Chen et al., 2024). Findings from Adeyemo et al.

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(2013) show that corporate social responsibility is positively affected by service and product innovation in service and manufacturing companies. In addition, this positive influence was arbitrated by collaborations with suppliers and the involvement of employees. However, when the comparison of corporate social responsibility effects was made on performance innovation, manufacturing companies had a lower effect than service companies. As a result, there must be an alignment between initiatives for innovation and corporate sustainability to acquire a strategic business collaboration. Moldavska and Welo (2019) highlight that corporate sustainability focuses on input rather than influence. Therefore, it can be argued whether financial performance can be used solely to measure the manufacturing company's corporate accomplishments. Stakeholders also need to be kept updated on matters impacting the company, and this is also one of the purposes of assessing corporate sustainability. Based on the above review, the following research hypotheses are proposed as this study is hinged on corporate sustainability theory:

Hypothesis:

H0: International Financial Reporting Standard disclosures are not connected with climate change effects

H1: International Financial Reporting Standard disclosures are connected with climate change effects.

Other sustainability reporting theories, Triple Bottom Line (TBL) Theory. The Triple Bottom Line (TBL) is a sustainability structure that encourages businesses, such as manufacturing companies, to measure their success beyond financial performance. According to Abdulmaksoud et al. (2025), TBL was developed in 1994 by John Elkington, which centres on three core dimensions: People, Planet and Profit (PPP), which is all part of social, environmental and economic sustainability. Manufacturing companies can have a sustainable value by neutralising these core dimensions. This can be done by reducing the environmental and social impacts (non-living items) as profit remains the essence of the business environment. (Ciliberto et al., 2021) state that the biggest mistake humans make is being worried about ways their business can have financial wealth, but forgetting about measures to take to preserve the environment. It is more valuable to have a sustainable business that develops strategies to preserve the environment. Birkel and Muller (2021) understand that the TBL structure assists manufacturing companies in maintaining growth and wealth by balancing social, environmental and economic sustainability. However, there may still be challenges encountered but incorporating all the sustainability aspects can bring about a positive business impact and lead to longer business continuity. Pandiangan et al. (2022) mention that the going concern principle applies to manufacturing companies if they follow sustainability guidelines like mitigating environmental factors and contributing to the needs of the community. On the other hand, there is confusion around TBL due to different perceptions by various companies on how stakeholders recognise TBL (Khanzode et al., 2021). Not knowing which dimension to prioritise can result in uncertainty. Consequently, this hinders manufacturing companies from adopting sustainable guidelines. Unswervingly, sustainability guidelines followed by manufacturing companies encourage continuous product life cycle and create value through different channels so that a contribution to sustainable TBL is carried (An et al., 2021). Therefore, the main concern of maintaining environmental sustainability is the way manufacturing companies operate and the measures they adopt to reduce waste and carbon footprints, which damage the environment. There are newer technologies implemented to maximise manufacturing outputs using effective resources, which is carried out by Industry 4.0 (I4.0), such as the Internet of Things (IoT) (Khan et al., 2021). These technologies stimulate productivity and efficiency, which forces systemic ways to solve environmental problems. As a result, a sustainable environment demands that manufacturing

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companies adopt strategies to assist in improving the way they conduct business. According to Ivanov (2023), Industry 5.0 (I5.0) must be parallel to human perspectives for decision making, resilience and sustainability. Therefore, I5.0 is an enhanced technology from I4.0 as it consists of inimitable combined metrics that focus on human craftsmanship and improved automated systems designed to eliminate any hindering obstacles that do not create improved productivity and efficiency to enable environmental sustainability.

Extended Producer Responsibility (EPR). Extended Producer Responsibility theory was propounded by Thomas Lindhqvist (1990). Extended producer responsibility enables manufacturers to take accountability for reprocessing products which have reached their end of life. According to Liu et al. (2022), enforcing accountability from these manufacturers will necessitate some stakeholders to partner in venturing on ERP. This can reduce apprehensions such as equality from a variety of stakeholders. A variety of initiatives and tools can be used by utilising ERP as a guideline to promote accountability (Joltreau, 2022). Guidelines of ERP are essentially for the association of waste and product to foster product design while saving on waste expenses. However, most manufacturing companies whose products fail quality inspections are regarded as wastage. As a result, they are recycled instead of being repaired. This is in line with (Thapa et al., 2023) who agree that manufacturers must take precautions of their manufactured goods and reuse wasted materials to improve sustainability. Favot et al. (2022) highlight that ERP is responsible for assisting in waste reduction and minimising costs associated with damaging the environment. Liu et al. (2022) indicate that cost pressure triggered by ERP can be reduced simply by shifting some of the manufacturers' responsibilities to retailers. This shift can be made through adding mark-up prices in wholesalers. However, the shift can cause doubts about the fairness of how profit will be dispersed. This again leads to concerns of inequality from the eyes of stakeholders. That is why ERP guidelines are crucial to manufacturers so that environmental sustainability can be improved by looking at retailers' concerns and fairness versus reusing wasted materials. Reused materials can sometimes be questionable in terms of quality and whether products can be repaired to standard (Thapa et al., 2023). Zhao et al. (2021) disagree that reused products cannot be of good quality. Furthermore, ERP can be used to avoid low-quality products being produced while checking for any defects. As a result, this improves the standardisation of products from recycled materials should appropriate and influential guidelines are followed. The ERP goal is to encourage manufacturing companies to innovate in technology. Putting more energy towards technological innovation and applying green principles encourages resource responsibility and minimises issues associated with the environment. Shooshtarian et al. (2021) highlight that there are two sets of responsibilities. The first one is an individual responsibility, which deals with an individual manufacturer being accountable for its own manufactured items. On the other hand, there is a collective responsibility which involves every manufacturer who produces batch production of the same items and similar streams of waste. Conversely, ERP goals can prompt upstream variations, sometimes even when financial responsibility is allocated to manage waste. Product design is sometimes not implemented the way it was initially anticipated (Leclerc & Badami, 2024). Thus, there are fewer enticements to stimulate product design the way it should be and ERP schemes battle to promote this. This is reflected in the small portion of the sales price that is represented by recycling costs, which electronic equipment has been used (Maitre-Ekern, 2021).

Resilience Theory. Rooted in ecology by C.S. Holling (1973) and applied to manufacturing by scholars like Thomas et al. (2016), resilience theory signifies how adaptive organisations are. Camarinha-Matos et al. (2024) describe resilience theory as a paradigm signifying how adaptive manufacturing organizations are. In addition, the term resilience alone in the context of an

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operational organisation means the ability of a company to repair its formal condition or improve its undesirable condition to a more suitable one without going beyond its elastic limit. So, despite any interferences, systems guide companies during uncertainties to adapt and function properly. It may not be an easy task to aggregate sustainability benefits with resilience (Rajesh, 2021). The challenge faced by manufacturing companies when aggregating these two variables is the conflicting company goals. This may be due to implementations made to achieve an objective but using irreconcilable objectives. Companies applying resilience should include frameworks to handle climate change challenges so that their business can flourish. Goals can be achieved by using a pillar of resilience and solidity and critically looking at the company's performance and culture. Souza et al. (2017) highlight that the pillars of a company's resilience help to maintain sustainability and they are; adaptability, eco-efficiency, cohesion and diversity of strategies. The resilience of a company hinges on the field its being applied because of its different socio-technical patterns (Balugani et al., 2020). Nevertheless, resilience theory provides a valuable lens for enhancing the sustainability of manufacturing companies by fostering adaptability, diversity, and innovation. Companies can not only survive but thrive in a rapidly changing world while meeting sustainability goals. Thomas et al. (2016) indicate that improvement plans are necessary to boost resilience and sustainability like integrating lean and dexterity. Accordingly, flexibility is possible through the innovation of sustainable production and guidelines being followed (Ameer et al., 2024). Thus, leading to reduced production cost per unit and greater production volumes. Furthermore, capitalising in the relationship with suppliers can improve the company's sustainability performance and be more rigid when it comes to disruptions and not forcing manufacturers to buy elsewhere (Negri et al., 2021). In the end, it is not the environment of harsh conditions that is significant, but what is more vital is the way manufacturing companies handle those adversities and improve their coping mechanisms.

Materiality Theory. Materiality Theory was pioneered in sustainability by Eccles et al. (2012). The conception of materiality is a precarious theory that involves sustainability within the manufacturing segment. This concept supports prioritizing ESG dynamics which is considered to be crucial for the public, businesses and stakeholders (Calabrese et al., 2017). In other words, impactful dynamics are aligned with sustainability determinations which uphold hazard management and enhanced decision-making. The standards of materiality can be found in both financial accounting and auditing. The terminology on its own denotes a tolerable level that is considered important to the company caused by any errors or misstatements which could affect financial decisions. According to Oll et al. (2025), the Sustainability Accounting Standards Board (SASB) and Global Reporting Initiative (GRI) are supportive structures for sustainability reports which has procedures to resolve any issues considered material by the company. However, materiality does not only concern issues associated with financial factors like manufacturing costs and consumption of energy. It also takes note of the non-financial issues such as company's goodwill, societal and employee issues. Similarly, the criteria to recognize financial and non-financial information is alike (Mio et al., 2020). Once material issues have been identified they are then categorised and ranked according to the level of importance. So, many organisations deal with a lot of information which they try to make sense in terms of relevancy within the business. Calabrese et al. (2017) state that there is a possibility of subjective judgements when dealing with several stakeholders and their outlooks need to be considered. Consequently, this can improve the concern of completeness while dealing with internal analysis and processes. On the other hand, materiality may be twistedly used without thinking that stakeholders belong to different groups and they have dissimilar interests (Beske et al., 2020). Nonetheless, the misuse of material information is

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likely used to separate negative information that would affect the decision makers because materiality analysis supports manufacturing companies to interact with different stakeholders through communicating relevant sustainability matters. Hsu et al. (2013) indicate that incomplete reporting can be triggered by failure to identify information required by stakeholders. As a result, this affects transparency, which calls for the development of balanced processes while understanding the material vitality of sustainable reporting. Ngu and Amran (2024) suggest that board meetings are essential to increase the level of material disclosure. This will result in delivering relevant material information needed stakeholders as communication will be improved. Preparing climate-change-related information is equally important in materiality. This will assist in several ways, like identifying and addressing material issues, manufacturing companies can better manage risks, seize opportunities, and drive sustainable practices that contribute to long-term value.

Resource-Based View (RBV) Theory. Wernerfelt (1984) and Barney (1991) propounded RBV. Agrawal et al. (2024) describe the Resource-Based View (RBV) theory as a strategic framework that focuses on the internal resources and capabilities of a firm as the key determinants of sustainable competitive advantage. In addition, the RBV offers valuable insights by emphasizing the development and utilization of exclusive resources to achieve long-term sustainability in environmental, social, and economic measurements. It has become a strategic necessity to improve sustainability practices and systems in order to boost performance (Ferreira & Ferreira, 2024). Therefore, by leveraging the RBV structure, manufacturing companies can create a vigorous foundation to attain sustainability. This will ensure both competitiveness and long-term sustainability in an increasingly eco-conscious global market. That is why manufacturing companies must adopt these strategies as they show a vital picture to stakeholders of their interests. Not forgetting that a successful business is not simply driven by finance on its own in the long run. Samadhiya and Agrawal (2024) agree that manufacturing companies should practise sustainability so that their success can benefit future generations. Furthermore, the importance of RBV is the insight obtained knowing how well a company has performed by making use of resources. However, Savino and Shafiq (2018) mention that a company's efficiency is driven by the consistent usage of resources which will determine the company's effectiveness. This goes to show that if manufacturing companies apply RBV, a different perspective can be drawn to arrange their strategic abilities. Resources are considered to be inputs to product manufacture and include skills, staff, finance and equipment (Gavronski et al., 2011). So, creating new assets and training more employees to upskill themselves increases the business's survival. Additionally, in a competitive environment that consists of dynamic capabilities, organizational knowledge is the ultimate capability because it affords the reinforcements of those capabilities. According to Khan et al. (2023) implementation of innovative and value-enabling strategies is advantageous to a business that has scarce and different assets from other competitors. As a result, if competitors cannot replicate scarce resources from other competitors, those resources are unique and remain difficult to substitute. Shibin et al. (2020) found that RBV enlightens the tracks that manufacturing companies should follow by using resources to obtain a competitive advantage. Similarly, RBV may be used as a base for ideas generated about economic facets through supply chain sustainability. Resources are important for business continuation in a competitive environment such as the manufacturing industry. However, the resources become less important if they are not cogently combined. Nonetheless, if green management programs are implemented effectively, environmental performance will be enhanced. Even though some manufacturing companies have enforced these practices, supply chain should be added to their internal environmental programs (Gavronski et al., 2011). Consequently, production,

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operational performance, product safety and quality will be enhanced while keeping up with sustainable environmental practices.

METHODS

Data source. The annual financial reports for the specified manufacturing companies are obtainable from Refinitiv Eikon, WRDS and Iress . However, some information might not be retrieved, so additional sites like Google Finance and StatSA were used. Moreover, information on climate-related matters was gathered from the 'Resource Watch' website, which is monitored by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA). Therefore, the study adopts a desk review approach.

Population and Sample. The study investigated all the manufacturing companies listed on the JSE in South Africa. The reason for investigating all the listed manufacturing companies is to identify potential risks associated with supply chain disruptions, extreme weather events, and shifting consumer preferences. Mitigating these risks can encourage healthy competition and innovation within the manufacturing industry. Therefore, building trust with the investors as there will be transparency in the financial reporting. The manufacturing sector has a global impact, and its actions can significantly affect the environment and society. Thus, investigating these companies holds them accountable for their global responsibilities and encourages them to contribute to global sustainability goals. In addition, the study wants to assess how viable manufacturing companies will be in the long term as the world is facing climate change and resource constraints.

There are a lot of factors surrounding climate change which include some of which are not included in the study. Therefore, not all the listed manufacturing companies are impacted by the climate change factors that this study intends to investigate, such as Increased energy costs, changing consumer preferences, capital access, supply chain disruptions, greenhouse gas emissions, waste management, and industrial Processes. As a result, some manufacturing companies might fall out as they may not be a good sample to obtain information and use along with the study's climate change factors. In addition, manufacturing companies that are not listed on the JSE, including those that have been delisted (E.g., failure to comply with regulations), will be disregarded as they might not have financial data for the period that the study intends to investigate. This consideration has been made to avoid investigating only successful companies and leaving out non-surviving companies.

The reason for using these factors for this study is that they involve encouraging and supporting manufacturing companies to adopt sustainable practices, such as reducing emissions and minimising their environmental impact. Thus, it plays a role in incentivising and guiding manufacturing companies toward more responsible and climate-friendly practices to enhance their financial well-being. Some factors may be based on misinformation or misconceptions, and incorporating them into decision-making can lead to inefficiencies and unnecessary costs for manufacturing organisations. It is essential to rely on reputable sources of information and scientific consensus when evaluating the impact of climate change on financial reporting sustainability, and to exclude factors that lack empirical evidence or are not pertinent to a specific industry or region.

Research method. Saud et al. (2020) highlight that using a panel estimation technique gives the variables used in a study a natural logarithm which smooths the data so that there is a more reliable estimation. On the other hand, panel data deals with omitted variable bias due to heterogeneity in the data (Rotimi & Ngalawa, 2017). In addition, panel data allows organisations to review how the variables are changing over time and how they could affect trends in future.

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It is crucial to carry out tests to determine the robustness, validity, performance and any limitations of the model. This is to ascertain that the model has generated good results. So, before the analyses are done to achieve the objectives, a preliminary test will be conducted on the data. Specifically, the panel unit root test and panel co-integration test will be conducted in addition to the descriptive and correlation analysis.

Panel Unit root test: This is also known as the stationarity test that is used to depict the stationarity of panel data. As panel data is a combination of both time series and cross-sectional data, there is an indisputable need for a stationarity check to detect the presence of unit root in the variables and affirm the validity of the relationship between the variables. If panel data has a unit root, the data will move at random. The decision rule is that: if a critical value is less than the absolute value of the statistics, there is the presence of stationarity in the observed data. This indicates that the null hypothesis is rejected.

For this study, the Augmented Dickey-Fuller (ADF) Fisher test, Levin, Lin and Chu (LLC) t-test, and Philips-Perron (PP) Fisher test are the types of unit root tests to be considered. Furthermore, to avoid spurious regression, it is important to check that the variables are well aligned. In addition to the unit-root test, the study will apply a stability test to assess the stability of the model. Yoo et al. (2022) highlight that the stability test reveals any structural breakage over time between the variables.

Ultimately, unit- root is written as $\Delta Q_{it} = \partial Q_{i,t-1} + \sum_{j=1}^{kw} \forall_i \Delta Q_{i,t-m} + \beta_i \gamma_{it} + \varepsilon_{it}$ it. From the equation, γ_{it} is the deterministic component $\varepsilon_{it} \approx idd(0, \forall_i^2)$. The hypothesis is stated below.

$$H_0: \varphi = 0$$
$$H_1: \varphi < 0$$

The null hypothesis indicates that the y process has a unit root for each individual i while the alternate hypothesis indicates the data is stationary.

The ADF estimation is asserted below:

$$\Delta Q_{it} = \theta_i + \partial_i Q_{i,t-1} + \sum_{j=1}^{j=k_i} \forall_{ij} \Delta Q_{i,t-j} + \varepsilon_{it}$$

Therefore, the null and alternative hypothesis is asserted as:

$$H_0: \varphi_i = 0$$
$$H_1: \varphi_i < 0$$

Panel co-integration test estimation. This is a test used to detect the existence of long-run relationships amongst the variables examined in a model. Specifically, in this study, both Kao, Pedroni and Residual co-integration tests (see (Pedroni, 2004) will be conducted. These are Engle-granger-based but necessary for the analyses because they insist on the homogeneity of units in the dataset.

The panel co-integration estimate is:

$$Q_{it} = \delta_{1i} + \delta_{2i}\beta_{it}^{c} + R_{it}\rho_{1i} + R_{it}\rho_{2i}\beta_{it}^{s} + \varepsilon_{it}$$

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From the equation above, $R_{it} = R_{i,t-1} + \mu_{it}\ i = 1 \ldots \ldots . M, t = 1 \ldots \ldots W$

$\delta_{1i}\ and\ \delta_{2i}$ are unique constants, ρ_{1i} and ρ_{2i} are slope parameters, ε_{it} is the stationary disturbance term, Q_{it} and R_{it} are a unified process of order one for all i. Panel cointegration assumes that a deterministic trend does not exist.

The null and alternative hypothesis for "between dimension" and "within dimension" is written as:

Between dimension:

$$H_0: \forall_i = 1$$
$$H_1: \forall_i < 1$$

Within dimension:

$$H_0: \forall_i = 1$$
$$H_1: \forall_i = \forall = 1$$

Firstly, the Pedroni's panel co-integration tests statistic is written as:

$$l_{it} = \sigma_i + \sum_{k=1}^{j} \delta_{ik} d_{kit} + \varepsilon_{it}$$

i stands for the individuals, t stands for the time; σi is a coefficient that permits the individual-specific fixed effect; εit is the projected residual that portrays the divergence from the long-run correlation between the variables.

That is, $\varepsilon_{it} = \forall_i \boldsymbol{\varepsilon_{i(t-1)}} + \boldsymbol{\gamma_{it}}$

Secondly, the Kao ADF co-integration test's estimate is stated as:

$l_{it} = \sigma_i + \gamma d'_{it} + \mu_{it}$. The estimated residual is μit,

where $\mu_{it} = \forall \mu_{i(t-1)} + \sum_{k=1}^{j} \zeta_{ik} \Delta \mu_{i(t-k)} + \gamma_{it}$

i are the companies that range from $1, \ldots \ldots \ldots \ldots j$ is the time (years).
γ represents the vector of the slope parameters; $\mu it$is the disturbance white noise error term.
$\sigma i$is the constant term.
$lit$is the integrated process of order one (1) for all individual i that is,

$$d_{it} \approx I(1) \forall i, \Rightarrow d_{it} = d_{i(t-1)} + \mu_{it}$$

$\{l_{it}, d_{it}\}$are independent across all individuals.
$\theta_{it} = (u_{it}, \varepsilon'_{it})''$is a linear process.

The long-run covariance matrix of $\theta it$is denoted by π which leads to:

$$\pi = \sum_{k=j}^{j} E(\theta_{ik}, \theta'_{i0}) = \begin{pmatrix} \tau_u & \tau_{u\rho} \\ \tau_{\rho u} & \tau_\rho \end{pmatrix}$$

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$$\sum = E(\pi_{i0}\pi'_{i0}) = \begin{pmatrix} \Sigma_u & \Sigma_{u\rho} \\ \Sigma_{\rho u} & \Sigma_\rho \end{pmatrix}$$

the null and alternative hypothesis of no co-integration is applicable under the Kao test.

$$H_0: \partial = 1$$
$$H_1: \partial < 1$$

Following the null hypothesis that states there is no co-integration between the variables, the Kao ADF test statistic is written as;

$$ADF = \frac{t_{\hat{\partial}} + \sqrt{6a\hat{\rho}_v/2\hat{\rho}_{0v}}}{2\hat{\rho}_{0v}} \approx A(0,1)$$
$$\sqrt{\hat{\rho}^2_{0v}/2\rho^2_v + (3\hat{\rho}^2_v/10\hat{\rho}^2_{0v})}$$

Where,

$$\hat{\rho}^2_v = \hat{\Sigma}_u - \hat{\Sigma}_{u\gamma} - \hat{\Sigma}^{-1}_\gamma \; and \; \hat{\rho}^2_{0v} = \hat{\tau}_u - \hat{\tau}_{u\gamma} - \hat{\tau}^{-1}_\gamma$$

Johansen Fisher panel co-integration test has trace statistics and Maximum Eigen value of which both are based on the aggregates of the Probability values. Assuming ∂_i is the probability value for the individual (insurance company) i, under the null hypothesis $H_0: \partial_i = 1$, tare t-statistics is given $-2\sum_{i=1}^{j} log(\partial_i) \approx \chi^2_{2a}$. The test statistic (∂trace) below will test the null hypothesis, $H_0: C \leq u$ and alternative hypothesis $H_1: u = C$

This is explicitly computed as: $\partial_{trace}(C) = -T\sum_{i+1}^{j} ln(1 - \hat{\partial}_i)$, where $\partial C + i \ldots\ldots\ldots \partial p$ is the least value of Eigenvectors $(j - C)$. The maximal Eigenvalue test (∂_{max} with $H_0: C$ cointegrating vectors against $H_1: C + 1$ cointegrating vector is given as; $\partial \widehat{ln}(_{max}$

Model. The study's objective adopts the model employed by Amran et al. (2014). This study is unique as it considers the Economic, social and governance score (ESG) in the model. The Climate Change Disclosure Index multiple regression model for South Africa is developed to be tested in this study is stated as:

$$CCD_{it} = \beta_0 + \beta_1 ENC_{it} + \beta_2 DEC_{it} + \beta_3 AUR_{it} + \beta_4 DUA_{it} + \beta_5 SIZ_{it} + \beta_6 BOS_{it} + \beta_7 GEN_{it} + \beta_8 ESG_{it} + \alpha_i + \lambda_t + \varepsilon_{it}$$

CCD is the Climate Change Disclosure score. ENC is the Environment certificate index; DUA is the CEO duality structure; SIZ is Firm size; BOS is Board size; GEN is the Proportion of female directors on the board; ESG is the economic, social and governance score, β_0 is the intercept, $\beta_1 - \beta_6$ and ε_{it} is an error term. Note that the CCD score has data readily computed on Refinitiv to be extracted.

Table 1. Definition of variables for objective two

Variable type	Variable name	Variable code

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Dependent variable	Climate Change disclosure	CCD
Independent variable	Environment certificate index	ENC
Independent variable	CEO duality structure	DUA
Independent variable	Firm size	SIZ
Independent variable	Board size	BOZ
Independent variable	Proportion of female directors on the board	GEN
Independent Variable	Economic, social and governance	ESG

For this study, static panel data analysis, specifically, the pooled, fixed effect (FE) and random effect (RE) models will be estimated. FE resolves the problem of increased-level variance of heterogeneity bias and only estimates the within impact, which makes it simple and persuasive (Allison, 2009). Similarly, RE models are accompanied by random coefficients, cross-level relations and complex variance functions that make them promptly extendible. According to Schurer and Yong (2012), the FE model is referred to as the gold standard default mode, while RE is the multi-level model.

The estimate of the RE model, which is also known as the feasible generalized least squares, is stated below.

RE is written as:

$$Q_{it} = \partial + \pi R'_{it} + \delta p'_i + \sigma_{it}$$

$\sigma_{it} = (c_i + \varepsilon_{it})$ because RE assumes that c_i and ε_{it} are normally distributed.

$$\text{Unambiguously, RE} = \begin{pmatrix} \hat{\partial} RE \\ \hat{\pi} RE \\ \hat{\delta} RE \end{pmatrix} = (Y' \, \hat{\cap}_{\sigma}^{-1} \; Y)^{-1} Y' \, \hat{\cap}_{\sigma}^{-1} \, Q$$

$Y = [\partial_{WM} \; R \; P]$ *and* ∂_{WM} *is* $WM \; X \; 1$ vector of ones. The error covariance matrix

$$\cap_{\sigma} = V[(\sigma | R, P)] = \begin{pmatrix} \cap_{\sigma,1} & 0 & 0 \\ 0 & \cap_{\sigma,i} & 0 \\ 0 & 0 & \cap_{\sigma,N} \end{pmatrix}_{WM \; X \; WM}$$

with a typical element:

$$\cap_{\sigma,i} = V[(\sigma_i | R_i, P_i)] = \begin{pmatrix} \emptyset_{\sigma}^2 & \emptyset_{c}^2 & \emptyset_{c}^2 \\ \emptyset_{c}^2 & \emptyset_{\sigma}^2 & \emptyset_{c}^2 \\ \emptyset_{c}^2 & \emptyset_{c}^2 & \emptyset_{\sigma}^2 \end{pmatrix}_{M \; X \; M}$$

Where $\emptyset_{\sigma}^2 = \emptyset_{c}^2 + \emptyset_{\varepsilon}^2$

$$\hat{\emptyset}_{\sigma}^2 = \frac{1}{W} \sum_{M=1}^{M} \sum_{i=1}^{W} \hat{\sigma}_{it}^2 \, , \hat{\emptyset}_{c}^2 = \hat{\emptyset}_{\sigma}^2 - \hat{\emptyset}_{\varepsilon}^2$$

Then, $\hat{\emptyset}_{\varepsilon}^2 = \frac{1}{WM-W} \sum_{t=1}^{M} \sum_{i=1}^{W} \left(\hat{\sigma}_{it} - \overline{\hat{\sigma}}_i \right)^2$

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$$\hat{\sigma}_{it} = Q_{it} - \gamma_{POLS} - R'_{it}\hat{\pi}_{POLS} - P'_{it}\hat{\delta}_{POLS} \; and \; \overline{\hat{\sigma}}_i = 1/M \sum_{t=1}^{M} \hat{\sigma}_{it}$$

$\widehat{\emptyset}_{\varepsilon}^2$ denotes the model's degree of freedom adjustment which is asymptotically crucial when $W \to \infty$.

To specify the fixed effect model:

$$Q_{it} = \gamma + \pi R'_{it} + \delta P'_i + c_i + \varepsilon_{it}$$

The within model is stated as:

$$\ddot{Q}_{it} = \pi \ddot{R}'_{it} + \ddot{\varepsilon}_{it}$$

Where the $\ddot{Q}_{it} = Q_{it} - \bar{Q}_i \ddot{R}_{itl} = R_{itl} - \bar{R}_{il} \; \ddot{\varepsilon}_{it} = \varepsilon_{it} - \bar{\varepsilon}_i$

The individual-specific effect is c_i, the intercept is γ and the vector of the time-invariant independent variable is P'_i.

The fixed effects or the within estimator of the slope coefficient π is;

$$\hat{\pi}_{FE} = \left(\ddot{R}' \, \ddot{R}\right)^{-1} \ddot{R}' \ddot{Q}$$

To conduct the robustness tests, both the Wu-Hausman test and the cross-sectional dependence test will be conducted.

Firstly, The Hausman test is used to select the best estimate from the FE and RE. This is with the assumption that RE is preferred under the null hypothesis due to increased efficiency, while under the alternative hypothesis, FE is at least as consistent and thus a preferred estimate.

Table 2. The Hausman test

	Alternative hypothesis is affirmed	**Null Hypothesis is affirmed**
FE estimator ($\beth_0$)	Consistent	Consistent Inefficient
RE estimator ($\beth_1$)	Inconsistent	Consistent Efficient

$$\boldsymbol{H = (\beth_1 - \beth_0)'\left(Var(\beth_0) - Var(\beth_1)\right)^{+}(\beth_1 - \beth_0)}$$

Vividly, the hypotheses are stated below:

H_0: The estimates are both consistent but RE estimates are efficient.

H_0: RE estimates are inconsistent while FE estimates are consistent.

The + in the equation above signifies the Moore–Penrose pseudoinverse.

$$H \sim \chi_d^2$$
$$d = \omega\left[Var\left(\hat{\beth}_0\right) - Var\left(\hat{\beth}_1\right)\right]$$

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ω is the rank of a matrix which has asymptotically the chi-squared distribution with the number of degrees of freedom correspondent to the rank of a matrix $Var(ב_0) - Var(ב_1)$ underneath the null hypothesis. A consistent estimate denotes coefficients of a model knitting to their true parameter values with a rise in sample size and efficient estimates denote that coefficients have the least variance as compared to other estimators' coefficients. This further denotes that the difference between projected and true values is minimal in the case of efficient estimates when compared with other estimates.

The coefficients of the RE model and FE model are consistent under the specified null hypothesis. Nevertheless, only the RE model coefficients are efficient if the critical chi-square value is less than the calculated value and the null hypothesis is rejected. It is then concluded that there is a consistent FE estimate. Conversely, based on the same situation, RE estimates are deemed inconsistent, the FE model is reliable, preferred and should be used. If the critical chi-square value is higher than the calculated value, the null hypothesis should be accepted. Then, it can be concluded that both FE and RE are consistent but RE estimates are efficient and more reliable.

Secondly, the cross-sectional dependence (CSD) test will be conducted using the Lagrange multiplier (LM) test by Breusch and Pagan (1980).

$$LM = M \sum_{i=1}^{W-1} \sum_{j=i+1}^{W} \varphi_{ij}^2$$

$\varphi_{ij}$the Pearson correlation coefficient between the estimated residuals from the Augmented Dickey-Fuller regressions of panel members i and j. There is a chi-square of W(W-1)/2 in the LM estimation with the hypotheses stated below.

H_0: There is an existence of cross-sectional dependence.

H_1: There is a non-existence of cross-sectional dependence.

CSD has asymptotically, a regular distribution under the null hypothesis that no cross-sectional dependence exists, having the test estimate written as:

$$CSD = \sqrt{\frac{2M}{W(W-1)}\left(\sum_{i=1}^{W-1} \sum_{j=i+1}^{W} \varphi_{ij}^2\right)}$$

The other robustness tests that will be conducted are the redundancy test for variables, the Residual tests and multi-collinearity tests. Multi-collinearity happens when the independent variables are extremely correlated with each other. Highly collated variables can disturb the interpretation and stability of regression coefficients. Therefore, the variance inflation factor (VIF) diagnostic test will be carried out. Outlier Analysis - outliers can hugely impact regression results. Visual inspection of scatterplots or boxplots, leverage plots, or studentized residuals can assist in identifying influential observations.

As a result, the study will use Cook's distance technique. Normality of Residuals - it is on the assumption of linear regression that the remainders follow a normal distribution. Normality will be assessed by conducting the Kolmogorov-Smirnov test. A heteroscedastic test will be made to confirm if there is a variance of unequal residual over multiple variables being measured. Berenguer-Rico and Wilms (2021) highlight that heteroscedasticity refers to occurrences where the variability is unequal across a series of values in the predictor variable.

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RESULT AND DISCUSSION

Establish the connection between the International Financial Reporting Standard (IFRS) disclosures and climate change factors and develop a climate accounting disclosures index to enhance the financial reporting sustainability of JSE-listed manufacturing companies in South Africa.

Descriptive analysis of Results.

Table 3. Descriptive analysis of Results

	CCD	ENC	DUA	SIZ	BOS	GEN	ESG
Mean	0.9284	7.2220	0.4106	7.7457	47.9850	0.9038	0.0743
Median	0.6920	6.2850	0.3300	8.0350	47.0000	0.6810	0.2685
Maximum	8.3333	316.670	0.9990	11.7246	84.0000	10.5751	21.4826
Minimum	0.0155	-158.650	0.1000	0.6171	0.0000	0.0000	-303.5475
Std. Dev.	0.9213	19.1086	0.2924	1.8280	13.0983	0.9471	7.9745
Skewness	4.9165	2.5684	0.5186	-0.8622	-0.1913	5.1851	-37.4222
Kurtosis	32.0253	71.7228	1.8150	3.7526	3.1597	35.3250	1425.682
Jarque-Bera	57758.54	292077.1	152.5320	217.7227	10.5726	70875.69	1.25E+08
Probability	0.0000	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000
Sum	1370.447	10659.78	606.1266	11432.79	70825.94	1334.128	109.7314
Sum Sq. Dev.	1252.114	538581.0	126.1313	4928.901	253059.2	1323.218	93801.31
Observations	1476	1476	1476	1476	1476	1476	1476

Source: Researcher's Computation, 2025

In Table 3, the descriptive analysis of results for the variables under consideration in this study is presented. The variables are hash climatic conditions captured by Climate Change Disclosure score (CCD) and factors influencing financial performance of manufacturing businesses captured by environmental certificate index (ENC), CEO duality structure (DUA), firm size (SIZ), board size (BOS), proportion of female directors on the board (GEN) and economic, social and governance (ESG). The mean of the performance variables, such as CCD, for the period under consideration is 0.9284. These ranged from 0.0155 to 8.3333, respectively. The mean of the factors influencing the financial performance of manufacturing businesses such as ENC, DUA, SIZ, BOS, GEN and ESG are 7.2220, 0.4106, 7.7457, 47.9850, 0.9038 and 0.0743, respectively. The range of values for these aforementioned factors are between -158.650 to 316.670, 0.1000 to 0.9990, 0.6171 to 11.7246, 0.0000 to 10.5751 and -303.5475 to 21.4826, respectively. The rate at which CCD, ENC, DUA, SIZ, BOS, GEN and ESG deviated from their respective mean values is revealed to be 0.9213, 19.1086, 0.2924, 1.8280, 13.0983, 0.9471 and 7.9745, respectively. Thus, it can be emphasized that ENC has the highest rate of deviation from its respective mean, followed by GEN. However, DUA is found with the smallest deviation from its mean.

In Table 3, the skewness result revealed that CCD, ENC, DUA, and GEN are positive with skewness coefficients of 4.9165, 2.5684, 0.5186, and 5.1851, respectively. Thus, the variables are skewed to the right of their various means. The results also showed that SIZ, BOS, and ESG are negatively skewed with skewness coefficients of -0.8622, -0.1913, and -37.4222, showing skewness to the left of the mean. The kurtosis results revealed that CCD, ENC, SIZ, BOS, GEN, and ESG are leptokurtic with a kurtosis coefficient index greater than 3. While the kurtosis of DUA is observed to be platykurtic, with a kurtosis coefficient index of less than 3. The Jarque-Bera values with the associated p-value < 0.05 indicated that the climatic change disclosure and the factors influencing

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the financial performance of manufacturing businesses under consideration that including CCD, ENC, DUA, SIZ, BOS, GEN, and ESG, are from normally distributed population datasets.

Correlation analysis of results.

Table 4. Correlation Analysis Results

	CCD	ENC	DUA	SIZ	BOS	GEN	ESG
CCD	1.0000	0.0906	0.0191	-0.0069	-0.0581	0.0317	-0.0182
ENC	0.0906	1.0000	-0.0238	0.0080	-0.0679	-0.0199	0.0059
DUA	0.0191	-0.0238	1.0000	0.2283	0.0417	0.0199	-0.0330
SIZ	-0.0069	0.0080	0.2283	1.0000	0.0182	0.0289	-0.0054
BOS	-0.0581	-0.0679	0.0417	0.0182	1.0000	0.1147	-0.0201
GEN	0.0317	-0.0199	0.0199	0.0289	0.1147	1.0000	-0.0117
ESG	-0.0182	0.0059	-0.0330	-0.0054	-0.0201	-0.0117	1.0000

Source: Researcher's Computation, 2025.

In Table 4, the correlation coefficients result showing the degree of relationship among the explanatory variables under consideration in this study, including CCD, ENC, DUA, SIZ, BOS, GEN and ESG are presented. From Table 8, it is revealed that CCD positively correlated with ENC, DUA and GEN with the correlation coefficient of 0.0906, 0.0191 and 0.0317, respectively. It is also revealed that CCD has a negative correlation with SIZ, BOS and ESG, with correlation coefficient values of -0.0069, -0.0581 and -0.0182, respectively. Also, it is found that ENC is positively correlated with SIZ and ESG, with the correlation coefficient of 0.0080 and 0.0059, respectively. It was further revealed that ENC has a negative correlation with DUA, BOS and GEN with correlation coefficient values of -0.0238, -0.0679 and -0.0199, respectively. In Table 8, it was found that DUA is positively correlated with SIZ, BOS and GEN with correlation coefficients of 0.2283, 0.0417 and 0.0199, but negatively correlated with the ESG with a correlation coefficient value of -0.0330. Furthermore, it was also found that SIZ is positively correlated with BOS and GEN with correlation coefficients of 0.0182 and 0.0289, but negatively correlated with the ESG with a correlation coefficient value of -0.0054. The results show that BOS is positively correlated with GEN with a correlation coefficient of 0.1147 and negatively correlated with ESG with a correlation coefficient of -0.0201. However, it is found that the correlation between GEN and ESG was negative, with a correlation coefficient value of -0.0117. Thus, the low or weak correlation between the variables under study revealed the absence of a multicollinearity problem in establishing a linear and dynamic linear relationship among the variables and, as such, established the independence of the explanatory variables under investigation. As noted, the data set for this study is made up of variables consisting of cross-section and time series, and as such, a need to examine the stationarity among the variables. Hence, in Table 5, the stationarity test results are presented.

Stationary Test.

Table 5. Stationarity or Unit Root Test

	Levin, Lin & Chu t*		Im Pesaran and Shin W-Stat		ADF - Fisher Chi-Square		PP - Fisher Chi-Square	
Variables	**Statistic**	***p*-value**	**Statistic**	***p*-value**	**Statistic**	***p*-value**	**Statistic**	***p*-value**
CCD (0)	-31.9415	0.0000	-25.8461	0.0000	883.632	0.0000	1032.66	0.0000
ENC (0)	-24.2452	0.0000	-20.0094	0.0000	884.173	0.0000	912.787	0.0000
DUA (1)	-1747.84	0.0000	-3.8197	0.0000	19.7229	0.0000	20.1619	0.0000
SIZ (0)	-8.8679	0.0000	-8.53261	0.0000	355.187	0.0000	371.764	0.0000
BOS (0)	-27.2705	0.0000	-25.0201	0.0000	852.695	0.0000	1194.64	0.0000

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GEN (0)	-30.6862	0.0000	-26.8478	0.0000	902.876	0.0000	1113.75	0.0000
ESG (0)	-24.0972	0.0000	-20.5287	0.0000	996.991	0.0000	806.611	0.0000

Source: Source: Researcher's Computation, 2025

In Table 5, the results of the stationarity or the unit root test are presented to examine the short-run equilibrium relationship among the variables considered in this study. This test is carried out using Levin, Lin & Chu t* to test for the group unit root or stationarity, while Im, Pesaran and Shin W-Stat, ADF-Fisher Chi-Square and PP-Fisher Chi-Square are used to test for the individual variable's stationarity or unit root. From the results presented in Table 13, it is found that in absolute terms that CCD, ENC, SIZ, BOS, GEN and ESG across all the group of 82 cross section with Levin, Lin & Chu t* statistics of 31.9415 (p-value < 0.05), 24.2452 (p-value < 0.05), 8.8679 (p-value < 0.05), 27.2705 (p-value < 0.05), 30.6862 (p-value < 0.05) and 24.0972 (p-value < 0.05) respectively reveal that the factors influencing financial performance of manufacturing businesses and climatic change disclosure under consideration are stationary at level except DUA across all the group of 82 cross section with Levin, Lin & Chu t* statistics of 1747.84 (p-value < 0.05) which is stationary at first difference

However, for the individual cross-section, the ADF-Fisher Chi-Square and PP-Fisher Chi-Square Statistic are used to test for the unit root of the factors influencing the financial performance of manufacturing businesses and climate change disclosure under consideration. Thus, from Table 13, CCD, ENC, DUA, SIZ, BOS, GEN and ESG with the value 883.632 (p-value < 0.05), 884.173 (p-value < 0.05), 19.7229 (p-value < 0.05), 355.187 (p-value < 0.05), 852.695 (p-value < 0.05), 902.876 (p-value < 0.05) and 996.991 (p-value < 0.05) for ADF-Fisher Chi-Square and 1032.66 (p-value < 0.05), 912.787 (p-value < 0.05), 20.1619 (p-value < 0.05), 371.764 (p-value < 0.05), 1194.64 (p-value < 0.05), 1113.75 (p-value < 0.05) and 806.611 (p-value < 0.05) respectively for PP-Fisher Chi-Square Statistic. This shows that the factors influencing the financial performance of manufacturing businesses and climate change disclosure under consideration are stationary. Evidently, it can be stressed that all the factors influencing the financial performance of manufacturing businesses and climate change disclosure under consideration are stationary and, as such, establish the short-run stability or equilibrium relationship among the variables. Based on this result, the long-run stability or equilibrium relationship among the variables is examined, and the results are presented in Table 6.

Pedroni and Kao Residual cointegration test.

Table 6. Panel Cointegration Test (Pedroni and Kao Residual Cointegration Test)

Cointegration		
Pedroni Residual Test	**CCD, ENC, DUA, SIZ, BOS, GEN and ESG**	
	Statistic	***p*-value**
Panel v-Statistic	-9.2926	1.0000
Panel rho-Statistic	6.3344	1.0000
Panel PP-Statistic	-16.4721	0.0000
Panel ADF-Statistic	-13.1085	0.0000
Group rho-Statistic	9.5467	1.0000
Group PP-Statistic	-25.8931	0.0000
Group ADF-Statistic	-15.2703	0.0000
Kao Residual Test		
ADF	-4.4995	0.0000
Residual variance	1.6170	
HAC variance	0.3337	

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Null Hypothesis: No cointegration and Trend assumption: No deterministic trend
Source: Researcher's Computation, 2025

In Table 6, the test for cointegration using the Pedroni and Kao residual test is presented. The test is carried out using the Group PP-Statistic, Group ADF-Statistic for the Pedroni residual test, and ADF for the Kao residual test. In the results presented in Table 10, it is found in absolute term that, Group PP-Statistic value of 25.8931 (p-value < 0.05) and Group ADF-Statistic value of 15.2703 (p-value < 0.05) from the Pedroni residual test reveals the existence of cointegration among the factors influencing financial performance of manufacturing businesses (ENC, DUA, SIZ, BOS, GEN and ESG) and climatic change disclosure (CCD) for each of the firms under consideration. Also, the Kao residual test with ADF Statistic value of 4.4995 with associated (p-value < 0.05) further reveals cointegration among the factors influencing financial performance of manufacturing businesses (ENC, DUA, SIZ, BOS, GEN and ESG) and climatic change disclosure (CCD) use for fitting the models for this study. Thus, it can be posited based on this that there is a long-run equilibrium relationship and stability among the variables for the fitted models under investigation. Hence, it can be emphasized based on this result the appropriateness of modelling and estimating the relationship between the factors influencing financial performance of manufacturing businesses (ENC, DUA, SIZ, BOS, GEN and ESG) and climatic change disclosure (CCD) under consideration with reliable and robust statistical method such as panel least square method comprises of pooled, fixed and random effect models moment. The results are presented in Table 7.

Panel least squares method.

Table 7. Panel Least Squares Method (CCD, ENC, DUA, SIZ, BOS, GEN and ESG)

	Pooled Effect Panel Model		Fixed Effect Panel Model		Random Effect Panel Model	
Variable	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**
C	1.0790	0.0000	1.1020	0.0000	1.0727	0.0000
ENC	0.0042	0.0007	0.0031	0.0207	0.0041	0.0008
DUA	0.0799	0.3413	-0.1964	0.6113	0.0781	0.3686
SIZ	-0.0069	0.6072	-0.0019	0.9099	-0.0065	0.6303
BOS	-0.0040	0.0270	-0.0021	0.2690	-0.0039	0.0321
GEN	0.0387	0.1275	0.0004	0.9849	0.0355	0.1584
ESG	-0.0021	0.4702	-0.0010	0.7356	-0.0020	0.4860
R-squared	0.0135		0.0874		0.0126	
Adjusted R-squared	0.0095		0.0302		0.0085	
F-statistic	3.3678	0.0026	1.5281	0.0016	3.1293	0.0047
					S.D.	Rho
Cross-section random					0.0679	0.0056
Idiosyncratic random					0.9073	0.9944

Source: Researcher's Computation, 2025

Table 7 shows the results of the pooled, fixed and random effect panel least square method for examining climatic change disclosure (CCD) in relation with the factors influencing financial performance of manufacturing businesses (ENC, DUA, SIZ, BOS, GEN and ESG). Thus, in the results presented in Table 6, it is found that a linear relationship exists between CCD, ENC, DUA, SIZ, BOS, GEN and ESG. Specifically, the results of the three panel least square models show that ENC, DUA, SIZ, BOS, GEN and ESG are positively and negatively related with the CCD for the selected manufacturing businesses under consideration. As revealed in Table 6 by the pooled and random

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effect panel least square, ENC, DUA and GEN are positively related with CCD of the selected manufacturing businesses, while SIZ, BOS and ESG are negatively related with the CCD of the selected manufacturing businesses for this study. However, the fixed effect panel least square model reveals that ENC and GEN of the selected manufacturing businesses are positively related with the CCD while DUA, SIZ, BOS and ESG of the selected manufacturing businesses are negatively related to the CCD under study.

Specifically, the results of the pooled effect panel model show that ENC, DUA and GEN contribute to the improvement in CCD are to the turn of 0.42%, 7.99% and 3.87% respectively, while SIZ, BOS and ESG hamper the CCD by 0.69%, 0.39% and 0.21% respectively. From the fixed effect panel least square model, the results show that ENC and GEN contribution to the improvement in CCD are to the turn of 0.31% and 0.04% respectively, while DUA, SIZ, BOS and ESG hindered the CCD to the turn of 19.64%, 0.19%, 0.21% and 0.10% respectively. The random effect panel least square model results show that ENC, DUA and GEN contribute to the improvement in CCD is to the turn of 0.41%, 7.81% and 3.55% respectively, while SIZ, BOS and ESG hamper the CCD by 0.65%, 0.39% and 0.20% respectively.

The probability values with ($P < 0.05$) show the statistical significance of the factors influencing the financial performance of manufacturing businesses in assessing the CCD considered for this study. Also, the probability of the F- statistics ($p < 0.05$) indicated the statistical significance of the fitted panel least square model, and therefore valid, reliable and appropriate for assessing the contributions of the factors influencing the financial performance of manufacturing businesses (ENC, DUA, SIZ, BOS, GEN and ESG) to the climatic change disclosure (CCD) considered for this study. The idiosyncratic random error term with a rho value of 0.9944 reveals a strong correlation between the individually selected manufacturing businesses and the cross-sectional error term. Thus, to further evaluate the reliability, appropriateness and the most efficient panel least square model between the fixed and random effect model for this study, the post-estimation tests, such as the Hausman test and residual cross-sectional dependency test, are carried out, and the results are presented in Table 8 and Table 9 respectively.

Hausman test.

Table 8. Correlated Random Effects - Hausman Test

Test cross-section random effects				
Test Summary		Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random		27.3566	6	0.0001
Cross-section random effects test comparisons:				
Variable	Fixed	Random	Var (Diff.)	Prob.
ENC	0.0031	0.0041	0.0000	0.0548
DUA	-0.1964	0.0781	0.1418	0.4660
SIZ	-0.0019	-0.0065	0.0001	0.6688
BOS	-0.0021	-0.0039	0.0000	0.0005
GEN	0.0004	0.0355	0.0000	0.0000
ESG	-0.0010	-0.0020	0.0000	0.1332

Source: Researchers' Computation, 2025

Table 8 shows the result of the Hausman Test for the cross-section random effect. The chi-square value 27.3566 > 12.592 and the probability value of 0.0001 < 0.05 revealed that the random effect model cannot be rejected in examining the factors influencing the financial performance of manufacturing businesses (ENC, DUA, SIZ, BOS, GEN and ESG) on the climatic change disclosure

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(CCD) considered for this study. Thus, a random effect panel least squares model is preferred and better than the fitted fixed effect panel least squares model. This makes the random effect model more appropriate and reliable in assessing the factors influencing the financial performance of manufacturing businesses (ENC, DUA, SIZ, BOS, GEN and ESG) on the climate change disclosure (CCD) considered for this study. This also implied that the random effect panel least squares model is the most consistent, sufficient and efficient model, and hence, the need to carry out a residual cross-sectional dependence test for further examination of the fitted panel models. The results are presented in Table 9.

Residual cross-section dependence test.

Table 9. Residual Cross-Section Dependence Test for the Fitted Panel Models

Null hypothesis: No cross-section dependence (correlation) in weighted residual
Periods included: 18
Cross-sections included: 82

	Pooled Effect Model		Fixed effect Model		Random effect Model	
Test	Statistic	Prob	Statistic	Prob	Statistic	Prob
Breusch-Pagan LM	3524.30	0.0071	3542.29	0.0038	3525.20	0.0069
Pesaran scaled LM	1.4883	0.1367	1.7091	0.0874	1.4994	0.1338
Pesaran CD	0.0956	0.9238	-0.0639	0.9490	0.0881	0.9297

Source: Researchers' Computation, 2025

In Table 9, the results show the residual cross-section dependence test, which is done using Breusch-Pagan LM, Pesaran scale LM test and Pesaran CD. Thus, the Breusch-Pagan LM value of 3524.30 ($p < 0.05$) and 3542.29 ($p < 0.05$) and 3525.20 ($p < 0.05$) for the pooled, fixed and random effect panel models, respectively, show the rejection of no cross-section dependence. While Pesaran scale LM value of 1.4883 ($p > 0.05$), 1.7091 ($p > 0.05$) and 1.4994 ($p > 0.05$) for the pooled, fixed and random effect panel model respectively show that the no cross-section dependence that cannot be rejected. Also, Pesaran CD values of 0.0956 ($p > 0.05$), -0.0639 ($p > 0.05$) and 0.0881 ($p > 0.05$) for the pooled, fixed and random effect panel models respectively show that the no cross-section dependence cannot be rejected. Hence, based on and Pesaran scale LM and Pesaran CD tests, it can be stressed that there is no cross-section dependence among the factors influencing the financial performance of manufacturing businesses in determining the climate change disclosure considered for this study.

Implication of findings. The accounting standard setters are organizations responsible for developing and issuing accounting standards that govern financial reporting (Botosan et al., 2025). These bodies establish guidelines to ensure transparency, consistency, and comparability in financial statements across industries and jurisdictions. The common standard setters include: International Accounting Standards Board (IASB), International Public Sector Accounting Standards Board (IPSASB), Financial Accounting Standards Board (FASB), Financial Reporting Council (FRC) and European Financial Reporting Advisory Group (EFRAG). These bodies work to synchronise the accounting standards worldwide, ensuring accurate financial reporting for investors, regulators, and other stakeholders. The accounting standard setters can also use the findings of this study to recommend or formulate policies that would improve the transparency of financial reports in manufacturing companies in South Africa. Additionally, they could review and formulate relevant policies that impact companies' operational efficiency. Doing so may create more sustainable businesses that are environmentally cautious. According to Fiume et al. (2022) the standard setters are increasingly emphasizing climate-related financial disclosures as climate-related impacts vary

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depending on variety of factors. Therefore, non-disclosure of such information by manufacturing companies can have significant implications, including regulatory, financial, and reputational risks. Proactively adopting climate-related reporting standards can enhance transparency, attract investment, and ensure long-term business sustainability. Manufacturing companies that fail to adopt sustainable practices may face higher taxes, penalties, loss of incentives, and trade restrictions. However, aligning with sustainability frameworks not only reduces tax burdens but also enhances financial performance, regulatory compliance, and market competitiveness. Sustainability and ESG reporting help manufacturing companies comply with climate regulations, attract ESG investors, and avoid greenwashing risks. Consequently, standard setters shape financial and sustainability reporting, enforce tax compliance, and drive ESG transparency in manufacturing companies. So, aligning with these standards helps manufacturers enhance credibility, attract investors, and navigate global regulations effectively. On the other hand, investors are attracted by proper compliance from manufacturing companies which influences them in being part of corporate governance matters. That is why the policies made by standard setters have some criteria that is followed when reviewing the performance of investors that many clients benefit from. There is a significant governance challenge and financial constraint for some companies. However, such issues can be corrected by listing and privatizing these companies by government consideration. Consequently, these standards compel companies to adhere to the regulations and possibly promote transparency, compliance and corporate governance.

CONCLUSION

This research investigated IFRS disclosures and the dynamics of climate change in listed manufacturing companies in South Africa. The study used data collected from data sources of a certain period from the past. Data collected assisted in capturing the variables of the study's objective to determine the connection of the variables being tested. Several tests were made, guided by models which generated a report indicating whether a relationship exists among the constructs. This research is vital to policymakers in the manufacturing industry in South Africa. This is the first study in South Africa to integrate a disclosures index to examine how to enhance financial performance in the field of manufacturing. The study signalled that climate-related disclosures are associated with the manufacturing companies' sustainability and that non-disclosure negatively influences the company's financial performance. As a result, some manufacturing companies are relying on climate disclosures to sustain their financial performance since their reporting on their climate disclosure is scrutinized by stakeholders who have an interest in their company. Deciding to disclose on climate matters concerning your company may influence the kind of information you include in the financial reports. The study has found factors influencing climate change important to consider, not only when making business decisions but also when including climate-related matters in financial reports. Therefore, manufacturing companies should not overlook the critical information required for disclosure in their reporting, as this can be a reflection of deviating from disclosing material information to deceive or overstate financial statement items. From an analyst's point of view, few reports consist of matters pertaining to climate change by manufacturing companies. Instead, the majority of analyst reports are focused on business industries that have differential values considered to be material. Consequently, the findings of this study match the perspective of analysts prioritizing industries that are compliant in disclosing crucial climate-related data that can influence users of that information when making decisions. However, manufacturing companies are gradually becoming motivated to disclose their climate information. It may not have been compulsory to disclose in the past, but with the drastic changes in climate in recent years, it is

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a compelling need to be transparent on such information that could be a risk to the organisation or the investor. Manufacturing companies must be cautious with not disclosing their material climate-related risks and should not assume that their company will be included among complying companies when analysts are compiling climate change reports. The study seeks to establish ways that the study's variables could trigger issues of climate change non-disclosure so that implications can be drawn to inform policy to enhance the financial reporting sustainability.

Study's recommendations. Further research could be inspired by this study as the current study has some limitations. The models used for this study tested variables within the scope of this research. As a result, a wider scope could be looked into which will broaden the financial reporting sustainability subject matter. The research could pay attention to manufacturing companies or non-manufacturing companies outside South Africa. The disclosure index developed for this study could be used by manufacturing companies or non-manufacturing companies outside South Africa to measure their financial performance indicators. This will allow prospect researchers within the same focus area to make comparisons from their findings against this study. Secondly, since the study relied purely on statistical data, a different approach to the method used to collect and analyse data can be used. Moreover, the study investigated manufacturing companies listed on the JSE for a period of 17 years (2005 – 2022). Therefore, further study can assess the financial reporting after this period. Lastly, the results of the research study apply to listed manufacturing companies in South Africa, making the information ungeneralizable with other manufacturing companies besides South Africa. Every country has its own conservative guidelines; thus, the impact of climate change may vary from one region to the next. So, future research may consider replicating this study using the data from another stock exchange.

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