ASSESSING THE INTERCONNECTION OF SUSTAINABILITY FACTORS IN SOUTH AFRICAN COMPANY REPORTS

Kristen Tamryn Fourie

1607573

Supervisor: Dr Ute Schwaibold, Animal, Plant and Environmental Sciences (AP&ES)

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DECLARATION

I declare that this Dissertation is my own, unaided work. It is being submitted for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

Kristen Tamryn Fourie

Date: 09/09/2024

ABSTRACT

South African companies face increased pressure from stakeholders and investors regarding their environmental, social, and economic/business activities. Most companies are still approaching reporting on these factors in a tick-box manner, and a systems approach to reporting on these factors may aid in creating value for companies through risk management refinement. This study aimed to assess the level of interconnection in company reports between environmental, social, and economic/business factors compared to connections found in the literature. To achieve this, a mixed methods approach was used by conducting keyword searches and thematic content analyses to create interconnectedness maps of sustainability factors discussed in both peer-reviewed literature and company reports, with a key focus on environmental factors. Interviews with ESG analysts/sustainability managers were also conducted to determine where and why gaps between connections existed in company reports.

The literature review indicated that the most prevalent connections between environmental, social, and economic/business factors are linked to five key environmental factors. Strong connections existed for ‘climate change’, ‘water availability’, ‘land degradation’, ‘energy/natural resources’ and ‘biodiversity loss’. Within company reports these five key environmental factors were considered, however, with varying and lower strength of connections. From the interviews, it was found that gaps existing are data-driven challenges and the perception that connections are being made for most companies.

Companies are considering connections that are valuable for risk management, however, many critical connections are still lacking. Making use of a systems approach to reporting by connecting various factors can lead to better risk management and increased sustainability within a company’s value chain.

KEYWORDS: Sustainability, reporting, systems thinking interconnectedness, environment

DEDICATION

I would like to dedicate this thesis to my brother, Brendon James Fourie, who has shown his unwavering support throughout my academic journey. Always lending a word of wisdom or encouragement to motivate me to get through the hurdles I faced on this journey, and the ones leading up to this time.

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reports for the Basic Materials industry and 82 for the Consumer Services industry over the five years (2017 to 2021).

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LIST OF ACRONYMS

COP	Conference of the Parties
CRISA	Code for Responsible Investing in South Africa
CSI	Corporate Social Investment
ESE/B	Environmental, social, and economic/business
ESG	Environmental, social and governance
FCM	Fuzzy Cognitive Mapping
GRI	Global Reporting Initiative
GR	Governance Report
IFRS1	International Financial Reporting Standards
IIRC	International Integrated Reporting Council
IR	Integrated Reporting
<IR> Framework	Integrated Reporting Framework
IPCC	International Panel on Climate Change
ISSB	International Sustainability Standards Board
JSE	Johannesburg Stock Exchange
King IV	The most recent King report on Corporate Governance
MSCI	Morgan Stanley Capital International
NDP	National Development Plan
PRI	Principles for Responsible Investment
SDGs	Sustainable Development Goals
SR	Sustainability Reporting
TBL	Triple Bottom Line
UN	United Nations

WEF	World Economic Forum

Chapter 1: Introduction

An increased call for transparency and disclosure from companies is emerging with the growing concern for how businesses are impacting the natural environment and equally how environmental risks will impact businesses and their stakeholders (de Villiers & van Staden, 2010; Hossain & Masum, 2022). Due to this growing concern for the impacts that this environmental risk would have on investors and other stakeholders, as well as how the environment may be impacted by further anthropogenic disturbance, investors are seeking to be assured that their investments will be viable in the long-term, and they can hold companies accountable for their operations that may impact the environment and further worsen environmental risks (de Villiers & van Staden, 2010; Zahid *et al.,* 2019; Di Simone *et al.,* 2022). This concern has prompted investors and other stakeholders to put pressure on companies, especially those registered on stock exchanges, to increase their transparency and report on issues that are not only financial but also include environmental and social factors that were previously excluded from company reports (Flöstrand & Ström, 2006; Czerwińska & Kaźmierkiewicz, 2015; Doktoralina *et al.,* 2018; Raimo *et al.,* 2020).

Many studies have shown the importance of including reporting on these ESG factors as this increased transparency can improve a business' reputation by building trust between the business and its stakeholders which would allow for increased investment and ultimately the well-being of the company (Czerwińska & Kaźmierkiewicz, 2015). The company would also aim to improve its corporate sustainability and ultimately ensure the long-term performance of the business by reducing risks that might arise due to the environmental or social impacts of a corporation, thereby further reducing any negative impacts for investors and stakeholders, and ultimately the business and its capital down the line (Czerwińska & Kaźmierkiewicz, 2015; Raimo *et al.,* 2020).

Reporting on non-financial factors has over time become mandatory in many countries but not yet to the same extent as financial reporting (Daske *et al.,* 2008; Stainbank, 2018; SteeleSchober, 2021; SAICA). Pressure for non-financial reporting to be provided due to growing stakeholder demands is increasing, with many countries around the world already introducing legislation and regulations that require mandatory disclosure of these non-financial data, especially on biodiversity and climate change risks (Camilleri, 2015). Sustainability reporting has become a crucial element of sustainability for a business. This reporting has enhanced the approach to risk management by ensuring that companies can

track risks related to sustainability and through this reporting enhance risk management systems within the company (Bischof *et al.,* 2022).

In South Africa there is growing demand for disclosures on environmental and social factors, with South Africa being one of the few developing countries, and the second country besides the United Kingdom, to include regulations that encourage the inclusion of reporting on these non-financial factors (Viviers & Els, 2017). In the past, where non-financial aspects of reporting have been considered, they were addressed as 'ticking-the-box', or as a 'copy and paste' procedure, whereby companies were addressing key sustainability issues but not delving into the complexity of these matters, and how they may be impacting these factors or be impacted by these factors (Liu *et al.,* 2019). Whilst several issues of sustainability reporting have been researched in literature, many issues have not yet been considered adequately. One such issue is the complexity of non-financial factors and ensuring that these factors and how this complexity should be addressed (Singhania & Saini, 2022).

Complex wicked challenges are material matters that are seen to have no definitive solution and as such cannot be solved or addressed in isolation, for example, poverty and healthcare (Head, 2022). According to Rittel and Webber, wicked challenges have defining characteristics that further iterate their complex nature, these characteristics are there is no set formulation, there is also no indication when these issues have been solved as there is also no real solve for these issues, as the solutions generally either work well or don't work well (Vermaas & Pesch, 2020). Therefore, industries, governments, and organisations must address these challenges in a way that factors in multiple role players and multiple risks. A systems approach could be considered to contribute to solving these complex wicked challenges, as this would ensure approaching the issue from a systems lens which would have contextualised the issue for those attempting to solve them (Williams & van 't Hof, 2014).

1.1 Aim and Objectives

Sustainability includes many factors which are known to be complex wicked challenges and solving them would require an approach that accounts for the systemic bout of issues that would too be affected by impacting any of the other sustainability factors (Reinecke & Ansari, 2016; Munro, 2020). In this study, the aim was to assess the level of systems thinking that is currently seen in company reports from various South African sectors as, currently, the

best approach to solving complex wicked challenges is to ensure a systems approach that will address the complexity of the issues more effectively than a linear approach which may not effectively interrogate the issues at hand (Zellner & Campbell, 2015; Probst & Bassi, 2017).

The study focused on five key environmental factors based on the World Economic Forum's (WEF) priorities and based on the most prevalent environmental issues currently being seen in South Africa. These key environmental issues are climate change, water availability, biodiversity loss, energy/resource depletion, and land degradation (Davids *et al.,* 2022; Ruwanza *et al.,* 2022; WEF, 2022). These environmental factors are leading risks according to the WEF, and accordingly are seen to have significant impacts on not only society but also on the economic development of countries. They are also complex wicked challenges that cannot be solved in isolation (Akadiri & Adebayo, 2022; Jahanger *et al.,* 2022; WEF, 2022).

To investigate this, my objectives were:

- to use literature to create a systems map that will show the actual interconnectedness of environmental, social, and economic factors linked to five key environmental concerns;
- to examine company reports and create a systems map to determine interconnectedness between the five key environmental issues and other environmental, social, and economic factors and to compare it to the systems map of actual interconnectedness;
- to assess and assign a score to the level of systems thinking seen from each map; and
- to understand, through interviews with topic experts, how sustainability reporting is currently executed and to determine where potential gaps may exist in the current approach.

1.2 Layout of this dissertation

In Chapter 1 of this dissertation the introduction, as well as aims and objectives are laid out. In Chapter 2 a full literature review is provided. Chapter 3 lays out the methods for the way this study was conducted. The results and findings of the study are detailed in Chapter 4. Lastly, Chapter 5 presents the discussion and conclusions of the study.

Chapter 2: Literature Review

The rapid expansion of economies since the industrial revolution has led to increased resource depletion as well as significant environmental and social impacts on countries and organisations around the world (Basiago, 1999; Ekonomou & Halkos, 2023). These nonfinancial impacts pose risks that have only recently been understood and acknowledged, as their implications have become evident and critical to businesses and their stakeholders (Fijalkowska & Hadro, 2022). The evidence of the implications of these risks has become clear based on several conferences wherein the focus on the environment and people has been paramount, such as the Earth Summit of 1992 (Setti & Azeiteiro, 2019). With increasing environmental risks focus on incorporating these risks into risk management processes within countries and organisations is growing in relevance to stakeholders and for the contribution towards sustainable development (Acheampong & Opoku, 2023; Wang & Su, 2023). Environmental, social, and economic/business factors thus have become very important in company reporting, not only for stakeholders and investors but also for companies. Looking into the history of sustainable development gives us insight into how reporting on nonfinancial factors has become relevant and critical to a company's reputation amongst investors and other stakeholders.

In chapter 2, section 2.1 looks at the concept of sustainable development in a brief analysis of the origin and where the concept is today. Section 2.2 looks at the various sustainability models over a period, and up until 2024 when this study was completed. Section 2.3 gives an overview of the current and past sustainability reporting landscapes. Lastly, section 2.4 of this chapter gives an overview of current systems thinking in sustainability reporting, and the possible future trajectory of this concept.

2.1 The sustainable development concept

Sustainable development is a concept that was introduced in the late 20th century and since the late 90s has grown in relevance. Due to the increasing risk of climate-related impacts and other anthropogenic impacts on the environment and businesses, sustainable development has become an integral aspect of organisations (du Pisani, 2006; Lozano, 2008; Mensah, 2019). Sustainable development has been defined in a multitude of ways, however, it was first formalised and defined by the Brundtland Commission Report *Our Common Future* in 1987 as: "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Brundtland (WCED), 1987; Keeble, 1988), with an end goal of reaching a state of sustainability, wherein

this definition can be put into practice. The Brundtland Commission Report was drafted with three spheres of sustainability in mind and aimed to show the connections that exist between the environment, society, and economy, as well as the need for a new approach to ensure sustainable development, the resulting development from sustainability practices, going forward in all manner of human development (Spangenberg *et al.*, 2002).

Although the concept of sustainable development was only formally defined in the late 1980s, this concept has existed since the early 18th century. Philosophers, economists, and environmentalists alike have all contributed to the literature regarding the preservation of our natural resources, the relationship humans have with the natural environment and how we can ensure this relationship continues to be mutually beneficial to both humans and nature and ultimately becomes sustainable (Du Pisani, 2006). Du Pisani (2006) delved deeply into the history of sustainable development, indicating that since the late 18th and early 19th century, the realisation that natural resources would not last forever and that humans would be adversely impacted by the sudden depletion of these resources was becoming evident (Du Pisani, 2006). This literature conveyed the deep-rooted relationship between society, the environment, and the economy, showing the complex interconnected relationship between these factors, with a strong focus on how the environment plays a pivotal role in this relationship (2006). These links were highlighted in a later report, the *Limits to Growth,* in 1972, wherein scientists and economists noted the limits that economic growth would face in the case of depleted natural resources, and the further implications that the depletion of this resource would have on society (Meadows *et al.,* 1972; Du Pisani, 2006; Srivastava, 2012).

Many global conferences addressing various environmental issues have been held since sustainable development was defined in 1987 (Linnér & Selin, 2013). These conferences further highlighted the complex interconnected relationships between the environment, society, and the economy. One such conference was the 1992 Earth Summit held in Rio de Janeiro Brazil, which led to the publishing of Agenda 21 (Sitarz, 1993). Agenda 21 was drafted to lay out a plan of action that would allow for positive steps to be taken against the growing ecological crisis that had been identified in the early 1970s (Sitarz, 1993; Lindner, 1997). The Earth Summit led to many countries agreeing to and ratifying Agenda 21 to ensure that the steps and action plan outlined in this document would be adopted and followed to the best of these countries' abilities (Dodds, 2019). South Africa itself became a signatory of Agenda 21 in 1994, with the city of Durban taking this action plan on board to

ensure stakeholder action towards sustainable development (Roberts & Diederichs, 2002). Agenda 21 set out to ensure better care for many different aspects of the environment such as the protection and promotion of biodiversity. Agenda 21 also embodied the increased involvement of multiple stakeholders in decision-making processes surrounding sustainable development and related environmental issues (Roberts & Diederichs, 2002; Dodds, 2019). This document introduced an approach that had never been taken before, one that considered multiple stakeholders, further highlighting the interconnections that exist between not only industries, corporations, and government, but also the interconnection that existed between the environment, society, and economy. This indicted how the challenge of sustainable development would be one of far-reaching magnitude with multiple issues that would impact almost all spheres of these three dimensions (Lee & Suh, 2022; Ye *et al.,* 2022). However, even with considerable action that has already been taken since Agenda 21 was published, financial issues are still considered to be the leading matters that receive greater attention when paralleled with environmental and societal issues (Ditlev-Simonsen, 2021). Agenda 21, with its policies regarding the environment, should not be considered a final solution, but rather a first step to reducing environmental damage and encouraging greater attention to non-financial issues in reporting on risks (Harris & Udagawa, 2004; Noor, 2022).

During the early 21st century, more conferences were held to address the state of the environment, including the 2002 World Summit on Sustainable Development held in Johannesburg, the United Nations Climate Change Conference in 2009, the United Nations Conference on Sustainable Development in 2012, the 7th Digital Earth Summit in 2018 and the Santiago Climate Change Conference in 2019 (United Nations, 2022).

These conferences all re-emphasised the understanding that environmental, social, and economic/business factors were more interconnected than previously recognised, that action must be taken to ensure that sustainability can be achieved and that these factors must be regarded in conjunction and not in isolation by use of a systems approach or transdisciplinary approach to reporting on these risks (Lebădă & Chasek, 2021). Transdisciplinarity is an approach to solving complex socio-ecological issues which comprises of involving multiple stakeholders across a broad range of disciplines, ranging from academia to outside of academia (Ibarra *et al.,* 2023).

The United Nations Sustainable Development Goals (SDGs) published in 2015 show the continued effort to include multiple stakeholders in the focus to achieve sustainability (Nonet

et al., 2022). These goals originated as a continuation of the Millennium Development Goals (MDGs) of 2000 (Kumar *et al.,* 2016). These goals have since led to the adoption of Agenda 2030, wherein most corporates are aiming to have significantly contributed to achieving certain goals that they are aligned with (Pedersen, 2018). SDGs are global goals linked to sustainable development that a company can contribute to; however, these goals are narrowly focused and do not exhibit the interconnectedness between factors (Chopra *et al.,* 2022).

2.2 Sustainability models

Since the first open discussions on sustainability, our understanding of this concept has evolved significantly over the past 40 years. The three spheres model is a model of sustainability that includes economic, social, and environmental dimensions (Correia, 2019) and was one of the first models used to visually represent the sustainability concept in the 1980s (Purvis *et al.,* 2019). This model shows the three dimensions as spheres interlinked in a Venn diagram, with the centre, where all three spheres overlap, indicating an area of intersection between them. This intersection was thought to represent sustainable development and was to be a critical area for businesses to fall into (Figure 1; Lozano, 2008; Sandhu *et al.,* 2014; Correia, 2019). However, this model faced scrutiny for its 'unrealistic' approach to the complex issue of sustainability. Many scholars have since deemed this model weak as it fails to assign any hierarchical value to the dimensions, rather showing them as equal components with equal weighting and similar importance, with very little interconnection between them, and where connections are seen they are limited and vague (Lozano, 2008; Sandhu *et al.,* 2014; Correia, 2019).

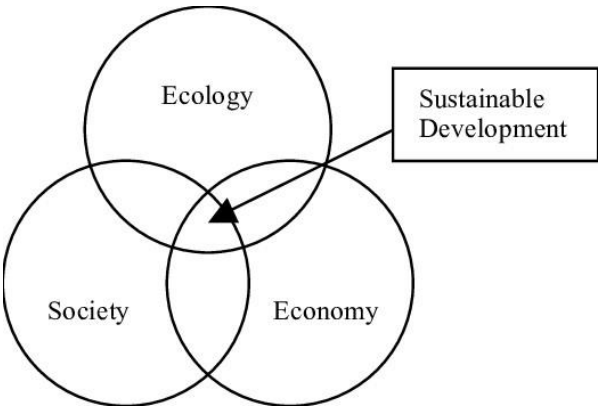

Figure 1. The three spheres of the sustainable development model show ecology/environmental, society, and economy spheres, with the centre indicating a space

where ideal sustainable development would exist when all three spheres interlink (Kim, 2007, p. 8).

The Triple Bottom Line concept was introduced in 1994 by John Elkington, showing that three main aspects would be vital to any business; these aspects were 'people, planet and profit'. This concept followed a similar approach to the three spheres model by showing the three dimensions that were considered as important to a business and that there would be interconnections between these three aspects that would need to be recognised to achieve the goal of sustainability (Arowoshegbe & Emmanuel, 2016; Correia, 2019). The triple bottom line concept was seen to be a better approach to understanding the aspects involved in sustainable development within companies, and a more realistic approach to the notion of including factors that are not only financial in the way in which businesses operate as these factors were not viewed weakly, but rather as single entities that were connected to some degree (Cubas-Díaz & Sedano, 2017).

Growing critique of the three spheres model led to the introduction of the nested model (Figure 2a), which shows a more realistic and integrated approach to the three spheres of sustainability and is applied in line with the triple bottom line approach (Lozano, 2008; Sandhu *et al.,* 2014). This model conveys the two-way relationship that exists between the three dimensions of sustainability with the environmental sphere being the foundation for the societal and economic spheres (Giddings *et al.*, 2002; Correia, 2019). This model has been further transitioned into the six capitals model (Figure 2b), which effectively translates the nested model into a context more relevant to business. This model was especially pertinent for guidance on integrated reporting as it gave a far more specified view of the various components that are the building blocks of the three spheres, thereby providing more clarity and more detail that can be included in reporting and managing risks related to any of the six capitals (Almășan *et al.,* 2019). These transitions all show an increase in the need for

integrated thinking and approaches to sustainability that include an interconnected approach (Adams, 2015; Almășan *et al.,* 2019).

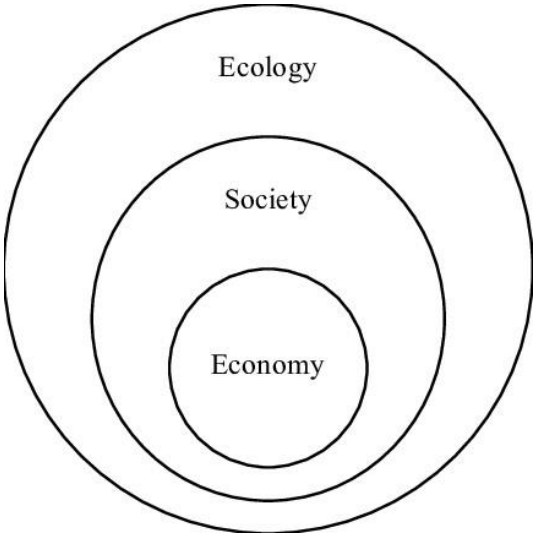

Figure 2a. The nested model which shows a two-way relationship between each of the three spheres of sustainability, ecology/environment, society/social and economy/governance (Kim, 2007, p. 10).

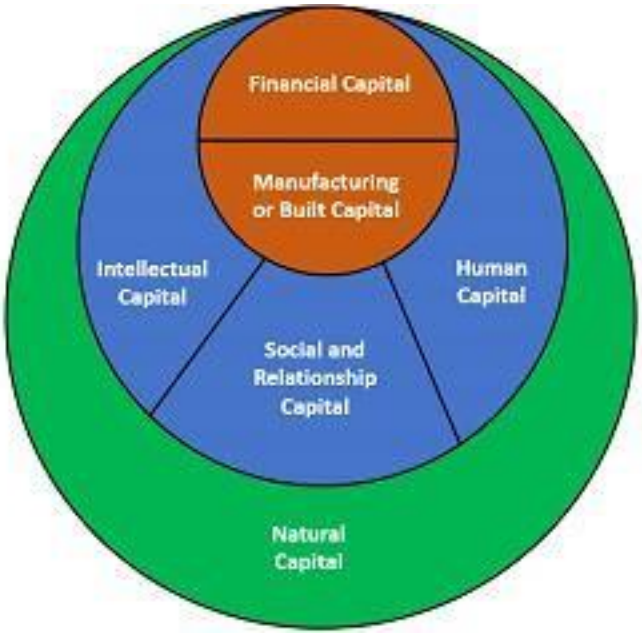

Figure 2b. The six capitals model depicts the more interconnected and complex relationships between the six capitals seen in a company (Simmonds, 2019).

The shift from the three spheres model (Figure 1) to the nested model (Figure 2a) and ultimately the six capitals model (Figure 2b) shows the complexity within sustainability itself, with the nested model exhibiting the ideology that 'limits to growth' do exist, and that

growth will only be possible based on the limits of the outer sphere, the environmental sphere (Bongers, 2016). There has been a growing realisation that a multidisciplinary approach, to introduce a greater level of systems thinking, would be needed to approach the complexity that is presented by sustainability and dealing with these three factors which are in and of themselves complex systems interacting on a two-way scale between and within groups (Geiger *et al.,* 2017). The recent shift to the six capitals model for businesses aims to ensure an integrated thinking approach to not only business practices but also the way that these businesses are reporting on non-financial factors to contribute to sustainability. (Mähönen, 2020).

2.3 Sustainability reporting

Reporting is an important aspect of a business, with most of the reporting focusing on the business' finances which aids in ensuring transparency for stakeholders and investors, allowing investors to make informed decisions regarding their investments (Ahmed, 2022; Ellili, 2022). Although financial reporting has dominated the landscape in corporate spaces, by the early 1990s after the concept of sustainable development had been defined, first attempts at reporting on non-financial aspects began to take place, and the realisation that there was interconnectivity between the environment, the economy and society became more evident (Villiers *et al.,* 2017). These non-financial aspects included environmental and social factors, and this reporting was greatly influenced by the various models of sustainability (Dumay *et al.,* 2015; Gokten *et al.,* 2020).

Environmental, social, and economic/business factors are part of an overarching platform on which companies can be assessed /rated to denote their contribution to ensuring the sustainability of their company. They allow investors and companies to determine the longterm viability of a company (Gillan *et al.,* 2021). These factors are not merely just a guide for businesses to better manage the multitude of risks facing their operations, but also to measure their standing against other companies in their sector, and to create value for the company in a variety of ways that include providing information to stakeholders and by managing environmental, social and economic/business related risks (Henisz *et al.,* 2019)

Sustainability Reporting (SR) gained popularity in the 1990s, as many businesses started to become aware of their impacts on the environment and to ensure a reduction in their negative contribution to the ecological crisis (Buallay, 2022). To guide sustainability reporting, many

frameworks and guidelines have been introduced, one such standard is the Global Reporting Initiative (GRI) launched in 2000 (Mock *et al.,* 2013; Larrinaga & Bebbington, 2021; De Villiers, 2022). The GRI standards were aimed more specifically at sustainability reporting at a time when corporate social responsibility was becoming crucial for businesses (Brown *et al.,* 2007; De Villiers, 2022). The GRI standards have undergone several transformations, with the most recent being the transformation to the GRI4 or Core Option, which indicates that an organisation has opted to report on all topics relevant to the context of that organisation; this option has gained prominence for its ability to increase the interconnectivity of factors for stakeholders (De Villiers, 2022). This standard was not updated to specifically increase the interconnectivity between factors; however, the updated reporting guides aimed to increase transparency and refine reporting which ultimately increases the connections between certain factors (Rudyanto & Wimelda, 2019).

Integrated reporting gained popularity in 2010 after the International Integrated Reporting Council (IIRC) was established to help standardise reporting and increase the accountability of a business through the disclosure of financial and non-financial data (De Villiers *et al.,* 2017). IR does not focus on one aspect, but rather on a holistic approach to reporting on information such as risks facing the company, with many sections on environmental, social, and economic/business topics incorporated into one report to give stakeholders an overview of the company's governance and risk management (Dumay *et al.,* 2015; du Toit, 2017).

Environmental, social, and governance (ESG) reporting followed, with the buzz term ESG becoming popular and denoting the dominant factors required by investors in company annual and sustainability reports (Atkins & Maroun, 2015). ESG reporting focused less on only financial data but aimed to show the interconnectedness that exists between each ESG factor. ESG reporting also gave guidance for what information or factors may be relevant to SRs to increase the focus in these reports on risks linked to environmental, social, and governance factors (Atkins & Maroun, 2015; PWC, 2022).

Currently, most reporting is voluntary, (Krueger *et al.,* 2021), and companies that choose to report on these non-financial aspects are seen to perform better, with various studies showing a positive relationship between higher scores surrounding their environmental, social, and economic/business factors and overall financial performance (Filbeck *et al.,* 2019; Alareeni & Hamdan, 2020; Albitar *et al.,* 2020). Reporting on non-financial information is fast

becoming mandatory in many parts of the world, especially in parts of Europe, Australia, Asia, and even in South Africa, as pressure is mounting due to the escalating threat of climate change, and alongside this crisis also socio-economic crises caused by the impacts of Covid19 and many other wicked challenges that are likely to be worsened by any future disruptions due to climate change (Lokuwaduge & Heenetigala, 2016; Ismail & Latiff, 2019; Bose, 2020; Conca *et al.,* 2020; Faccia *et al.,* 2021).

In South Africa, the Pension Fund Act's Regulation 28 stipulates the need to make information regarding the sustainability of investments available to stakeholders and investors (Viviers & Els, 2017; Geral, 2019). The Principles for Responsible Investment (PRI) Code for Responsible Investing in South Africa (CRISA), and the King Code on Corporate Governance have all made significant contributions to the increasing number of responsible investment actions seen in South Africa, resulting in an increased demand for information regarding both financial and non-financial data to be reported on and disclosed to investors, with any company listed on the Johannesburg Stock Exchange (JSE) expected to supply investors with information on both financial and non-financial/ESG data (Viviers & Els, 2017). These bodies that promote responsible investing have all evolved to include the incorporation of ESG data as a critical component for any report published by a business in South Africa (Foster, 2020).

Over time, reporting shifted towards including non-financial factors, at the same time we also see the evolution of many of the codes and principles that guide corporates on best practices for not only financial benefit but also for sustainable development (Corvino *et al.,* 2020). King III and King IV, released in 2009 and 2016 respectively, both include a broader approach to governance by encouraging the inclusion of sustainability as a main goal in conjunction with better governance in companies (Corvino *et al.,* 2020). King IV was a particularly big step towards a more integrated approach to reporting and corporate governance as we see a change from the previous 'apply or explain' to 'apply and explain', which requires businesses to give more context to their data; we also see further alignment with the IIRC with regards to the IR for King IV. This all aided in ensuring less of a tick-box approach to IR and governance itself (Padayachee, 2017; Corvino *et al.,* 2020).

Recent reporting guidelines and frameworks have developed exponentially in the past few years. The Task Force on Climate-related Financial Disclosures (TCFD) is one such guideline that helps companies disclose material matters in the company that are related to climate risks

and pose financial risks to the business (Chua *et al.,* 2022). The TCFD shows the links between climate change and the economy, further showing the need to understand the interconnectedness of these factors (Schriber & Koppes, 2021). The Task Force on Nature-related Financial Disclosures (TNFD), in a similar fashion, aims to give further guidance on nature-related risks and opportunities for businesses (Irvine-Broque & Dempsey, 2023). The TNFD further shows how interconnected environmental factors are with economic/business factors, by the application of their disclosure guidance.

Other non-financial reporting guidelines that aim to show the connection between environmental, social, and economic/business factors include the Carbon Disclosure Project (CDP). The CDP has evolved since its inception in 2000, and now promotes a deeper disclosure of climate-related risks and opportunities for businesses, with a strong focus on deforestation and water security (Pattberg, 2017). The Endangered Wildlife Trust developed the National Biodiversity and Business Network (NBBN) in 2013, which led to the introduction of a biodiversity disclosure framework that would guide companies to disclose on and reduce biodiversity impacts through the Biodiversity Disclosure Project (BDP) (Murison. 2020). The BDP shows the value of integrating biodiversity risks and opportunities into business activities (Friedman *et al.,* 2022).

Many challenges have surfaced with the onset of increased non-financial reporting requirements, some of which include the standardisation of the reporting frameworks and requirements, making it difficult to compare and standardise the quality of reporting across companies (Bose, 2020; Cort & Esty, 2020). Whilst reporting is assumed to be an indication of the practices that are taking place within a company, this is not always the case as some information reported on does not always encapsulate the required information by investors. There may be risks that are not included in company reports as these risks may not be seen as major risks and may not be perceived as important in terms of risk management (Hąbek & Wolniak, 2016; Dumay *et al.,* 2018). However, with more laws and regulations surrounding good governance and reporting on financial and non-financial factors, such as regulations stipulated by the Johannesburg Stock Exchange, as well as the Green Finance Taxonomy, there is a notion that the availability of this information will increase and that the quality of reports containing this information will also increase (Islam, 2012; Hąbek & Wolniak, 2016; Dumay *et al.,* 2018).

2.4 Systems thinking in sustainability reporting

One issue that is gaining more attention but has not yet gained much popularity in literature is the level of systems thinking that is employed in reporting sustainability-related factors (Singhania & Saini, 2022). Systems thinking is a tool that can be used to solve complex issues; in circumstances where systems thinking has been applied, it has allowed for the understanding of how factors can be managed to solve problems that are deep-rooted and complex (Sheffield *et al.,* 2012). Systems thinking, in this study, relates to the interconnectivity of system elements, systems thinking generally relates to identifying the system as a whole, rather than considering the parts of that system individually (Behl & Ferreira, 2014). Research has shown that the use of systems thinking to solve complex issues results in long-term positives where it is applied (Singhania & Saini, 2022). This has already been noted in the context of sustainability, with one such study showing that to achieve sustainable energy goals, this complex and multifaceted industry would benefit from using a systems approach that would ensure solutions to a variety of issues that are interlinked within this industry, such as the issue of poverty and energy access (Laimon *et al.,* 2022).

In a study that assessed a systems approach to non-financial reporting, it was found that making use of a systems approach towards not only reporting on non-financial matters but also on implementing sustainability efforts would make this practice far more effective as it could increase the use of long-term far-reaching solutions to the multitude of problems faced by companies (Hervieux & Voltan, 2019). This could result in higher-quality reporting that can be of more value to businesses. This may lead to understanding the relevance of environmental, social, and economic/business factors and being able to address these factors from a systems approach. A systems approach will ensure viable solutions are put in place to solve issues rather than approaching issues with a linear approach in which the solutions are often short-term and unable to solve the issues at hand (Hervieux & Voltan, 2019; Singhania & Saini, 2022). Similarly, a study conducted on climate risks showed that many of the risks associated with climate change are interconnected and that their impacts tend to be at least indirectly connected to other important factors in a business setting (Yokohata *et al.,* 2019). Climate change can be connected to factors affecting certain sectors, one example of this is the indirect link between climate change and the food sector through the impacts of climate change on water availability, thereby indirectly impacting the food sector (Yokohata *et al.,* 2019). This study aimed to show how viewing climate change from a systems approach could

help limit further risks to socio-economic systems by highlighting all possible impacts that climate risks could cause for businesses (Yokohata *et al.,* 2019).

The top risks that have been identified by the World Economic Forum over the past decade include all three dimensions (environmental, social, and economic factors), however, environmental factors are largely seen as predominant risks that are likely to increase over the next few years, and will impact not only businesses but also human health and well-being which may in turn impact businesses and economies (Davids *et al.,* 2022; Ren *et al.,* 2022; Ruwanza *et al.,* 2022 Tong *et al.,* 2022; WEF, 2022; WEF, 2023). A complex relationship exists between these three factors as indicated by various studies alongside the introduction of the nested model of sustainability, showing that two-way relationships exist between each factor (Peter & Swilling, 2014). However, from this model, it is seen that the environmental sphere encompasses the other two spheres, which denotes the importance of the environment for both social and economic factors, and that if this sphere reaches capacity, for example, through the loss of natural capital, both other spheres will suffer the consequences of this loss (Jahanger *et al.,* 2022). Risks will continue to manifest in a way that leads other risks to become pertinent as impacts from a particular risk worsen, for example the risk of climate change may increase through its impacts on the environment, thereby leading to increased extreme weather events, leading to business risks through physical and reputational risks (Jaroslav *et al.,* 2014; Zaidi, 2018).

Several clear interconnections between the three dimensions of sustainability have already been identified, as seen in the World Economic Forum's annual interconnected risk map (see Figure 3, released by the World Economic Forum in 2023). The WEF's map shows the links between various environmental, social, and economic risk factors, the level of complexity in these linkages, and that these factors should not be viewed linearly or solved in isolation (WEF, 2023). Environmental, social, and economic risks were all seen amongst the top ten global risks for 2023, with interconnections seen between risks identified for each sphere of sustainability (McGuinness, 2020; WEF, 2023). In 2022 and 2023 similar risks were noted within the top ten global risks, with environmental, social, and economic aspects still seen in the top ten risks and predicted to increase in frequency and significance in the future (WEF, 2022; WEF 2023). Most connections were seen between environmental risks and social risks (Figure 3), with fewer but still many connections seen between society and economic factors (WEF, 2023). This map gives the reader an indication that these factors are connected, and it

is certain that for these issues to be solved from a long-term perspective, a systems approach should be implemented to better manage, and address these complex issues (McGuinness, 2020).

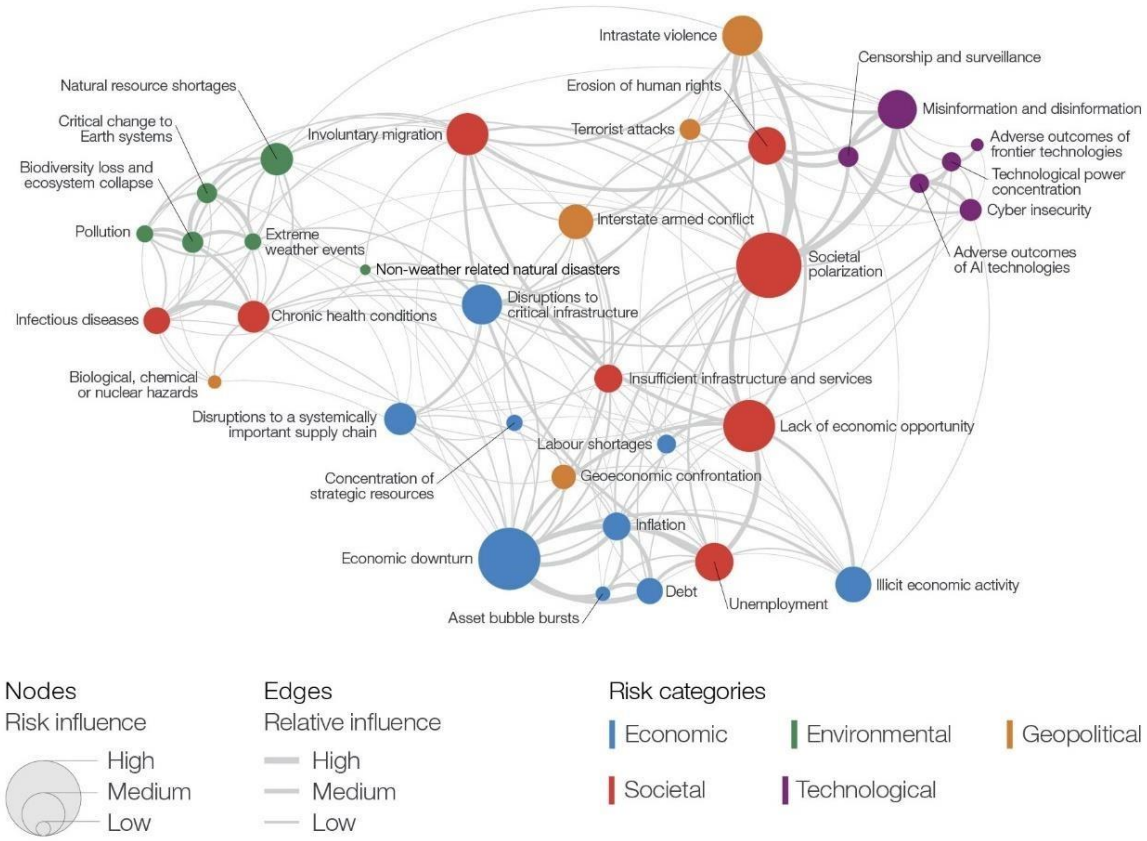

Figure 3. Interconnected map of risks posed in 2023-2024 with strong links found between environmental risks and social risks, however, interconnections exist between multiple different environmental, social, and economic/business risks (WEF Global Risks Report, 2024, pg. 9).

Much of the literature that currently exists focuses solely on the social implications of environmental, social, and economic/business impacts and the level of systems thinking that exists within the social responsibility that businesses have. Few studies have approached systems thinking from the environmental sphere which encompasses all the other capitals and may be an effective way to frame these complex issues and risks in business (Maltz & Pierson, 2022). This reporting has been extensively researched to find ways to increase the standardisation and quality of the reporting to ensure that it does not merely become a tickbox exercise (Al Hawaj & Buallay, 2021; Balogh *et al.,* 2022).

Increased pressure from stakeholders and investors has led to sustainability reporting becoming an important part of business practice and has also encouraged the need to refine and perfect how reporting is conducted (Lokuwaduge & Heenetigala, 2016; Balogh *et al.,* 2022). Introducing a systems approach to reporting could aid in the refining of this reporting, it will allow for a more suitable way to approach the individual and unique issues faced in many different parts of the world where certain standards cannot be as easily applied. Thus, it is critical to attempt to understand the systems thinking that is present within reporting as it stands today (Ahlström *et al.,* 2020; Maltz & Pierson, 2022). With greater understanding of how these complex risks are interconnected, it will allow for a better understanding of ways to ensure decreased impacts from these risks, and to ensure a sustainable path for businesses in the face of increasing global environmental risks (Folqué *et al.,* 2015; Singhania & Saini, 2022). For example, an increasing use of systems thinking for sustainable business management models has been studied and shown to be more effective business management and risk management. An example of this increased effective management is seen through policies incorporating a systems approach to sustainability, where these policies have become far more effective through reducing the narrow sectoral based views with less coordination (Voulvoulis *et al.,* 2022). This increases effectiveness of policies, decision-making and further business management (Voulvoulis *et al.,* 2022).

Non-financial reporting is growing in popularity in corporate spaces and may be a tool to ensure the implementation of systems thinking (Ahlström *et al.,* 2020; WEF, 2020; Ellili, 2022). With the aid of reporting frameworks such as the Global Reporting Initiative (GRI), links between and within social, environmental, and economic factors as well as the interconnectedness of these factors between industries are being seen and highlighted to help standardise reporting for businesses. In company reports currently, we are seeing many of these factors still being reported on in isolation, with very little connection between spheres; this results in a tick-box approach to reporting (Adams *et al.,* 2022; Garst *et al.,* 2022). We also see an overwhelming number of guidelines for non-financial reporting which may in turn create more complexity within reporting, thus, making it difficult for businesses to compare their progress and effectively connect environmental, social, and economic/business factors (Courtnell, 2021).

Chapter 3: Methods

This study employed an exploratory sequential mixed-methods approach, in which both qualitative and quantitative data were collected in three steps. Firstly, key links between five key environmental factors linked to sustainability, and other factors were determined from literature using a keyword search and thematic content analysis. Secondly, a similar thematic content analysis was employed to determine the five key environmental links with other factors in 366 company reports from three different industries: Basic Materials, Financials, and Consumer Services. Finally, interviews were conducted with topic experts and practitioners to gain a greater understanding of the challenges with non-financial reporting and the extent to which a systems approach is used within company reporting structures.

Shortcomings of the methodology used include human error where connections may have been missed due to manually searching for connections in company reports. There may also have been alternative names for certain identified factors, this in turn would have meant missing connections due to naming conventions not identified during the search stage.

3.1 Thematic content analysis: creating an interconnectedness map from literature.

The study focused on five key environmental issues, 1) climate change; 2) water availability; 3) biodiversity loss; 4) energy/ natural resource depletion; and 5) land degradation (Davids *et al.,* 2022; Ruwanza *et al.,* 2022; WEF, 2022), which were chosen based on the World Economic Forum's (WEF) analysis of environmental risks that were likely to be seen to increase in 2022 and 2023. 37 peer-reviewed literature sources, published between 2012 and 2022 were reviewed to identify links between environmental, social, and economic/business risks (see Appendix 1 for a list of definitions used based on publications reviewed). A keyword search indicated where connections between the five key environmental factors and other factors were seen in the literature (as per Kitsikopoulos *et al.*, 2018). Keywords used were 'climate change',
'climate', 'water availability', 'water', 'biodiversity loss', 'biodiversity', 'land degradation', 'land', 'energy', 'natural resources', and 'energy/natural resources'. These terms were further analysed for any connections that were within the context of the search, for example in some literature sources the term 'water availability' omitted connections. In a paper specifically discussing the impacts of climate change on water availability in southern Africa, the key

factor ‘water’ was sometimes coupled with other words such as ‘stress’ (see Hamududu & Ngoma, 2019). This meant that the broader search became necessary as water stress is closely associated with ‘water availability’. Each keyword was assessed in context, for example when searching for the term ‘climate change’, all factors linked to this term were explored to further determine if any other factors connected were relevant to the study.

The results of the thematic keyword search in the literature review were used to create a qualitative map of interconnections which was then analysed by quantitative and qualitative means. To create this map, NodeXL (version: 1.0.1.448) was used, which is a free platform that forms a plugin within Excel and is an analysis tool that generates complex systems maps of connections, more often associated with social media networks. Although NodeXL is mainly used to show the interconnection between social media networks, such as Twitter and other systems, this tool can be used for a variety of system and map analyses and is not limited to social networks (Hansen *et al.,* 2010). This platform uses Fuzzy Cognitive Mapping (FCM), a software analysis tool for system maps that computes and generates key metrics that are important for interpreting system maps and how interconnected they are. The advantages of this software are the way the software can track complex connections, saving time and ensuring accuracy, as well as the FCM ability which generates key metrics for map comparison. Some disadvantages of using NodeXL include human error if factors are entered into the excel system incorrectly, other less significant disadvantages of the software are the errors that can persist, the platform crashing, and sometimes slowed down with large datasets. A linear connection was classified where one factor, such as the key environmental factor, was connected to at least one other factor, be it environmental, social, or economic (Kitsikopoulos *et al.*, 2018). A more complex connection was identified as a key environmental factor linked to at least two factors.

Overall graph metrics were selected in NodeXL, which were calculated automatically and tabulated in a separate worksheet on the Excel platform. The graph metrics that were analysed included the number of degrees which indicated the number of connections for a certain factor, and the number of edges, which indicated the total number of connections in the map. The number of edges included both unique and duplicate edges, showing connections that were not repeated and those connections that were repeated or emphasised in the literature. The number of vertices or nodes indicated the overall number of factors within the map. The average geodesic distance showed the average number of connections, or hops, needed to link any two factors; a lower geodesic distance indicated fewer connections

needed to link factors, which indicated a greater level of interconnectedness between these factors. Finally, graph density was considered; this metric showed the extent of how interconnected the factors within the map were by providing an overall density value assessing the extent of connectedness within the map between edges. Graph density was calculated as the total sum of edges divided by the possible number of edges that would have existed if all factors had been related to each other within the map. A high graph density, a number closer to one, indicated a higher amount of connectedness between factors, whilst a lower graph density, a number further from one, indicated fewer connections between factors within the map (HaiJew, 2013; Social Media Research Foundation, 2016).

Once connections had been analysed, they were added to NodeXL which automatically generated a connection map between the vertices. Sizing of the vertices, colour of labels, and vertices were modified for aesthetic purposes with vertices and edges weighted based on the number of connections generated for each factor.

The layout algorithm chosen for this study was the 'Vertical Sine Wave' layout, which layers factors vertically according to their number of connections. The map was further altered for visual appeal by grouping the different factors, with environmental factors on the top left, social factors on the bottom left, and economic/business factors on the right side of the maps.

3.1.1 Scoring literature connections

The links between the five key environmental factors and other factors identified in the literature were scored based on their weighting assigned in NodeXL, with weights automatically calculated based on the number of connections seen for each factor within the systems map. Scores ranged from 0.5mm to 5mm. Single-level connections tended towards 0.5mm whilst multiple connections tended towards 5mm.

These connection scores were then tested in R-Studio (version) using a three-way ANOVA to determine any differences between scores for the key environmental factors with the other environmental, social, and economic/business factors between the mean values of the different key environmental factors and any differences in scores between the environmental, social, and economic/business factors, which showed either significantly lower scores or significantly higher scores. A Tukey HSD test was conducted to determine where these differences in means were found for those factors that were found to be significantly different from each other from the ANOVA tests.

3.2 Report content analysis

3.2.1 Sample selection

Environmental, social, and economic/business factors were important across all industries, with varying direct and indirect impacts seen on different factors within each industry and further into each sector (Schramade, 2016). Three industries within the 2022 Top 40 JSE listed companies in South Africa were chosen for this study. The three industries were chosen based on their contribution to the market capital within South Africa and were all within the top ten contributors according to the Morgan Stanley Capital International (MSCI) South African Index in 2022 (JSE, 2022; MSCI, 2022). As per the FTSE Russel (2022) definitions, specifically focusing on the Industry Classification Benchmark (ICB), the three selected industries included the Basic Materials (this industry includes companies from sectors that are involved with the extraction/processing of raw materials which includes, but is not limited to, metals and minerals), Financials (this industry includes companies from sectors which provide financial services and includes, but is not limited to, banking, asset management and investment services), and Consumer Services (this industry includes companies from sectors which provide products and services to consumers, considered staple to households).

In total, 30 companies were selected randomly, Basic Materials included nine companies, Financials included 14 companies, and Consumer Services included seven companies within the top 40 JSE-listed companies (see Appendix 2 for a list of all companies assessed). Some companies included were both international and local, which may have impacted the reports for these companies as they were governed by standards that are employed at an international level instead of only legislature, frameworks, and guidelines from South Africa. This mainly impacted the Basic Materials industry as many of the companies within this industry were found to be multinational.

3.2.2 Report analysis and systems mapping

All company reports from the 30 selected companies that included material on sustainability factors and were published between 2017 and 2022 were included for analysis; this included Sustainability Reports, Integrated Reports, Governance Reports, ESG reports, and any other reports that conveyed non-financial factors. Reports that were excluded from analysis based

on the nature of these reports included financial results and remuneration reports as these reports contained only financial disclosures which did not include information relevant to this study. A total of 366 reports were analysed across the three industries.

After the first systems map was created from peer-reviewed literature, a second map was created using company reports (as per Kitsikopoulos *et al.*, 2018) to understand the level of interconnectedness seen between the five key environmental factors and other environmental, social, and economic/business factors in current reporting.

A keyword search for all five key environmental factors was employed for each of the individual reports across all companies in the chosen industry. The same methodology used for the literature review was applied to report analysis, using the same keywords and contextual assessment.

Using the data gained from the report analysis and following the same methodology as for the literature review, three industry maps and one map showing the overall results were developed using NodeXL.

Overall graph metrics were calculated for each of the company annual report maps, and the same metrics (number of degrees, number of edges, the number of nodes/vertices, the average geodesic distances, and lastly the graph density) throughout were analysed and compared to those seen from the literature maps.

3.3 Report type and reporting standards

Further analysis of company reports was done by determining the types of reports from each industry that contained sustainability information over the five years that the study observed. The reporting guidelines and frameworks used were also noted, and for each industry, the average percentage of each guideline/framework was calculated based on the total number of reporting guidelines seen for each industry to determine the most frequently used guidelines and standards across the industries and the five years.

3.4 Scoring connections from company reports

The connections seen from company annual reports were scored to determine the level of connection indicated in these reports. These scores were based on the weights assigned to them in NodeXL, with weights automatically calculated based on the average number of connections seen for each factor within the systems map. Edge weights were then added to

the edges between factors and were divided by two for ease of aesthetics and for the map to still be easy to read. Edge weights were based on 0.5mm to 5mm in width with a higher width indicating more connections between factors. Only the five key environmental factors were scored with all the other factors in the map.

A three-way ANOVA was then conducted in R to determine if any differences were seen between the scores of factors. A post-hoc Tukey HSD test was further conducted to determine where the differences between these factors were.

3.5 Similarity map

After mapping connections identified in the literature as well as those identified in company reports, a similarity map comparing the two datasets was created. This map combined the literature and overall company report map to show and highlight where similarities in connections between factors were seen. This map was analysed by highlighting the edges between the connections that were similar between the literature map and the company annual report maps. This map also reflected the number of repeated connections between factors, with differing edge weights also highlighted on this map.

3.6 Interviews

After ethics clearance was granted by the University of the Witwatersrand Human Research Ethics Committee (non-medical; H23/04/10), interviews were conducted with topic experts in Johannesburg South Africa, either at a venue chosen by the participant for in-person interviews or using an online platform such as Zoom/Microsoft Teams/Google Meet as decided by the participant. The participants were chosen using a non-probability method of sampling called purposive sampling (Palinkas *et al.,* 2015), and more specifically expert sampling wherein participants were chosen specifically based on their expertise with regards to their field, and in this case their occupation as either an ESG analyst or sustainability manager involved in non-financial reporting at one of the 30 selected companies. The interviews were semi-structured and consisted of 20 questions that were a mixture of questions related to reporting, systems thinking and risk perception and were used to better understand how companies were reporting on sustainability factors and the challenges they experienced in applying a systems approach to reporting (see Appendix 3 for the interview questions).

As done in a prior study that examined the use of a systems approach to the social aspects of ESG factors (see Hervieux & Voltan, 2019), interviews were used to determine various problems relating to measuring environmental impacts, how interviewees were understanding their assessments and if this understanding could be likened to a systems approach or not. The interviews aimed to address and ask questions that allowed for a deeper understanding specifically relating to the level of systems thinking present in non-financial reporting and specifically addressing the five identified environmental factors - climate change; water availability; biodiversity loss; energy/resource depletion; and land degradation. The interviews were audio-recorded after the consent of the participant was granted and were later transcribed to analyse responses from the interviews. Responses to questions were grouped into categories based on the answers to the questions and relayed as an average percentage to infer where ESG analysts and sustainability managers who prepare reports agree or disagree, and further to better understand any potential differences in interconnectedness identified in the literature sources and company annual reports.

Chapter 4: Results

To assess the level of systems thinking that is currently seen in company reports from various South African sectors, data were collected in three steps, firstly through a literature review, secondly through company report analyses, and finally through interviews with topic experts. This chapter presents the results of all three research steps.

4.1. Thematic content analysis: creating an interconnectedness map from literature

Connections between climate change, water availability, biodiversity loss, energy/ natural resource depletion, land degradation, and other environmental, social, and economic risks were identified from the literature review and are presented in Figure 4. The highest degree of connectedness is accounted for by ‘climate change’ with 35 degrees, followed by ‘water availability’ and ‘land degradation’, both with a degree of 27. The factors with the lowest number of degrees have a degree of one and are ‘soil degradation’; ‘supply chain disruption’, ‘technology’; ‘reputation’, and ‘employment’. There are a total of 602 edges in this systems map. The average geodesic distance is 1,900 hops. The graph density is 0,237. The edges were weighted on a scale of 0,5 to 5,5mm and corresponded with the line thickness.

Connections were found to be clustered around the environmental factors and throughout the social factors, with less clustering around economic/business factors. However, 'economy' and 'governance/management' factors were seen to have thicker connections with each of the five key environmental factors as opposed to with factors in the social sphere. All factors in this systems map were connected to two or more other factors, there were no factors with only one connection to another factor.

Climate change had the strongest connections with 'society', 'economy', and each of the key environmental factors. Other strong connections existed with 'water availability' being influenced by 'climate change', 'climate change' was connected to 'precipitation', which was further connected to seasonality and temperature, both of which were also connected to 'climate change' (natural changes and those exacerbated by anthropogenic activities) (see Betts *et al.,* 2018; Mapndeli *et al.,* 2018; Konapala *et al.,* 2020; IPCC, 2022). 'Water availability' was further connected to 'agriculture', and 'irrigation'. 'Food security' was connected directly to 'water availability' and to 'agriculture'. 'Water availability' was connected directly to 'human health', with connections also seen between 'society' and 'water availability', between 'society' and 'human health', and between 'society' and 'food security'; these factors were all further connected to various economic/business factors (see Edokpayi *et al.,* 2018; Konapala *et al.,* 2020). 'Extreme weather events' were seen to alter 'water availability' through floods and low-grade infrastructure to contain water, or through droughts, which limited the amount of water available (see Betts *et al.,* 2018; WEF 2019; IPCC 2022). 'Agriculture' was impacted by 'water availability', also due to 'extreme weather events', and in turn impacted 'food security' (see WEF 2020; IPCC 2022).

Land degradation was the factor with the second highest number of degrees. This factor was connected primarily to the social factors in the map, and other environmental factors, with fewer, but still present connections between the economic/business factors. There was a strong connection between 'land degradation' and 'biodiversity loss', with other environmental factors that were connected to 'land degradation' being 'agriculture' and climate change'. Within the societal factors 'land degradation' was connected to every societal factor, with the strongest connections between 'society'. Within the economic/business dimension, 'land degradation' was connected strongly with 'governance/management', and weaker connections were found between this key environmental factor and 'operations', and 'political stability'. Land use change was used to indicate land degradation as land use often resulted in the degradation of land by various

destructive activities such as deforestation, land cover change, or destruction of ecosystems (see Mainuri & Owino, 2014). Links also made here included ‘land use/land degradation’ linked to ‘society’, ‘land use/land degradation’ linked to the economy, and lastly ‘land use/land degradation’ linked to other aspects of the environment which in this case included ecosystems and the respective ecosystem services (Sutton *et al.,* 2016).

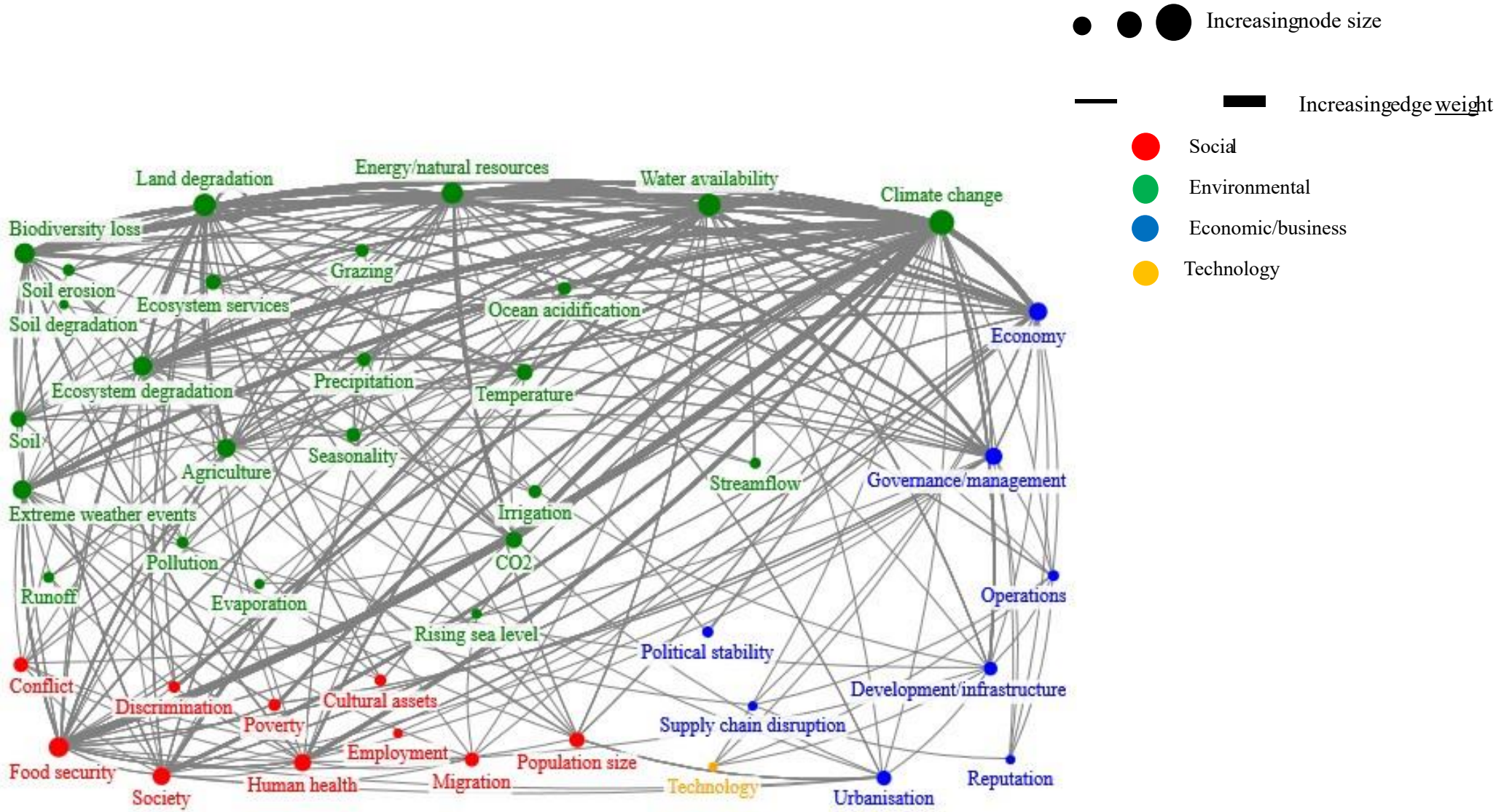

Figure 4. Interconnected systems map of key sustainability risks (environmental=green, social=red, orange=technology, and economic/business==blue) derived from 37 literature sources for a period of ten years (2012 to 2022).

4.1.1 Scoring literature connections

The mean values for the connection between each key environmental factor and factors from the three spheres, environmental, social, and economic/business, were calculated (Table 1). Climate change had the highest mean connection with other factors in the social sphere with a mean value of 3,43 (±1,49), followed by 3,19 (±1,31) with other environmental factors. The third highest mean value was 2,73 (±1,66) which was accounted for by climate change connected to economic/business factors. The lowest mean value for connections was seen within the biodiversity sphere score between climate change and the other environmental factors at 0,80 (±0,26), this was followed by the second lowest mean value of 0,83 (±0,29) between biodiversity loss and various economic/business factors. The third lowest score was seen as a mean value of 1,00 (±0,37) between land degradation and various social factors.

Climate change had the highest mean score values among the three spheres (environmental, social, and economic/business) and all the key environmental factors seen in the literature. This was followed by water availability. Land degradation followed with the third highest mean values, while energy/natural resource depletion had the fourth highest mean. Biodiversity loss had the lowest connection scores based on the literature review. There was a significantly lower score within biodiversity loss between the E, S, and E/B factors ($F_{2,20}$= 10, 31$p<0,001$).

Land degradation had a significantly higher score between the E, S, and E/B factors ($F_{2,62}$=10,96, $p<0.001$). Energy/natural resources had significantly higher score ratings between E, S and E/B factors ($F_{2,49}$=3,72, $p<0.001$). Overall there was a significant difference in the score ratings between all of the key factors for literature scores, with climate change having a significantly higher total score ($F_{4,545}$=19,01, $p<0.001$).

Table 1. The mean (±SD) literature connection scores seen from 37 literature sources for the period of ten years (2012-2022). The scores were seen between each of the five key environmental factors and other environmental factors, social factors, and economic/business factors from different literature sources.

	mean(±SD)			
Key Factor	E	S	E/B	Total
Climate change	3,19(±1,31)	3,43(±1,49)	2,73(±1,66)	*2,99(±1,49)
Biodiversity loss	*0,80(±0,26)	1,70(±0,63)	0,83(±0,29)	1,88(±1,36)
Water availability	1,78(±0,86)	2,28(±0,77)	2,08(±0,42)	2,15(±1,12)
Land degradation	*2,38(±0,93)	1,00(±0,37)	2,42(±1,24)	2,11(±1,06)
Energy/natural resources	2,21(±0,93)	1,38(±0,69)	*2,42(±0,89)	0,98(±0,99)

'' indicates a significant difference.*

4.2 Report content analysis

4.2.1 Report analysis and systems mapping

An interconnectedness map was created for 366 company reports for the three industries (Basic Materials, Financials, and Consumer Services) and 30 companies in total from the top 40 JSE (Figure 5). This systems map contains 35 vertices/nodes, with a total of 623 edges, and has a graph density of 0,168. The average geodesic distance is 1,824 hops. The maximum degree is 29, with the minimum degree found to be one. The edge weights range from 0,5 to 5,5mm.

In the overall company systems map (Figure 5), the highest degree of 29 is accounted for by 'climate change'. 'Climate change' is connected to many other factors and most of the repeated connections are seen between this key environmental factor and other factors. 'Climate change' is connected to all the social factors in the graph, except for the 'cultural assets' factor. 'Climate change' also has strong connections with 'economy', 'governance/management', and 'operations'. There were thinner connections between 'climate change' and 'development/infrastructure', 'supply chain disruption', and 'reputation'. There was a strong connection between 'climate change' and 'extreme weather events' for the company report map, and with 'CO_2'. 'Food security' and 'society' had the strongest connections with 'climate change'.

'Water availability' had a degree of 28 and had the second highest number of degrees in the overall systems map for company reports. 'Water availability' is strongly linked with 'society' and 'operations' within the social and economic/business factors. 'Water availability' is also connected to each of the economic/business factors for the overall systems map. The strongest connections were seen between 'water availability' and 'operations' and between 'water availability' and 'governance/management'. There was also a strong connection between 'water availability' and 'climate change'.

'Energy/natural resources' and 'biodiversity loss' both had the third highest degrees with 20 degrees each. 'Biodiversity loss' had a strong connection to 'land degradation' and also to 'society', 'operations', and 'climate change'. Within the Basic Materials industry, two prominent connections that were seen were 'biodiversity loss' and 'land degradation'. Thicker connections were seen between 'land degradation' and 'governance/management' than between 'biodiversity loss' and 'governance/management'. 'Biodiversity loss' was also

shown to be connected to many other factors including other environmental factors, social factors, and economic/business factors. ‘Biodiversity loss’ had connections with ‘operations’ and ‘ecosystem degradation’.

Land degradation had the smallest degree amongst the key environmental factors with a degree of 18. It was seen to have the strongest connection with ‘biodiversity loss’, followed by ‘operations’ in the economic/business factors sphere, and the third highest number of connections with the social factor ‘society’. ‘Land degradation’ was important for ‘society’ as it was connected to ‘food security’ and ‘agriculture’. ‘Land degradation’ was also connected to ‘climate change’. ‘Land degradation’ was seen to be connected to ‘cultural assets’ within the society sphere for this industry.

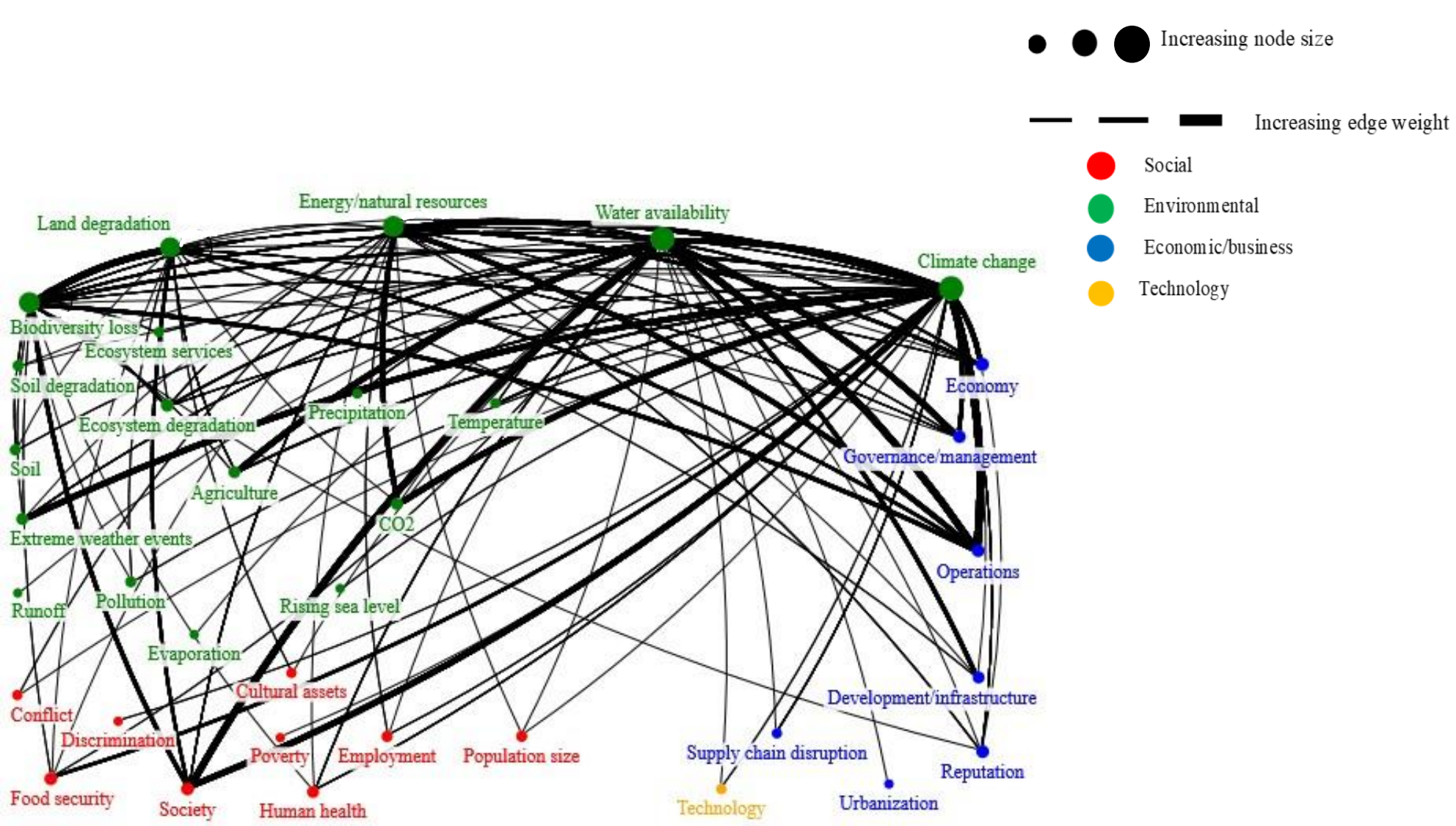

Figure 5. Overall connections seen from 366 company reports within the top 40 JSE-listed companies across three industries. Red labels = social factors, green = environmental factors, and blue = economic/business factors. Edge weight ranged from 0,5 to 3. Node size ranged from one degree to 36 degrees.

4.2.2 Basic Materials systems map

Connections seen in the systems map for the Basic Materials industry (Figure 6), which comprised nine companies, had a total of 33 vertices/nodes, with a total of 330 edges. A graph density of 0,152 was found for this systems map. There was an average geodesic distance of 1,886 hops. A maximum degree of 25 was found for the Basic Materials systems map and a minimum degree of one. The edge weights for these connections ranged from 0,5 thickness to 5,5mm thickness.

Connections in the Basic Materials industry were seen to be clustered around the key environmental factor 'water availability'; this factor also had the highest degree at 25 degrees. 'Water availability' as a key factor was connected to at least one factor within each of the environmental, social, and economic/business spheres. The strongest connections were seen between 'water availability' and 'climate change' with climate change expected to impact water availability. These further impact 'operations', 'economy', and 'development/infrastructure'. Weaker connections were seen between 'water availability' and the factors 'supply chain disruption', 'technology', and 'reputation'. 'Water availability' had the highest connection with 'society'.

'Climate change' had the second highest degree for the Basic Materials industry, with 24 degrees. This key environmental factor was connected widely across the systems map with multiple factors from each of the environmental, social, and economic/business spheres. The most repeated connections for this factor in the Basic Materials industry were the connections between 'climate change' and 'operations', 'economy', 'society', 'energy/natural resources', and 'extreme weather events'.

'Biodiversity loss' had the third highest number of degrees for the Basic Materials industry, with 17 degrees. The highest number of repeated connections was seen between this key environmental factor and 'land degradation'. There were also connections between 'biodiversity loss' and 'operations'. 'Society' and 'biodiversity loss' had the highest number of connections between this factor and the social sphere. 'Biodiversity loss' was also connected to 'food security' and to all the other key environmental factors in the systems map.

The fourth highest degree was shared by both 'land degradation' and 'energy/natural resources', with each having 13 degrees in the Basic Materials systems map (Figure 6). The highest edge weight for 'land degradation' was between this key environmental factor and

‘biodiversity loss’. ‘Land degradation’ was also connected to ‘society’ and ‘operations’. ‘Energy/natural resources’ was connected to ‘climate change’ and ‘water availability’ within the key environmental factors. ‘Energy/natural resources’ was also connected to ‘CO_2’, which was further connected with ‘climate change’. ‘Energy/natural resources’ was connected amongst the governance/business factors as well, with connections seen between ‘operations’ and ‘economy’. ‘Energy/natural resources’ was connected to only two societal factors; the first strong connection was seen with ‘society’ and lastly also with ‘conflict’.

The factors in the Basic Materials systems map that had only one degree were factors from the environmental sphere and factors from the societal sphere and included ‘evaporation’, ‘rising sea levels’, ‘runoff’, ‘food security’, and ‘discrimination’. ‘Evaporation’ was seen to be connected to ‘water availability’ but no other factor within this systems map. ‘Rising sea levels’ was connected to ‘climate change’ only. ‘Runoff’ was connected only to ‘water availability’ while ‘food security’ was connected only to ‘biodiversity loss’. ‘Discrimination’ was only connected to ‘climate change’.

Within the Basic Materials industry, two prominent connections that were seen were ‘biodiversity loss’ and ‘land degradation’. Thicker connections were seen between ‘land degradation’ and ‘governance/management’ than between ‘biodiversity loss’ and ‘governance/management’. ‘Biodiversity loss’ was also shown to be connected to many other factors including other environmental factors, social factors and economic/business factors. ‘Biodiversity loss’ had connections with ‘operations’ and ‘ecosystem degradation’.

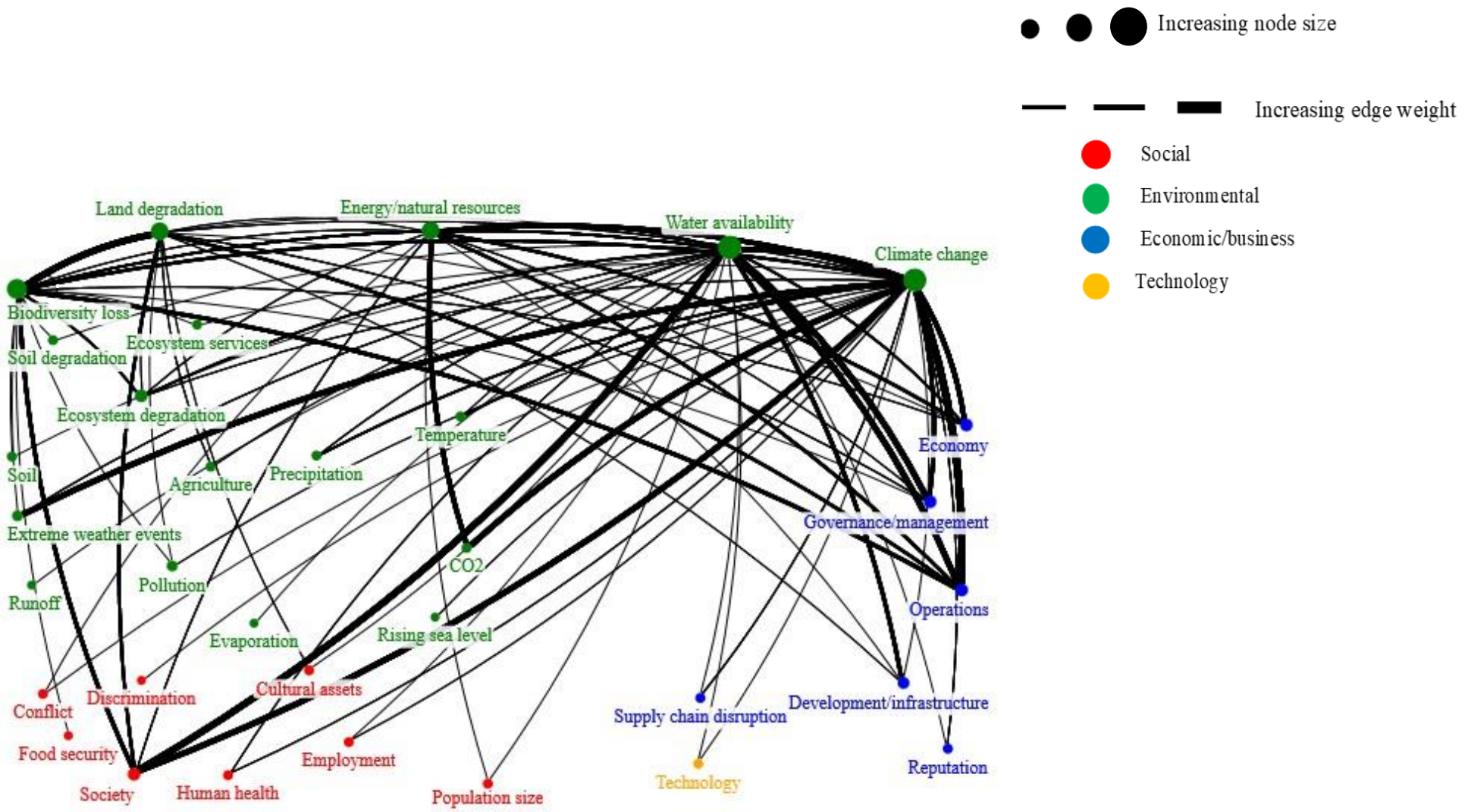

Figure 6. Connections documented from company reports of nine companies within the Basic Materials industry for a period of five years (2017 -2021) (environmental dimension = green, social dimension = red, and economic/business dimension = blue)

4.2.3 Financial systems map

Connections seen in the systems map for the Financials industry (Figure 7), which comprised of 14 companies, had a total of 23 vertices/nodes, with a total of 88 edges. This systems map has a graph density of 0,174. The average geodesic distance is 2,056 hops. There was a maximum degree of 17 for the Financials systems map and a minimum degree of one. The edge weights for the connections in this systems map ranged in thickness from 0,5 to 2mm.

In the Financial industry systems map, the repeated connection with the thickest edge weight was seen to be 'climate change'. 'Climate change' was the key environmental factor that was seen to have the highest number of degrees with a degree of 17 (Figure 7). Specific factors that were connected to 'climate change' include 'CO_2', 'economy', 'operations' and 'society'. 'Extreme weather events' were also connected to 'climate change'. 'Climate change' was also strongly connected to 'economy' and 'operations'. Fewer connections were seen between 'climate change' and 'governance/management', with only four economic/business factors being found for the financial industry map.

'Biodiversity loss' and 'water availability' had the second highest number of degrees with 9 degrees. 'Biodiversity loss' had strong connections with 'operations' and weaker connections with 'reputation' and 'economy'. 'Water availability' did not have any strong connections, but instead had weak connections with multiple other factors. Notably, 'water availability' was connected with at least one factor from each sphere.

Land degradation had the second highest number of degrees, with a degree of 7. This factor was only connected to three other factors, 'Society', 'CO_2', and 'soil'. No other connections were seen for this factor. Energy/natural resources had the fewest degrees with a degree of 4. Strong connections with this factor were 'society', 'CO_2', and 'reputation'.

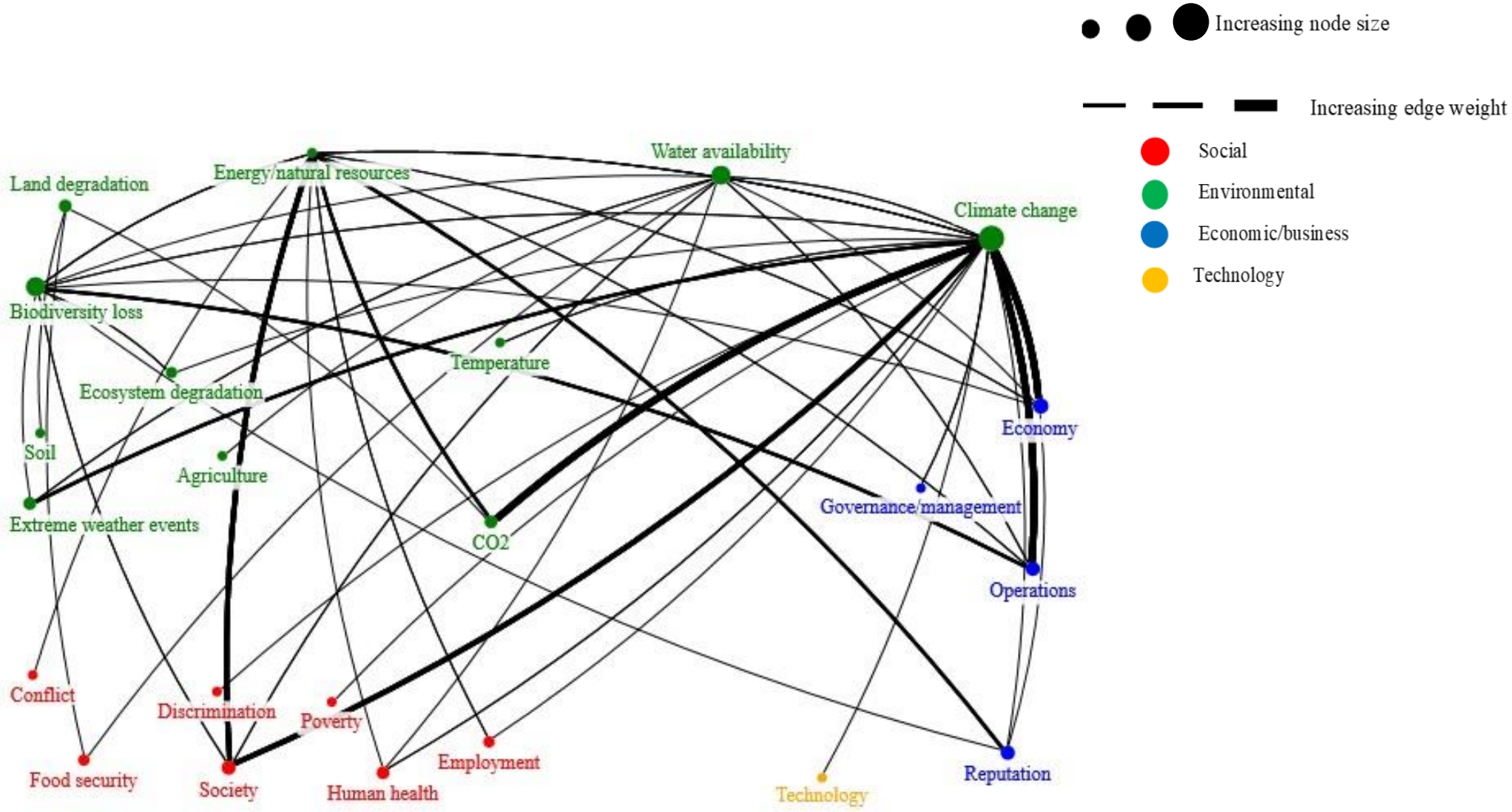

Figure 7. Connections identified for the Financials industry from company reports for 14 companies over a period of five years (20172021). Environmental factors = green, social = red, governance/business factors =* blue, technology = orange.

4.2.4 Consumer services systems map

Connections seen in the systems map for the Consumer services industry (Figure 8*),* which comprised of seven companies, had a total of 25 vertices/nodes and a total of 205 edges. This systems map had a graph density of 2,000. There was an average geodesic distance of 1,843 hops. The maximum degree for this systems map was seen to be 20 degrees, with a minimum of one degree.

Within the Consumer Services industry, most factors were seen to be clustered around 'climate change', 'water availability', and 'energy/natural resources'. 'Operations' was also seen to have a high number of repeated and clustered connections. 'Climate change' was a key environmental factor that had the highest number of degrees within the systems map with a degree of 20. 'Climate change' had a strong connection with 'society'. 'Food security' was also considered an important factor for this industry and was connected to 'climate change'. Many other factors were considered to contribute to the instability of the food system and were also seen to be worsened or exacerbated by climate change; these factors were connected to 'food security' and included 'water availability', 'extreme weather events', 'soil degradation' and 'biodiversity loss'. 'Climate change' was repeatedly connected to
'operations', the impacts of climate change were seen to directly impact the business operations of companies within the Consumer Services industry.

'Water availability' was the factor with the second highest number of degrees (17 degrees; Figure 8). Three of the top connections seen with this factor were 'climate change', 'agriculture', and 'operations'. 'Water availability' was further connected to 'agriculture' which was ultimately connected to 'food security'. This connection was seen in the systems map as 'water availability' was connected directly to both 'agriculture' and 'food security', and 'agriculture' was connected to 'food security'. 'Water availability' and 'climate change' were repeatedly directly connected, with impacts of 'climate change' seen to put strain on water resources. This impacted 'operations' whilst simultaneously being impacted by 'climate change' and other climate change-related effects.

The key environmental factor with the third highest number of degrees was 'energy/natural resources' with 14 degrees. For this factor, the top connections seen were with 'operations' and 'climate change', with 'economy' following at a lower repeated edge weight. 'Energy/natural resources' was connected to only two factors within the societal sphere,

‘society’ and ‘food security’, ‘and only connected to two environmental factors, ‘climate change’ and ‘CO_2’. ‘Energy/natural resources’ was less repeatedly connected to every other environmental factor except for ‘soil degradation’, ‘temperature’, ‘ecosystem services’, agriculture’, and ‘pollution’ which were factors it was not connected to.

The factor with the fourth highest number of degrees was ‘biodiversity loss’ with a degree of 13. The strongest connections to ‘biodiversity loss’ were ‘operations’ and ‘climate change’. ‘Biodiversity loss’ had weaker connections with the factors in the societal sphere, such as ‘food security’, ‘society’, and ‘human health’. Connections were also seen with ‘economy’ and ‘supply chain disruption’, indicating connections within the economic/business factors.

The environmental factor with the lowest number of degrees for the Consumer Services industry was ‘land degradation’ with only 8 degrees. The strongest connections to ‘land degradation' were seen to be ‘agriculture’ and ‘biodiversity loss’. Weaker connections for this factor also existed with ‘climate change’, ‘governance/management’, and ‘operations’. Some of the weakest connected factors within this systems map were found to be ‘population size’, ‘development/infrastructure’, ‘supply chain disruption’, ‘urbanisation’, and ‘pollution’.

The consumer services industry had a decent amount of the economic/business factors found within the company reports, with fewer of the social factors seen within this map. The environmental factors were focused on and most of the environmental factors that were seen in literature were also found for the Consumer Services map.

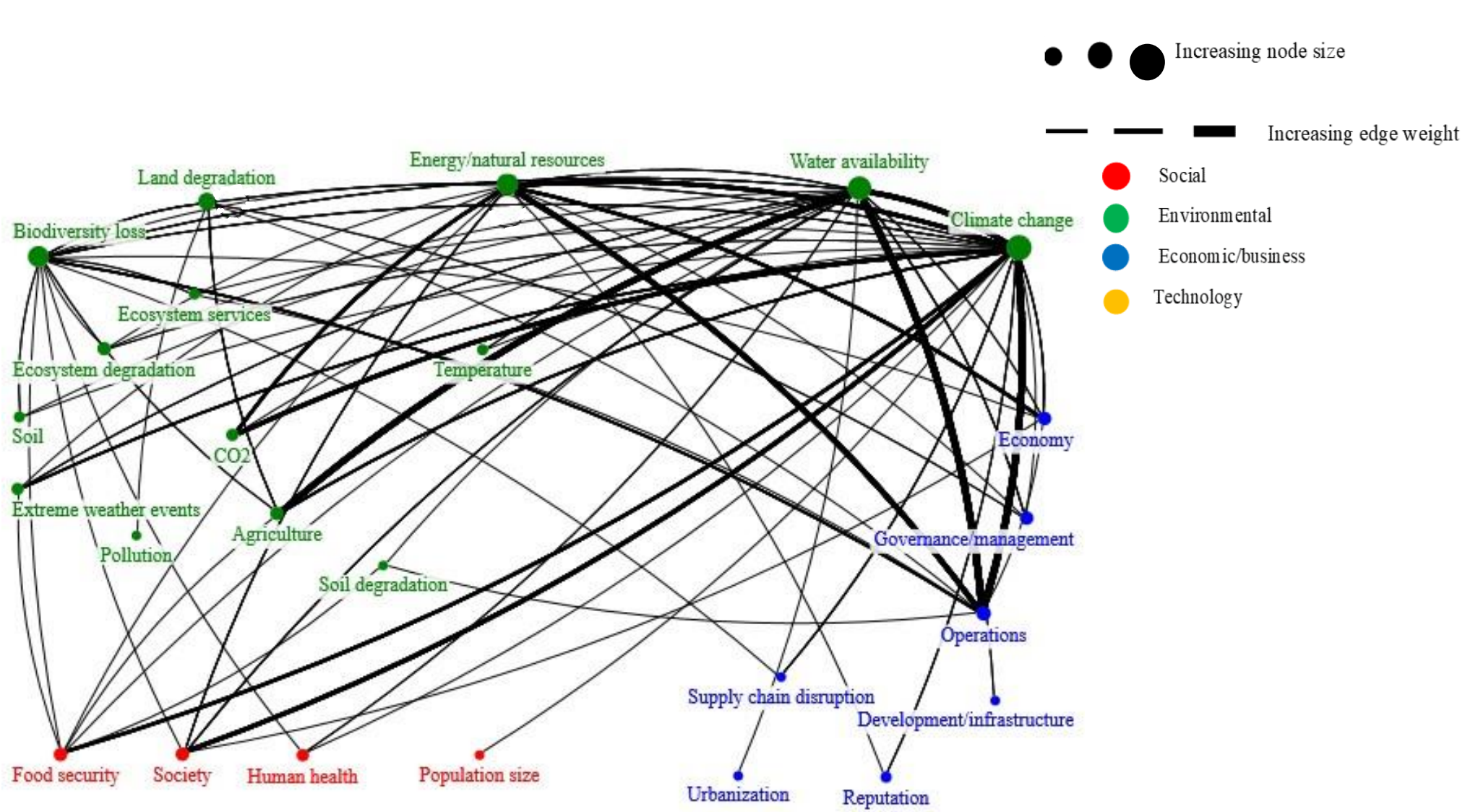

Figure 8. Connections found in the Consumer Services sector, from a total of seven companies over five years (2017-2021). environmental = green, social = red, economic/business = blue.

4.3 Report types and standards/guidelines

Of the total number of 366 reports that were analysed across the 30 companies and three different industries, the most common reports found to include non-financial information included annual integrated reports (150), sustainability reports (50), and governance reports (46) (Table 2). The least common reports included those reports that were specific to the company and were transformation reports (one), Basal 3 disclosure report (one), and water report (one).

The Basic Materials had the second highest number of report types seen across the three industries, with a total of 109 reports analysed for the study. Annual integrated reports accounted for the highest number of report types seen for this industry with a total of 45 reports analysed for the nine companies over the five years. This was followed by sustainability reports (22), and climate change reports/position statements (13). The fewest number of report types were accounted for by company-specific reports and there was a total of one report for each of the specific company reports.

The Financials industry accounted for the greatest number of report types across the industries, with a total of 169 reports that were analysed. Annual integrated reports made up the highest number of reports for this industry with a total of 70 reports analysed over the five years. This was followed by Governance reports (25), and Sustainability reports (17). The fewest number of reports were seen to be CDP reports (one), GRI report (one), Transformation report (one) and Basal 3 Disclosure report (one).

Within the Consumer Services industry, a total of 82 reports were analysed. Of these reports, annual integrated reports were the most common at 35 reports over the entire five-year period for the seven companies. This was followed by Governance reports (15), and sustainability reports (11). The fewest number of reports in this industry were seen for social reports (10), Good Business Journey reports (five), Climate Change/Climate Position statement reports

Table 2. The 366 company annual reports were analysed for interconnections for the company annual reports systems map, with 169 reports for the financials industry, 109 reports for the Basic Materials industry, and 82 for the Consumer Services industry over the five years (2017 to 2021).

Report type	Basic Materials	Financials	Consumer Services
Annual Integrated Report	45	70	35
Sustainability Report	22	17	11
Climate change report/climate change position statement	13	7	4
Good Business Journey	-	-	5
Social Report	-	-	10
CDP reports	1	1	2
Report to Society	-	13	-
TCFD	2	8	-
ESG	4	7	-
Principles for Responsible Banking	-	9	-
Governance Reports	6	25	15
Resilience Report	-	3	-
Risk Disclosure	-	4	-
Social and Ethics Committee Report	1	2	-
GRI Report	-	1	-

Report type	Basic Materials	Financials	Consumer Services
Transformation Report	-	1	-
Basal 3 Disclosure	-	1	-
Water Reports	1	-	-
Biodiversity Management Report	4	-	-
United Nationals Global Compact	8	-	-
Carbon Management	1	-	-
Supplementary Report	1	-	-
Total	109	169	82

The total number of reporting guidelines, standards, and regulations seen was 72 across all three industries (Table 3), with a total of 27 guidelines/standards being used by Basic Materials, 30 by Financials, and 15 by the Consumer Services industry. The most common reporting guideline/standard across all industries included the King IV Code for Corporate Governance, followed by the Integrated Reporting Framework

Table 3. The percentage (%) of companies using each of the various reporting guidelines/standards/frameworks from the various 366 company reports across the three industries observed in this study over five years (2017 to 2021).

Reporting Framework/guideline	Basic Materials (%)	Financials (%)	Consumer Services (%)
<IR> Framework	11.41	13.88	15.53
TCFD	5.03	5.36	1.94
SECR	0.34		
GRI (core option)	11.07	8.52	9.71
SASB	1.01	0.63	
FTSE/JSE SRI	1.34	0.63	3.88
Internally Developed Guidelines	1.68	0.32	
King IV Code	13.09	23.34	23.3
United Nations Global Compact (UNGC)	9.06	0.63	3.4
United Nations Sustainable Development Goals	3.69	3.47	4.85
SA Mining Charter 3	0.34		
SLPs	0.67		
ICMM	4.36		
JSE Listing Requirements	10.07	8.83	10.19

Metals and Mining Standard WGC Responsible Gold Mining Principles	1.01		
NYSE Listing Requirements	0.67		
Reporting Framework/guideline	**Basic Materials (%)**	**Financials (%)**	**Consumer Services (%)**
SA Companies Act 71 of 2008	10.07	7.89	10.68
SAMREC Code 2016	3.69		
Broad-Based Socio-Economic Empowerment Charter	4.03		
SA Companies Regulation	1.01		
Debt Listing Requirements	0.67		
United Nations Principles Reporting Framework	0.67		
AccountAbility 1000SES	0.67		
CDP	0.67	1.26	
Amendments to the Mining Charter	0.34		
EU Non-Financial Disclosure Directive	0.67		
MPRDA Act 28 of 2002	0.34		
UNEP		1.26	
FSC		3.15	
EE Act no. 55		0.63	
IFRS		10.09	9.71
UNPRI		0.95	
CRISA		0.95	

UNFCCC	0.32
IPCC	0.32

Reporting Framework/guideline	Basic Materials (%)	Financials (%)	Consumer Services (%)
Paris Agreement		0.63	
The Insurance Act 18 of 2017		0.63	
The Prudential Standards and Frameworks		0.95	
The Financial Sector Regulation Act 9 of 2017		0.32	
The Dow Jones Sustainability Index		0.63	
Regulation 43		0.95	
Dutch Corporate Governance Code		0.32	
Pillar 3 Disclosure Requirements		0.32	
SA Banks Act 94 of 1990		2.21	
Equator Principles		0.63	
OECD			1.94
ILO Principles			2.43
BBEE Act no. 53			1.46
Consumer EE Act no. 55			0.49

Occupational Health & Safety Act no. 85 of 1993	0.49

4.3 Company reporting connection scores

Overall, for the company reports, the key environmental factor with the highest mean score (Table 4) is seen to be climate change with a value of 2,90 (±2,10) followed by water availability with a value of 2,79 (±2,67). The lowest mean score is for biodiversity loss with a value of 1,98 (±1,40). A significant difference was found between the mean score values of the key environmental factors. Climate change had a significantly higher score than biodiversity loss ($F_{3,50}$=3,89; p=0.0000942). Water availability had a significantly higher mean score than biodiversity loss ($F_{4,535}$=16,01;p=0.0002758).

The dimension with the highest total mean score value is the economic sphere with a mean score of 2,94 (±2,28), followed by the environmental sphere with a mean score of 2,46 (±1,96). A significant difference was found between the means with a significantly higher mean score value seen for the economic/business sphere of 2,94 (±2,28) ($F_{9,353}$ = 1,97; p<0.001).

Table 4 The average connection scores for the key environmental factors across all three industries and 30 companies from annual company reports from 2017 to 2021.

	E	***S***	***E/B***	***Total***
Climate change	*2,78 (±1,69)	2,58 (±2,19)	3,27 (±2,53)	2,90 (±2,10)
Biodiversity loss	1,83 (±1,26)	2,19 (±2,19)	2,18 (±1,27)	1,98 (±1,40)
Water availability	*2,46 (±2,07)	2,57 (±3,82)	3,35 (±2,52)	2,79 (±2,67)
Land degradation	2,34 (±3,49)	2,05 (±1,58)	0,83 (±0,29)	2,22 (±2,39)
Energy/natural resources	2,43 (±1,57)	1,50 (±0,47)	3,67 (±1,30)	2,34 (±1,42)
Total	2,46 (±1,96)	2,29 (±2,33)	*2,94 (±2,28)	

'*' indicates a significant difference.

In the Basic Materials industry, it is seen that the highest mean score value for the key environmental factors is for ‘climate change’ (Table 5), with a mean value of 3,32 (±1,48). The lowest mean score is for biodiversity loss with a mean score of 2,58 (±1,10). A significant difference was found between the mean score values for the total scores of the key environmental factors. Climate change had a significantly higher mean score value amongst the key environmental factors ($F_{2,51}$=12,8; p=0.005).

The environmental, social, and economic/business mean score value was found to be the highest for the economic/business sphere across all key environmental factors with a mean score of 3,23 (±1,86), while the lowest mean score for the Basic Materials industry was found to be from the environmental sphere with a mean score of 2,82 (±1,90) across all the key environmental factors for the environmental sphere. There was no significant difference found between the total mean score values for the environmental, social, and economic/business factors.

Table 5. The mean connection scores for nine companies in the Basic Materials industry from company reports for the period of 2017 to 2021.

	E	***S***	***E/B***	***Total***
Climate change	3,15 (±1,31)	3,00 (±1,78)	3,72 (±1,51)	*3,32 (±1,48)
Biodiversity loss	2,40 (±1,06)	3,13 (±1,06)	2,68 (±1,17)	2,58 (±1,10)
Water availability	2,50 (±1,27)	3,50 (±2,02)	3,62 (±1,24)	3,10 (±1,51)
Land degradation	3,05 (±2,01)	2,50 (±0,93)	2,19 (±0,90)	2,67 (±1,57)
Energy/natural resources	3,02 (±1,24)	1,50 (±0,77)	2,56 (±0,81)	2,64 (±1,14)
Total	2,82 (±1,90)	2,93 (±2,74)	3,23 (±1,86)	

'*' indicates a significant difference.

For the Financials industry, the highest mean score (Table 6) was seen for ‘climate change’ with a total mean score value of 1,66 (±0,67) across each of the three dimensions. This is followed by energy/natural resources with a value of 1,24 (±0,23). The factor with the lowest mean score across the three dimensions and the key environmental factors is ‘land degradation’ with a total mean score value for this factor of 0,50 (±0). A significant difference between the mean scores was found across the key environmental factors. With climate change having a significantly higher mean score value ($F_{3,49}$=2,84; p=<0.001). Land degradation had a significantly lower mean score value ($F_{3,20}$=3,10; p=<0.001). Water availability had a significantly lower mean score value than climate change ($F_{4,50}$=2,61; p=<0.05).

For the Financials industry, we see that the economic sphere had the highest mean score with 1,52 (±0,73), while the lowest mean scores are seen to be from within the environmental sphere for all the key environmental factors.

Table 6. Average connection scores for 14 companies from the Financials industry from the company reports from 2017 to 2021.

	E	*S*	*E/B*	*Total*
Climate change	1,50 (±0,64)	1,28 (±0,51)	1,66 (±0,67)	*1,66 (±0,67)
Biodiversity loss	0,70 (±0,08)	1,00 (±0)	1,10 (±0,30)	0,92 (±0,17)
Water availability	0,70 (±0,08)	0,75 (±0,08)	0,83 (±0,83)	*0,75 (±0,07)
Land degradation	0,5 (±0)	0,50 (±0)	0	*0,50 (±0)
Energy/natural resources	1,21 (±0,07)	1,38 (±0,48)	1,00 (±0)	1,24 (±0,23)
Total	1,15 (±0,45)	1,17 (±0,41)	1,52 (±0,73)	

'*' indicates a significant difference.

The connection scores for the five key environmental factors from seven companies within the Consumer Services industry (Table 7) show climate change with the highest mean score across the five key factors and all three dimensions spheres with a score of 2,91 (±1,31). The key environmental factor with the lowest mean score across the five key environmental factors is seen to be land degradation with a mean score value of 1,19 (±0,60). A significant difference was found between the mean connection scores of the five key environmental factors, with climate change having a significantly higher mean score ($F_{10,678}$=1,831; $p<0.001$).

Factors in the economic dimension scored highest with a mean score of 3,02 (±2,69). There was a significant difference between the mean scores for the three dimensions with a significantly higher mean score value for the economic factors against environmental and social factors, with no significant difference between the social and environmental dimensions ($F_{6,883}$=2,099; $p<0.001$).

Table 7. Mean (±SD) connection scores for five key environmental factors within the environmental, societal, and economic sphere for the Consumer Services Industry for seven companies and their annual reports for the period of 2017 to 2021.

	E	***S***	***E/B***	***Total***
Climate change	2,76 (±1,14)	2,90 (±1,00)	3,21 (±1,77)	*2,91 (±1,31)
Biodiversity loss	1,00 (±0,34)	0,50 (±0,00)	2,17 (±0,82)	1,24 (±0,75)
Water availability	2,71 (±1,59)	1,50 (±0,65)	3,29 (±1,90)	*2,75 (±1,69)
Land degradation	1,30 (±0,63)	0	0,83 (±0,29)	1,19 (±0,60)
Energy/natural resources	2,17 (±1,06)	1,70 (±0,67)	3,19 (±1,15)	*2,56 (±1,19)
Total	2,31 (±1,77)	*2,06 (±1,45)	*3,02 (±2,69)	

'*' indicates a significant difference

4.5 Similarity map

Most of the connections that were made in company annual reports and literature are seen to be between all the key environmental factors. Every connection to key environmental factors made in company annual reports was covered by the literature sources, with only a few connections that were made in literature not having been made by company annual reports, or at least not having been highlighted as important or as repeatedly as they had been highlighted in the literature resources, highlighted indicating number of times reported on throughout various reports (Figure 11). The factors ‘climate change’ and ‘ecosystem degradation’ were repeatedly highlighted by literature resources but were not highlighted in company annual reports. Similarly, ‘land degradation' and ‘ecosystem degradation’ were repeatedly highlighted and connected in multiple literature resources, however, they were not highlighted in company annual reports.

‘Land degradation’ and ‘economy’ were repeatedly highlighted and connected in literature resources but were not repeatedly highlighted to the same weighting in company reports (Figures 4 & 5). ‘Climate change’ and ‘Development/infrastructure’ were repeatedly connected in literature sources but were highlighted less frequently and connected less in company reports. ‘Governance/management’ was repeatedly connected to ‘Energy/natural resources’ in literature, but less repeated in company reports. Connections between ‘Land degradation’ and ‘Water availability’ were repeatedly highlighted by literature resources but were less highlighted by company reports, and so did not appear as often in company reports as they did in literature. ‘Energy/natural resources’ were repeatedly highlighted as connected to ‘Land degradation’ by literature but less so in company reports.

Many of the social factors that were linked to other factors that were covered in literature were not highlighted as important by company reports, especially regarding the factor ‘food security’ which is strongly linked to other factors such as ‘agriculture’ and ‘climate change’ within the literature. However, these same connections were not repeatedly seen in company reports. Connections that were not highlighted by company annual reports in the social sphere include ‘Food security’, ‘poverty’, ‘society’, and ‘human health’. Connections between the social factor ‘food security’ and economic factors are not seen from company reports, however, these connections are seen between ‘food security’ and ‘economy,

‘governance/management’, ‘urbanisation’ and ‘development/infrastructure’ from literature sources.

Connections that were not considered in company reports were those mainly seen between social and economic factors. In the similarity map (Figure 11) connections between the environmental factors and social factors can be seen, as well as connections between environmental factors and economic/business factors, however, the social and economic/business factors are not connected in turn.

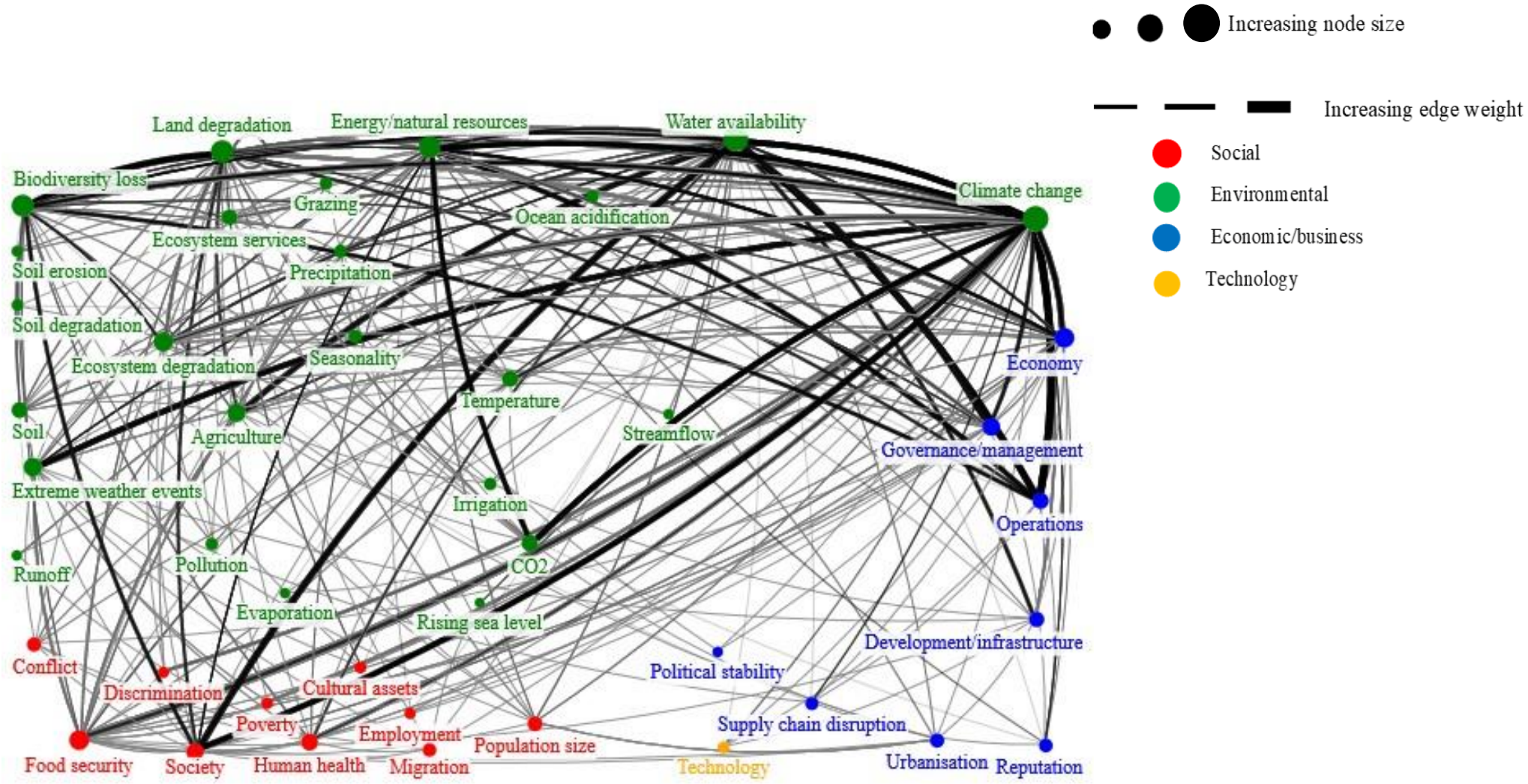

Figure 11. The similarity map highlights similarities between environmental, social, and economic/business connections in company reports, seen in black, and connections from literature resources, seen with grey lines.

4.6 Interviews

An interview sample size of 30 ESG analysts/sustainability managers was aimed for in this study. However, there was a lack of response from most companies approached, and companies who were certain all information could be gathered from reading the company reports, which was already done as part of the company report analysis.

Not enough data was collected for this section of the results to be conclusive. However, from the 3 interviews that were conducted, participants were all in agreement about the challenges related to reporting. This challenge was seen to be a data-driven challenge. One participant noted that challenges lay around differing departments conveying their data for the collation of reports.

Chapter 5: Discussion

Environmental, social, and economic/business factors are the main factors underpinning current data trends in reporting within companies in South Africa (Johnson *et al.,* 2019; Saini *et al.,* 2022). Reporting on these non-financial factors in a business has very positive implications for that business and its investors (Saini *et al.,* 2022). Yet non-financial reporting can pose many challenges for businesses, and many factors are often difficult to report on, such as historical greenhouse gas data or the indirect impacts of climate change, as these may be more difficult to identify (He, 2022). This could be due to the unavailability of data, reporting fatigue, or even due to the overwhelming number of reporting regulations which can make reporting vague. Viewing these factors through a systems lens would ideally aid businesses in evaluating and conveying specifically environmental and social risks to their stakeholders comprehensively and strategically (Acadian, 2021). A systems lens would imply viewing these factors as interconnected and not in isolation, which would allow for much better risk management, and further create value for companies and their investors. Much of the current reporting conducted by companies in South Africa focuses on these issues in isolation or with loose connectivity to other factors that in literature are linked in complex networks and need to be accounted for when considering risks to business capital (Kotsiopoulos, 2018). A recent study considering a systems approach to implementing and achieving SDGs conveys the potential that a systems approach could have in improving efforts, specifically within South Africa, where increased stakeholder engagement has become pertinent (Dhilwayo & Mabugu, 2023). An example in the case of this study, is the increase in focus on economic growth and the interconnectedness of this factor with unemployment, and further the linkages between inequality, where a systems approach would ensure greater outcomes based on interconnected policies acting to solve issues (Dhilwayo & Mabugu, 2023).

In this study, I thus set out to assess the level of interconnectivity between sustainability factors in company annual reports based on connections determined in literature sources. In this study I also set out to determine where gaps in connections were in company annual reports and through interviews, I aimed to determine why these gaps may still exist and why.

Overall, connections between environmental, social, and economic/business factors in literature were far more complex than the connections addressed by companies in their reporting. Climate change was found to be the most important environmental risk in both peer-reviewed literature and company reports, with this factor being the factor with the most degrees in all system maps, besides the Basic Materials map (Figure 6) where it was second highest. Whilst companies have shown remarkable improvement in their reporting and also in connecting factors compared to the study conducted in 2018 by Kitsokopolous, there is still room for significant improvement to ensure a systematic approach to reporting, especially amongst societal and economic/business factors, by ensuring that more complex connections are made and not only direct/linear connections between environmental factors and either social or economic/business factors as was the case in company annual reports. These complex connections could be those that are seen to connect environmental factors with a factor in the social sphere, as well as a factor within the economic sphere, for example, linking climate change with biodiversity, and further with the economy, or governance impacts.

5.1 Thematic content analysis: Interconnectedness map from literature

The literature sources that were consulted for this study were sources that revealed five environmental issues in South Africa namely, climate change, water availability, biodiversity loss, land degradation, and energy/natural resource loss (Darkoh, 2009; Chersich *et al.,* 2018; Mani *et al.,* 2021). Climate change was the key environmental risk which, for South Africa in particular, was seen to have a far-reaching impact and was associated with a large variety of impacts across all literature sources, indicating the high level of risk associated with this factor (Nhemachena *et al.,* 2020; van der Bank & Karsten, 2020; Ziervogel *et al.,* 2022). Climate change was connected to most of the other factors in the interconnectedness map, apart from ‘pollution’, ‘runoff’, ‘streamflow’, and ‘employment’. Climate change was connected to every economic/business factor within the map, showing this factor’s impact as a potential risk to the economic dimension (Blignaut & van Heerden, 2009; Molobela & Sinha, 2011; Calverley & Walther, 2022).

Climate change has multiple far-reaching impacts and will likely, especially within South Africa, have exhaustive impacts, thus, these connections become far more evident in

literature studies (Ziervogel *et al.,* 2014; Masipa, 2017). Where climate change was not connected to certain factors, these were not missing links, but rather links that were not directly made. For example, 'climate change' may have an impact on 'extreme weather events', which may ultimately lead to impacts on 'streamflow', or 'climate change' may impact 'precipitation patterns', thus, leading to impacts such as 'runoff' (Brosse *et al.,* 2022). It is therefore seen that 'climate change' can relate to many different factors, both directly and indirectly (Hime *et al.,* 2018).

One major area of impact of climate change was on human health and well-being (Chersich *et al.,* 2018). The study conducted by Chersich *et al.* in 2018 conveys that impacts on health will be far-reaching with health systems unable to bear the burden in a country where decent health care is currently unattainable by most of the population (Maphumulo & Bhengu, 2019; Govender *et al.,* 2021). These impacts will be exacerbated by the predicted increasing summer temperatures in South Africa, with cases of heat exhaustion and other various diseases increasing in number and severity, affecting much of the population, and straining the human capital in South Africa as working conditions could become unbearable (Chersich *et al.,* 2018; Wright *et al.,* 2021). These health issues are further linked to economic gaps, with the poor in the country suffering more as they become more susceptible to poor health conditions and lack of basic access to health care (Govender *et al.,* 2021). This further drives the inequalities seen in the country and exacerbates the already high levels of discrimination in South Africa, further interconnecting the social factors with environmental factors (Govender *et al.,* 2021).

Another pressing issue highlighted by literature was the connection between climate change and another societal factor, food security. Climate change will have profound implications for the agricultural sector, and therefore on the consumer services industry and the ability of this industry to provide food security to the nation. Rising temperatures and extreme weather events will have devastating impacts on food security within the country (Masipa, 2017). South Africa is a country wherein there is already a prominent lack of food resources to ensure the health of all its citizens (van der Berg *et al.,* 2022), therefore the exacerbation of increased temperatures would lead to threatening the health of crops and livestock (Masipa, 2017). Increasing climate change impacts also pose a threat to water resources, which in turn leads to increased implications for food security

and human health in the country, indicating a complex connection between these factors (Xola, 2021).

Connections between water availability and management of this resource were complexly linked in literature. This resource is a critical component for any organization that uses water and further especially in the Basic Materials industry where water management is critical for corporate social responsibility (Molobela & Sinha, 2011; Garcia-Zavala, 2023). The lack of this resource also impacts societal factors such as food security, and human health and can lead to conflicts around gaining this resource (Calverley & Walther, 2022). Land degradation was also focused on in literature, as land degradation is closely linked to climate change in literature where a complex interconnected relationship between land degradation and other environmental, social, and economic/business factors exists (Mani *et al.,* 2021). Land plays a critical role in most of the other factors within the environmental, social, and economic/business sphere, with a nexus existing between land, water, and energy in South Africa (UNCCD, 2022). Land is a vital resource which had many important social connections, such as 'food security', 'poverty', and 'human health'. In South Africa, especially, there is a vital link between land and social justice, with access to viable land enhancing the lives of individuals and allowing for reduced poverty and food security (Mtero *et al.,* 2021).

Energy/natural resources was well connected to the other five key environmental factors. This factor was also connected within the economic/business dimension, with the strongest connection between this factor being with governance/management. The improvement of governance/management practices with energy/natural resources can lead to the improvement of output and preservation of these resources, especially in economies that are still growing (Chen *et al.,* 2023). Energy/natural resources have a great connection to CO_2 within the environmental factors sphere, this indicates the risks that exist with CO_2 often being connected to energy/natural resources because energy currently produced still contributes to CO_2 emissions, especially in South Africa, where coal usage remains high (Hanto *et al.,* 2022). These emissions pose risks towards the 'just transition' in South Africa, and therefore mainly impact Financial institutions and those companies who are high emitters (Mirzania *et al.,* 2023). The just transition refers to the transitioning to a low-carbon economy, and moving away from the use of fossil fuels, thereby financing projects

not in line with the ‘just transition’ could pose risks (Mirzania *et al.,* 2023; Otlhogile & Shirley, 2023).

Biodiversity loss is the fifth key environmental factor that literature places a great emphasis on in South Africa. This factor was connected to all other key environmental factors and had the strongest connection with energy/natural resources. The depletion of resources and biodiversity loss will have dire consequences on humans, as this can impact food sources (Xiong *et al.,* 2023). Biodiversity loss also had connections to other societal factors such as ‘human health’, ‘cultural assets’, ‘population size’, ‘society’, and ‘food security’. Literature was able to convey the complexity of the relationship between biodiversity loss and society. Impacts likely to be seen are significant and disrupt food supply, and ecosystems, leading to outcomes that are likely still not fully understood (Díaz, 2006; Roe, 2019).

South Africa is a country that has, for many years, faced social injustices with a past that has amplified the discrimination and disparities between race and gender. Many of the current issues seen within the country stem from social issues which are highly exacerbated by environmental issues and economic injustices (Govender, 2016; Hlahla & Hill, 2018; Dasgupta *et al.,* 2023; Sibiya *et al.,* 2023). Literature therefore places a great emphasis on the social issues that are interconnected with not only environmental issues but also economic/business factors within the country (Van der Westhuizen & Swart, 2015). The literature systems map connects social factors to other factors within the social sphere and to economic/business factors, as well as to environmental factors. Society is connected to ‘economy’ and ‘governance/management’ and within the sphere, the factor ‘food security’ is connected to ‘poverty’. Connections such as these are complex and indicate that a risk to one factor can further impact or pose a risk to another factor.

Economic/business factors are similarly connected to not only other economic/business factors but also to social factors and environmental factors. Although well connected within the economic/business sphere, there are still gaps that exist between economic/business factors in literature and certain environmental and social factors. For example, although a connection between climate change and ‘governance/management’ did exist in the literature, this connection was not as well connected as expected. Governance/management is a huge aspect of industries, and even more so when connected

to climate change (Sridhar *et al.,* 2022). However, there are still many important connections that have been made between this sphere and factors from other spheres. Connections between governance/management and social factors such as 'conflict' and 'food security' all indicate that these are risks that need to be considered.

5.2 Report content analysis

The analysis of company reports showed climate change to be the main environmental risk reported. Climate change is a factor that poses many material risks to companies around the world (de Wit *et al.,* 2023). These risks were linked to selected social, environmental, and economic/business risks that would impact the company's financial capital and its investments and longevity in the future (Sustain Case, 2017; Laidlaw *et al.,* 2022).
The company report map showed a lower graph density than the literature map, indicating that there was a much lower level of connection among factors in the company report map. These findings are in line with the study conducted by Kitsikopoulos (2018) who found that fewer connections existed between the factors in company reports as compared with literature and those that did exist were considered linear in connectivity compared to the complex connections made in literature. These results are also consistent with those found in another study where company reporting was found to be far less about connecting factors and rather about explaining the context of risk assessment done in a company (du Toit *et al.,* 2017). Therefore, whatever a company determines to be a risk to the capital of that company is what a company may focus on when releasing its reports to stakeholders and investors; this incorporates any information relevant to the company's operations (Bell & Taylor, 2023).

In South Africa climate change has already affected industries in a multitude of different ways, with many of these risks being either direct or indirect. Many companies in South Africa are now expressing climate change in terms of either physical or transitional risks, which further validates that within the analysis of company reports climate change is a factor that can pose great economic risks to businesses (PwC, 2021).

Physical risks are risks linked to extreme weather events such as the destruction of property or operational shutdowns. In 2022 alone, floods caused by extreme weather events caused

damage in South Africa amounting to R17 billion rand alone, this is concerning as these incidents of extreme weather are predicted to increase in frequency in the future (Viljoen, 2023). Physical risks also impact intellectual capital by disrupting human productivity, especially in cases where human health is impacted. These impacts extend to hindering work in tough and harsh conditions. Manufacturing and financial capital also become impacted as there are increased pressures on infrastructure due to physical risks from extreme weather events which are exacerbated by climate change (Ebi *et al.,* 2021). Extreme weather events were not well connected to economic/business factors or social factors, a critical link that is important for risk assessment in businesses.

South Africa is currently experiencing significant shifts in line with a just transition to renewable energies (Connolly, 2022). Strong links in both literature and company reports indicate the relationship between climate change and greenhouse gas emissions such as carbon dioxide. These emissions are contributing to climate change, which further exacerbates other factors. The contribution towards climate change impacts the reputation of businesses and enhances risks in the Just Transition (Connolly, 2022).

Water availability had the second-highest number of connections within the company reports, which was in line with the results seen from the literature map and other studies (see Kitsikopoulos, 2018). Water availability is a crucial factor in businesses, across any sector this factor is essential for productivity within the value chain, with water being used for most manufacturing processes. However, in the study by Kitsikopoulos (2018), many factors were linked to water in the literature that were not linked to water in the company reports that were analysed. The results in this study indicate that these connections have since increased, indicating that company reports have been able to make distinct connections between water and other environmental, social, and business-related factors. However, in this study, there were still many literature-based links that were not identified in business reports.

In the case of water availability, company reports tended to neglect connections with social factors and to a lesser extent business or economic factors. In this regard water was heavily reported on in terms of water targets and goals, however, the risks that a lack of water would lead to were not adequately conveyed. A critical link that is not highlighted as frequently in company reports in the Consumer Services industry is the link between water

availability and food security. Water availability is essential for the growth of crops and aids greatly in food security (Vilakazi *et al.,* 2019).

5.2.1 Basic Materials Industry

The Basic Materials Industry in South Africa is an industry that has a distinct connection with the environment by virtue of the operations conducted such as mining for example and has led to this industry being expected to report on their non-financial data for much longer than other industries, as well as with more depth (Munnik, 2010; Carvalho, 2017; Sturdy & Cronje, 2017). There are multiple direct impacts that the activities of this industry have on not only the environment but also on society (Carvalho, 2017; Mancini & Sala, 2018). This industry undoubtedly has shown a lot more interconnectivity within its reporting on non-financial aspects over the past years (Steele-Schober, 2021; Mazza, 2022).

Water availability was seen to be the factor with the most interconnections for this industry. Water-related risks are becoming an increasing challenge for the Basic Materials industry as many of the processes in mining and extracting raw materials depend on a supply of water (Dietler *et al.,* 2021). Many of these processes also tend to disrupt the availability of clean water for those communities that are directly affected by this industry's operations (Ochieng *et al.,* 2010). This industry thus places a great emphasis on reporting on their targets, goals, and usage of water for stakeholders.

Connecting water-related risks to other risks was well done in the reports for this industry. Water availability was connected to factors from all three spheres with the greatest connections seen between water and society, operations, governance/management, and Energy/natural resources. Critical connections are still lacking between societal factors and economic/governance factors within reports from this industry. This conveys that companies in this industry can make the critical linear and direct connections but are unable to make more complex connections between more specifically the social sphere and the economic/business sphere in their reports and how these may be linked back to the environmental sphere. These connections were made in literature and so could be made by company reports (Rawashdeh *et al.,* 2016; Widana, 2019).

Many of the companies within this industry are guided by multiple frameworks and guidelines that are crucial to the reporting and governance of these companies. This has allowed companies in this industry to have time and practice with reporting to enable them to effectively bolster the skills of conveying material risks and opportunities in a way that incorporates a level of interconnectedness between risk factors (Janse van Rensburg *et al.,* 2019; Iredele & Moloi, 2020). However, there is still a level of transparency that could be increased for factors to be more connected within this industry's company reports, this goes beyond simply reporting risks but connecting risks and embedding risks in a systems approach (Carels *et al.,* 2014)

Strong connections in the Basic Materials industry were seen between Climate change and several of the economic sphere's factors. Factors not connected to climate change in this industry's map included 'political stability' and 'Urbanisation'. Strong connections were found between climate change and the economy, as seen in the literature map. Within the societal factors, the Basic Materials industry did not include the factors 'poverty' and 'migration', indicating that there were no connections between the key environmental factors and these societal factors in the reports for this industry. Connections between social factors are critical for this industry as there are multiple socio-economic impacts that mining activities have on communities surrounding their operations (Rey-Martí *et al.,* 2023).

A crucial connection that was prioritised in literature, but had the least connections made with it in the Basic Materials industry was land degradation. This is a surprising result as land plays a vital role in the activities of mining companies, and is often impacted negatively, which ultimately impacts communities and livelihoods (Gbedzi *et al.,* 2022). Land degradation has a vital link to the availability of water resources, as has been identified by several studies, there is a gap, however, in the fact that land degradation was connected so poorly to water resources and had the fewest connections overall for this industry (Karmakar & Das, 2012; Gbedzi *et al.,* 2022). There is also a cost that comes with land degradation, with a study in 2015 showing that global land degradation impacts amounted to a cost of US$231 billion (Nkonya *et al.,* 2015). These economic costs may not always be accounted for by mining companies, but with increasing pressure for transparency and accountability from stakeholders, this environmental risk will certainly

present greater economic risks in the future as currently occurring (Aldy & Viscusi, 2014; Campiglio *et al.,* 2022).

The Basic Materials industry map had the highest number of vertices compared to the other industries, and this indicates that far more factors have been included in their reports. This could be attributed to their longer duration of reporting and the pressure on these companies due to their activities which often have social and environmental impacts (Seloa & Ngole-Jeme, 2022; Serfontein-Jordaan & Dlungwane, 2022).

5.2.2 Financial Industry

Climate change was the top factor highlighted by the financial industry. There were many weighted connections to this environmental factor in company reports. This industry does not necessarily have a significant impact on the environmental sphere, at least not directly. However, as noted in the literature, there are serious implications posed by climate-related environmental risks for financial institutions, and this can present itself in the form of insurance claims and impacts on lending portfolios and loan books (Nor *et al.,* 2016). Two categories of risk are seen for this industry, either physical or transitional risks. The physical risks have direct impacts on the environment such as extreme weather events, and this risk also translates further into risks that are direct short-term and long-term risks such as a changing climate that can alter the Earth's functioning (Kearns, 2022). The transition risks are those associated with the just transition and likely manifest through a financial institution's lending and investment portfolios, damaging reputations with investors and stakeholders (Kearns, 2022). The reputational damage presents risks due to investing in companies or providing funding to companies that are not themselves on the journey to transition to net zero (Galletta *et al.,* 2022).

The Financials map indicated that there were more connections made due to the graph density being higher than that of the Basic Materials industry. The Financials map had a lower graph density compared with the Consumer Services industry, this made sense as there were more connections seen amongst the Consumer Services than the Financials industry. However, the Basic Materials industry had more connections and a lower graph density, which may be due to the higher number of factors that were found, thus, more

factors were identified and connected. This increase in connected factors may have led to more factors, however, these factors not being as connected as those within the Financials map.

Many critical connections were not addressed, especially in the environmental sphere. The Financials industry only identified four economic/business factors. These factors were 'governance/management', 'operations', 'economy', and 'reputation'. Economy and operations were connected strongly to climate change. However, there were fewer connections made between climate change and governance/management, a critical connection that has become crucial for companies, especially in companies where certain frameworks, such as the TCFD, are applied or even governance controls such as King IV (Reddell, 2018; Averchenkova *et al.,* 2019; Corvino *et al.,* 2020).

Climate change was connected well to CO_2, this connection aligns with literature wherein there is a transitional risk of the financing of portfolios that are contributing to emissions and further climate change (Diluiso *et al.,* 2021; Prasad *et al.,* 2022). Climate change was also linked to society. This connection is important as it is vital in literature with many climate-related impacts that will pose risks to society in a multitude of ways, and this will ultimately impact financial institutions as their clients will be impacted heavily (Shi, 2018; Abbass *et al.,* 2022).

Water availability was another factor that was not connected well in the financial industry map, along with land degradation. These are also critical connections that would have been expected to be seen with more connectivity in this industry. The financials industry does not necessarily have a direct impact on the environment as with the Basic Materials industry, this may be why critical connections are lacking for this industry (Scott, 2023).

Land degradation was the factor with the lowest connections out of the five key environmental factors, whilst literature bolsters this factor and how critical of an issue this factor is in South Africa (Mani *et al.,* 2021). It is, therefore, interesting that this factor does not get highlighted as it does in the literature. The reasons this may be seen are due to these institutions not having direct impacts on the environment, and so the connections that these companies have with land degradation are reported more vaguely (Tamazian & Rao, 2010; Akhtar-Schuster *et al.,* 2011).

5.2.3 Consumer services

In the Consumer Services industry map the factor with the highest number of connections was seen to be climate change, this was the case for the literature. Climate change is a pressing matter with many material risks for business capital (Panfil & Victor, 2022). Most connections with climate change were found to be with 'operations', 'CO_2', 'water availability', 'food security', and 'society'. From the literature map, there were far more weighted connections between 'climate change' and 'food security', this indicates that companies within the Consumer Services are making this vital connection as climate change is likely to impact this industry's ability to gain food items if crops are compromised (Leonard, 2022; Mutengwa *et al.,* 2023).

Similarly, climate change will also impact extreme weather events, which again will impact food security, and this was captured by the industry's map. As has been shown in Masipa's study, extreme weather events impact land and agricultural systems, which in turn place pressure on food security and resources, amplified for those who are already facing levels of poverty (2017). Poverty was a factor that was not identified by the Consumer Services report analysis, and as such it conveys that vital connections are not being made. Agriculture is, however, connected to climate change and water availability in this map, this conveys the crucial connections for this industry, with agriculture being heavily reliant on water resources (Nhemachena *et al.,* 2020). A study shows that more than 100 million people are at serious risk of hunger in the future under currently predicted climate change scenarios, which are set to impact agriculture and the economy, these vital connections, such as a connection between climate change/lack of water availability and food produced from agriculture being impacted, will need to be amplified in company reports in the future, as this poses great risk to the industry (Adom, 2024). Risks resulting from this connection would be lack of resources, and thereby decreased financial revenue for this sector, and further socio-economic impacts resulting from increased hunger and poverty (Shushu *et al.,* 2021).

Land degradation was the factor with the least connections among key environmental factors. This trend was followed for all company maps. The reason this may be the case for this industry is because this may seem to be a factor that is not directly related to the

operations of the industry. We see weak connections between this factor and operations, and this may suggest that there is a lower risk perception (Freudenstein *et al.,* 2021; Wiedemann *et al.,* 2023).

The connections that are not being made by this industry's reports are connections amongst social factors. Only four societal factors were identified in the company report analysis, and this has many implications for an industry that is directly involved with customers and providing for their needs. There were no connections between societal factors and economic/business factors, which is an area that could pose a risk for this industry, and with little research surrounding this industry, these risks may be ever hard-hitting if risks cannot be adequately assessed or managed (Lele, 2012).

5.3 Interviews

Conducting interviews was a difficult part of this research process. Companies are very transparent with their reporting and so much of the information that they provide is available in these reports. However, the struggles that companies are facing are often vague and not incorporated into the reporting. Thus, it becomes difficult to understand the realities that companies are facing when it comes to reporting on environmental, social, and economic/business factors.

Many companies were unable to participate in this study due to the busy schedules that many of the sustainability managers and ESG analysts are facing. It was portrayed that any information that would be relevant to the study could be found within the reports that the companies released, however, these reports often do not convey the full story that is needed to be understood by researchers. This is not the fault of the company, the companies in this study were all able to convey very important information regarding nonfinancial disclosure, however, the interconnection that was lacking could not be explained by the reports alone.

The few interviews that were conducted unsurfaced a couple of complex issues that may explain the lack of interconnectedness seen within company reports. Issues seen were the collection of data that would be used whilst compiling reports. Within companies, many different departments are working simultaneously, and the information regarding how that department is operating will be used to compile company reports. One of the participants

noted that this was one aspect of reporting that became difficult as these different departments tended to take longer to convey information to those compiling reports and often this caused a lack of interconnectivity between factors, these issues have been documented from other companies as well (NetSuite,2023).

5.4 Conclusion

Company reports have become far more inclusive of the vital connections between critical business factors since the study by Kitsokoupolous (2018). This shows progress in the landscape of South African reporting and increased interest in non-financial factors, which reflects the urgent need to address implications relating to sustainability in business (Kolk, 2004; Lozano & Huisingh, 2011)

Land degradation is a vital factor that is under-reported in company annual reports, and yet has a strong emphasis placed on it in the literature for its critical connections to society and climate change (Conradie *et al.,* 2019; Vorster, 2019; Mani *et al.,* 2021). As well as with the vital connection of land degradation, connections between social and economic/business factors do not exist. This finding shows that there is a lack of complex connections between factors and that most factors are being connected, but on a linear level. These linear connections may be harmful from a risk perception perspective as they could lower the perception of a risk that could be more potentially impactful (Lele, 2012).

For business risks to be adequately prepared for or adapted to, it should be imperative that companies are fully aware of the scope of that risk (Zainuddin *et al.,* 2022). This is where a systems approach to managing risks, specifically in this case environmental, social, and economic risks, could potentially help increase transparency within the reporting landscape and allow companies to attract more investors due to the knowledge of and management of risks (Mohammed & Knapkova, 2016).

Many of the problems that could be preventing companies from using a systems approach vary from levels of uncertainty to a lack of technology. Collecting ESG data poses critical challenges for most companies, and even with sound reporting regulations and frameworks, collecting, and collating this data becomes problematic (A-Team, 2022). ESG data for most industries is data that has not been collected as extensively as financial data,

the implications of this are a lack of data to compare against, and difficulty in understanding how to collect this data efficiently to present the data to shareholders (Ateam, 2022). In some industries, such as the Basic Materials industry, online platforms are used to collect the data which then still needs to be collated and presented efficiently. This may become problematic as certain teams involved in compiling company reports have very little context surrounding the data presented to them, leaving them unable to make connections between ESG factors based on the uncertainty around the data.

Reporting fatigue could also play a role in the lack of more complex connections (Davis, 2020). Reporting fatigue often results in reporting that is more in line with a tick-box approach, thereby limiting the possibility for connections to exist (Davis, 2020). In a study conducted reporting fatigue was one factor that was found to be part of the challenges with ESG reporting, and their findings indicated that a software framework for ESG reporting may help alleviate this fatigue (Cruz & Matos, 2023). This software would enable complex connections to be drawn from ESG data and may also eliminate the issues that ESG data presents for most companies (Cruz & Matos, 2023).

A systems approach could be a solution to ensuring better reporting, and increasing the level of risk management to adequately prepare for complex risks that take the form of wicked challenges (Barkhuizen *et al.,* 2012; Chondrogianni & Karatzas, 2023). Companies have made progress in their reporting; however, many critical factors are still underreported or not adequately connected to convey the complex risks they pose to businesses.

5.5 Limitations and future studies

The limitations faced in this study centre mainly around human error. Some connections may have been missed during the thematic content keyword search due to differing terms applicable to differing industries and oversights on these connections. Literature sources were directly aimed at the topic at hand, and as such gave connections that were desired, company reports were not aimed specifically at the five key environmental factors, thus, leading to discrepancies in making connections and capturing connections.

Another limitation was the conducting of interviews, many companies were approaching year-end when the interviews were being conducted, and thus, interviews were difficult to

organize. This leaves a gap in the research that would have potentially added value to the findings through context surrounding company reporting.

Future studies could focus on expanding the study by focusing on more countries within the JSE-listed companies to do a deeper analysis and comparison of sectors.

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Chapter 7. Appendices

Appendix 1

Table 8. Definitions of factors found in literature resources.

Factors	Definition	Citation
Agriculture	Includes farming to produce food. On both large and small scales.	(IPCC 2014; Sutton et al., 2016; Barbier & Hochard, 2018; Danish et al., 2019; Talukder et al., 2021; WEF 2021; IPCC 2023)

Biodiversity loss	The loss of organisms within ecosystems, this includes animals and vegetation. It can also refer to the disturbance of the organisms within ecosystems, not specifically the whole loss. Causing a loss of function within the ecosystem if crucial organisms are lost	(IPCC 2014; Di Marco *et al.,* 2019; IPCC 2023; Powers & Jetz, 2019; Nunez *et al.,* 2019; WEF 2020)
Climate change	Refers to the change in climate due to anthropogenic activities, resulting in altered atmospheric temperature and structure therefore impacting weather patterns.	(Conway et al., 2015; Betts et al., 2018; Mpandeli et al., 2018; Ray et al., 2019; Konapala et al., 2020; Tabari, 2020; Rusli et al., 2021; Talukder et al., 2021)

Greenhouse gases	Refers to the gases released due to anthropogenic activities that contribute to the warming of the Earth's atmosphere. These gases primarily consist of carbon dioxide.	(Betts et al., 2018)
Conflict	Refers to any conflict particularly civil conflict due to lack of resources	(Abel et al., 2019; Talukder et al., 2021)
Cultural assets	Assets that are crucial in providing cultural value to humans, whether through religious practices, cultural beliefs or through aesthetic enjoyment or leisure	(Sesana *et al.,* 2021; Chikodzi *et al., 2022)*
Development/infrastructure	Refers to projects and construction	(Barbier & Hochard, 2018; Mpandeli et al., 2018; Danish et al., 2019; Di Marco et al., 2019; Dahlmann & Bullock, 2020; Hamududu & Ngoma,

		2020; Talukder et al., 2021; Kahn et al., 2022; Rama et al., 2022)
Discrimination	Prejudice against an organisation or individual, particularly racism	(Islam & Winkel, 2017; Watson et al., 2020)
Economy	Includes all matters relating to finances of not only governments, but organisations, households, and businesses	(Barbier & Hochard, 2018; Hamududu & Ngoma, 2020)
Ecosystem degradation	Refers to the degradation of habitats and general function of an ecosystem	(Sutton et al., 2016; Betts et al., 2018)

Ecosystem services	The goods and services provided by nature to produce products, or to sequestrate greenhouse gases to lower climate change impacts	(Sutton et al., 2016; Di Marco et al., 2019)

Employment	The job opportunities resulting in the ability for humans to earn an income. Also refers to the life of an employee and their well-being	(Dahlmann & Bullock, 2020; Hamududu & Ngoma, 2020; Hussain et al., 2020; Konapala et al., 2020)
Energy/natural resources	Energy generated that provides humans with means to cook, produce goods and carry out services. Natural resources used to generate electricity	(Schaeffer *et al.,* 2012; Akuru *et al.,* 2015; Cronin *et al.,* 2018; Hunt *et al.,* 2020; Weiskopf, 2020; Muluneh, 2021)

Evaporation	The increased uptake of moisture into the atmosphere, especially with increased temperature	(Carrier *et al.,* 2016; Adegbule & Kibbey, 2022)
Extreme weather events	Weather events that result in natural disasters such as fires, floods, and tornadoes	(Betts et al., 2018; Mpandeli et al., 2018; Talukder et al., 2021)

Food security	The ability for individuals to ensure adequate sources of food are available and linked to the production of food	(Conway et al., 2015; Betts et al., 2018; Mpandeli et al., 2018; Ray et al., 2019; Talukder et al., 2021)
Governance/management	Refers to the governance or management at any level including local or international government. Management of resources in an organisation	(McIntyre-Mills, 2018; Di Marco et al., 2019; Dahlmann & Bullock, 2020; Rama et al., 2022)

Grazing	Refers to livestock grazing	(Sutton et al., 2016; Barbier & Hochard, 2018; Danish et al., 2019; Talukder et al., 2021)
Human health	Refers to the physical health and well-being of humans	(Mpandeli et al., 2018; Talukder et al., 2021)

Irrigation	The process of distributing water predominantly seen in agriculture	(Hamududu & Ngoma, 2020)
Land degradation	The altering of land types due to urban, agricultural, or business-related impacts. Land changes, deforestation.	(Sutton et al., 2016; Barbier & Hochard, 2018; Betts et al., 2018; Talukder et al., 2021)

Migration	The force exiting from an area or country due to unrest in that area	(Barbier & Hochard, 2018; Abel *et al.,* 2019; Talukder *et al.,* 2021)
Ocean acidification	The rising acid deposits in the ocean, resulting in hostile living conditions for ocean life. Usually seen due to chemical runoff	(Kroeker *et al.,* 2013; Falkenberg *et al.,* 2020)
Operations	The day-to-day workings of a company, crucial to delivering goods or services to customers	(Sonter *et al.,* 2018)

Political stability	Refers to the tension between ruling parties and citizens of a country or the tension between political parties	(McIntyre-Mills, 2018; Abel et al., 2019; Ray et al., 2019; Watson et al., 2020)
Pollution	Refers to any kind of pollution; air, water, chemical pollution	(Danish et al., 2019; Khan et al., 2022)

Population size	Number of individuals inhabiting an area	(Sutton et al., 2016; Barbier & Hochard, 2018; Hussain et al., 2020; Zubaidi et al., 2020; Seastedt & Oldfather, 2021)
Poverty	Refers to those living below the mean standard of living	(Barbier & Hochard, 2018)
Precipitation	Refers specifically to rain patterns	(Betts et al., 2018; Konapala et al., 2020; Tabari, 2020)

Reputation	The reputation of companies with their investors and stakeholders, as well as the general public	(Abel et al., 2019; Ray et al., 2019 ; Guastella *et al.,* 2022)
Rising sea level	The rise in sea water impacting coastal regions	(Betts et al., 2018; Edokpayi et al., 2018)

Runoff	Chemical runoff caused by heavy rains and extreme weather events	(Konapala et al., 2020)
Seasonality	Refers to the change in seasons and duration of seasons	(Konapala et al., 2020)
Society	Refer to general society at large	(Betts et al., 2018; Lehtonen et al., 2018; Konapala et al., 2020)
Soil	The change in soil chemistry, composition, temperature, or nutrients	(Seastedt & Oldfather, 2021)
Soil degradation	The decrease in soil chemistry due to certain environmental impacts	(Betts et al., 2018 ; Seastedt & Oldfather, 2021)

Soil erosion	Refers to the erosion of soil resulting in bare land	(Seastedt & Oldfather, 2021)
Streamflow	The direction of stream, and speed of streams	(Lehtonen et al., 2018; Ali et al., 2021)

Supply chain disruption	The interruption of production of goods upstream in a company's production line, often interrupting the operations of a business	(Betts et al., 2018; Edokpayi et al., 2018; Mpandeli et al., 2018; Dahlmann & Bullock, 2020)
Technology	The use of technology to combat climate-related factors	(Dwivedi, 2022)
Temperature	Refers to the average temperatures during different seasons	(Betts et al., 2018; Hamududu & Ngoma, 2020; Rusli et al., 2021; Seastedt & Oldfather, 2021; Khan et al., 2022)
Urbanisation	The growth of infrastructure in urban settlements	(Hussain et al., 2020; Zubaidi et al., 2020; Ali et al., 2021)

Water availability	This term refers to the amount of water available. This can include water that may not be available due to lack of quality or quantity.	(Conway et al., 2015; Betts et al., 2018; Edokpayi et al., 2018; Mpandeli et al., 2018; Dahlmann & Bullock, 2020; Hamududu & Ngoma, 2020; Konapala et al., 2020; Tabari, 2020; Zubaidi et al., 2020; Rusli et al., 2021; Seastedt & Oldfather, 2021)

Appendix 2

Table 9. The list of the 30 companies per their industry investigated for this study.

	Company Name	Industry
1.	BHG Group	**Basic Materials**
2.	Glencore	
3.	Anglo American	
4.	Impala Platinum	
5.	Gold Fields	
6.	Sibanye Stillwater	
7.	Anglogold Ashanti	
8.	Exxaro Resources	
9.	Northam Platinum	
10.	FirstRand limited	**Financials**
11.	Standard Bank Group	
12.	Capitec Bank Holdings	
13.	Absa Group limited	
14.	Nedbank Group Limited	
15.	Sanlam limited	

16. Discovery limited 17. Remgro limited 18. Investec 19. NEPI Rockcastle N.V 20. Reinet Investments SCA 21. Old Mutual ltd 22. Compagnie Financiere Richemont 23. Prosus N.V	
24. Shoprite Holdings limited 25. BidCorporation limited 26. Pepkor Holdings limited 27. Clicks Group limited 28. Woolworths Holdings limited 29. MultiChoice Group 30. Mr Price Group	**Consumer Services**

Appendix 3

Interview schedule for research project: **Assessing the interconnection of Sustainability factors in South African company reports.**

General reporting questions

1. What are the main reporting standards/guidelines that your company uses for nonfinancial reports?

2. Which division is responsible for conducting non-financial reporting in your company and does it differ from that of financial reporting divisions?

3. What are some of the challenges that you have seen with non-financial reporting in your company?

4. How do you think non-financial reporting could be improved within your company?

Systems/interconnected approach questions:

5. What is your understanding of a systems/interconnected approach to solving problems?

6. Does your company make use of a systems/interconnected approach to non-financial reporting?

7. If no systems/interconnected approach is used, what are the reasons for not incorporating this approach to non-financial reporting, and how is it approached instead?

8. If a systems/interconnected approach is used, how does your company apply this approach?

Non-financial reporting and environmental, social, and economic/business risk/target questions:

9. Which pillar/s is/are seen as most crucial when compiling non-financial reports and why? (E/S/E/B) (Please rank each sphere on a scale of 1-3, 1=least importance in terms of risk perception; 2=medium importance in terms of risk perception; 3=most importance in terms of risk perception. You can rank spheres with the same number if this is the case)

10. Which pillar/s presents the most challenges in non-financial reporting in your company? Explain why.

11. What is the main determinant for an ESE/B risk to be monitored/assessed within your company?

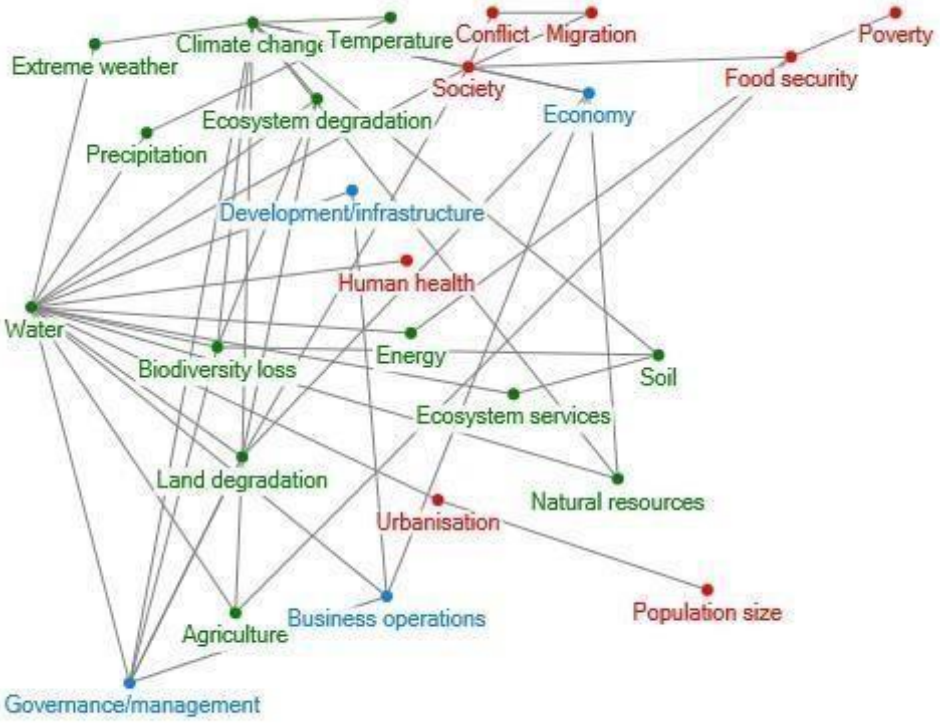
12. How (if at all) do these determinants differ for an ESE/B risk, and the actions taken around it to be reported on once physically monitored/assessed?

13. Are there ESE/B risks that are dealt with but not reported on in company reports and if so, how does your company approach these risks that are dealt with but not necessarily reported on?

14. What role do you believe reporting guidelines and frameworks should play in achieving a systems approach to non-financial reporting in South Africa?

15. What role do you believe legislature and policies should play in achieving a systems approach to non-financial reporting in South Africa?

16. Below are the connections shown for a South African environmental risk to many businesses, which is the availability of water. These connections have been made by numerous literature resources (e.g. IPCCC report among other scientific literature). Please examine the systems map and identify which connections you would consider to be relevant to your company's water risk management and name those not considered in your company either by risk assessment or those not reported on? (Green=E, red=S, blue=E/B)



17. If an ESE/B risk is considered an indirect risk as they are linked to a direct risk, but are not reported on, why would this be the case?

18. How are the above-connected risks approached if not reported on?

19. How might risk perception impact a systems map approach like the one above especially pertaining to your company?

20. Does your company apply a systems approach to ESE/B risk management that highlights multiple ESE/B connections as seen in the systems map above?

21. How does this approach in the question above compare with the approach to reporting on a risk?