PONTIFÍCIA UNIVERSIDADE CATÓLICA
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Aligning Values with Report:

Best Practices for ESG Reporting Management in the Brazilian Market

Masters Dissertation

Dissertation presented to the Professional Masters in Sustainability Sciences at PUC-Rio in partial fulfillment of the requirements for the degree of Master in Sustainability Sciences.

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Co-advisor: Prof. Paulo D. Branco

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Aligning Values with Data: Best Practices for ESG Data Management in the Brazilian Market

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ABSTRACT

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In an era increasingly driven by sustainability, the effective management of ESG (Environmental, Social, and Governance) data is critical for companies aiming to align their operations with societal values. Companies listed on Brazil's Corporate Sustainability Index (ISE) are pivotal in this shift. However, the literature highlights a gap in the practical implementation of comprehensive ESG data management processes, particularly in terms of automation and system integration. This research adopts a qualitative approach, utilizing semi-structured interviews with representatives from nine ISE-listed companies, and applies a framework based on Lima & Lezana's model to assess the current state of ESG data management and reporting. The findings reveal that while companies are making strides in ESG data collection, the processes remain largely manual and fragmented, with significant reliance on basic tools like Excel. The study underscores the need for enhanced automation, better integration of data systems, and a more robust structure to support ESG reporting. The proposed workflow provides a pathway for companies to streamline their ESG data management, ensuring higher data quality and reliability. The research concludes that a strategic focus on automation and integration is essential for advancing ESG reporting practices. Future research should explore the development of comprehensive methodologies to support these processes and the impact of regulatory changes on ESG data management.

Keywords: ESG, data management, sustainability, report, framework

RESUMO

Hazan, Amanda; Fornero, Anna. Alinhando Valores com Dados: Melhores Práticas para Gestão de Dados ESG no Mercado Brasileiro. Rio de Janeiro. 2024. 103p. Dissertação de mestrado - Departamento de Geografia e Meio Ambiente - Pontifícia UC-RJ

Em uma era cada vez mais orientada para a sustentabilidade, a gestão eficaz de dados ESG (ambientais, sociais e de governança) é essencial para empresas que buscam alinhar suas operações com os valores da sociedade. As empresas listadas no Índice de Sustentabilidade Empresarial (ISE) do Brasil são fundamentais nesse movimento. No entanto, a literatura destaca uma lacuna na implementação prática de processos abrangentes de gestão de dados ESG, especialmente no que se refere à automação e à integração de sistemas. Esta pesquisa adota uma abordagem qualitativa, utilizando entrevistas semiestruturadas com representantes de nove empresas listadas no ISE, e aplica o arcabouço de Lima & Lezana para avaliar o estado atual da gestão de dados e de relatórios ESG. Os resultados revelam que, embora as empresas estejam avançando na coleta de dados ESG, os processos permanecem em grande parte manuais e fragmentados, com uma dependência significativa de ferramentas básicas como o Excel. O estudo destaca a necessidade de maior automação, melhor integração dos sistemas de dados e uma estrutura mais robusta para apoiar os relatórios ESG. O fluxo de trabalho proposto oferece um caminho para as empresas otimizarem a gestão de dados ESG, garantindo maior qualidade e confiabilidade dos dados. A pesquisa conclui que um foco estratégico na automação e na integração é essencial para o avanço das práticas de relato ESG. Pesquisas futuras devem explorar o desenvolvimento de metodologias abrangentes para apoiar esses processos e o impacto das mudanças regulatórias na gestão de dados ESG.

Palavras-chave: ESG, gestão de dados, sustentabilidade, relatório, framework

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LIST OF ABBREVIATIONS

AI - Artificial Intelligence
AUM - Assets Under Management
B3 - Brasil Bolsa Balcão
BD - Big Data
BDAI - Big Data using Artificial Intelligence
BPM - Business Process Management
CDP - Carbon Disclosure Project
COP26 - 26th United Nations Climate Change Conference
CSR - Corporate Social Responsibility
CSRD - Corporate Sustainability Reporting Directive
DJSI - Dow Jones Sustainability Index
EFRAG - European Financial Reporting Advisory Group
ESG - Environmental, Social, and Governance
ESRS - EU Sustainability Reporting Standards
EU - European Union
EY - Ernst & Young
FTSE - Financial Times Stock Exchange
GRI - Global Reporting Initiative
GSSB - Global Sustainability Standards Board
IFC - International Finance Corporation
IFRS - International Financial Reporting Standards
IIRC - International Integrated Reporting Council
IM - Impact Management
IMS - Integrated Management System
IOSCO - International Organization of Securities Commissions
IoT - Internet of Things
IR - Integrated Reporting
ISE - Índice de Sustentabilidade Empresarial
ISS - Institutional Shareholder Services
ISSB - International Sustainability Standards Board
KPI - Key Performance Indicator

KPMG - Klynveld Peat Marwick Goerdeler

MSCI - Morgan Stanley Capital International

NLP - Natural Language Processing

SaaS - Software as a Service (ajuste na definição)

SASB - Sustainability Accounting Standards Board

SFDR - Sustainable Finance Disclosure Regulation

SME - Small and Medium-sized Enterprises

SRI - Socially Responsible Index

TCFD - Task Force on Climate-related Financial Disclosures

TCLE - Term of Consent and Free Clarification

UNGC - United Nations Global Compact

VP - Vice presidency

VRF - Value Reporting Foundation

WEF - World Economic Forum

XBRL - eXtensible Business Reporting Language

XML - Extensible Markup Language

If not me, who?

If not now, when?

1. RESEARCH PROBLEM

1.1 Introduction

Environmental, Social, and Governance (ESG) principles have emerged as a pivotal framework in the modern business landscape, driven by the urgent need for sustainable practices. The growing recognition of the negative impacts of human activities on the planet, such as those highlighted by Rockström et al. (2009), emphasizes the necessity of integrating ESG into corporate strategies. This is particularly evident as research shows that by 2023, six out of nine planetary boundaries had been exceeded, demonstrating the critical need for sustainability to maintain Earth's stability (Richardson, 2023). This context is essential for understanding the evolution of ESG principles and their adoption globally.

Historically, the global economic system has been shaped by shareholder capitalism, a model which often prioritizes shareholder profits over broader social and environmental concerns (Friedman, 2007). The adverse consequences of this model, including environmental degradation and social inequality, have led a shift towards stakeholder capitalism, which aims to create shared value by integrating the interests of all stakeholders, such as employees, customers, suppliers, and the broader community (Schwab, 2021). This transition is reflected in the increasing importance of ESG in investment decisions, promoting sustainable development and market resilience (World Economic Forum, 2021; Porter & Kramer, 2011).

The term ESG, first introduced by the United Nations Global Compact (UNCG) in 2005, refers to best practices adopted by companies in relation to the environment, society, and governance. In the environmental aspect, key practices include reducing CO2 emissions and improving resource efficiency. The social dimension focuses on diversity, inclusion, and wage equality. In governance, essential practices involve implementing policies and conducting materiality assessments to guide strategic decisions. These actions aim to create shared value and mitigate risks for investors (UNGC 2005).

Although initially slow to gain traction, ESG gained momentum during the COVID-19 pandemic, as these issues became central to corporate and financial agendas (CFA Institute, 2020; Adams & Abhayawansa, 2022). Larry Fink's 2020

letter from BlackRock, advocating for the integration of sustainability in investment strategies, further accelerated the adoption of ESG practices across industries (BlackRock, 2020). By 2021, ESG and sustainable investments had surged to USD 40 trillion, with projections reaching USD 53 trillion by 2025, making up a third of global Assets Under Management (AUM) (Bloomberg 2021; Cort & Esty, 2020; Ernst & Young, 2021).

In Brazil, the sustainability topic took off with the Rio 92 Earth Summit, a significant event that laid the foundation for environmental and sustainability initiatives in the country (Cordani et al., 1997). Despite challenges such as high levels of inequality and the economic costs of environmental degradation, Brazil has made notable progress in advancing ESG practices, particularly through the Brazilian Corporate Sustainability Index (ISE), established in 2005 (World Bank, 2023). The ISE has evolved, incorporating external assessments from the Carbon Disclosure Project (CDP) and RepRisk, reflecting a maturing market for corporate sustainability (ISE-B3, 2023; XP Investimentos, 2023).

Today, the majority of large corporations have formalized their commitment to ESG, embedding these principles into their sustainability strategies, setting specific goals, and developing Key Performance Indicators (KPIs) (Searcy & Buslovich, 2013). These commitments are documented in Sustainability or ESG Reports, which have become essential tools for communicating a company's progress on ESG issues to stakeholders (Chen, 2024). Over time, ESG reports have evolved beyond mere risk management tools, now serving as drivers of value creation by enhancing transparency, fostering trust, and improving communication with all stakeholders (Chopra et al., 2023; Mykolaivna et al., 2024).

The ESG reporting landscape is shaped by various frameworks and standards that guide companies in their sustainability disclosures. ESG frameworks, such as the Task Force on Climate-related Financial Disclosures (TCFD) and the International Integrated Reporting Council (IIRC), provide foundational principles for reporting, while standards like the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) offer precise metrics for evaluating ESG performance (Cruz & Matos, 2023). Both frameworks and standards aim to ensure that ESG reports are consistent and comparable across companies, enhancing their value for investors and stakeholders (CGI - Corporate Governance Institute).

Despite the proliferation of ESG frameworks and standards, the absence of regulatory requirements means that ESG reporting has largely remained a voluntary practice. This has resulted in inconsistencies in how companies report their ESG data, leading to challenges in assessing and comparing ESG performance across different organizations (Kotsantonis & Serafeim, 2019). The growing complexity of ESG reporting, often referred to as the "ESG alphabet soup," has contributed to reporting fatigue among companies, as companies struggle to meet the demands of multiple frameworks and standards (Cruz & Matos, 2023).

In response to these challenges, there has been a shift towards mandatory ESG reporting. Initiatives like the International Sustainability Standards Board (ISSB) and the Corporate Sustainability Reporting Directive (CSRD) are gaining prominence. The ISSB, established by the International Financial Reporting Standards (IFRS) in 2021, aims to create a global standard for sustainability disclosures, which will be mandatory in 168 jurisdictions (IFRS, [s.d.]). Similarly, the CSRD, introduced by the European Financial Reporting Advisory Group (EFRAG) in 2023, seeks to advance the European Green Deal by promoting a more transparent, accountable, and comparable standard for ESG reporting across the European Union (Ferehate et al., 2024; EC, [s.d.]).

The most widely used framework for ESG reporting is the GRI, which requires adherence to specific reporting principles, such as accuracy, balance, and clarity, and to disclose information on their material topics (GRI, 2021). Another significant framework is Integrated Reporting (IR), which focuses on how organizations create value over time and emphasizes the connectivity of information, stakeholder relationships, and materiality (IIRC, 2019). These frameworks highlight the importance of materiality assessments in ESG reporting, as they help companies identify and prioritize the most significant sustainability issues (Appelbaum et al., 2023; Nielsen, 2023).

Despite these frameworks, challenges persist in data quality and reliability. Companies often struggle with manual and fragmented processes, affecting ESG data accuracy and transparency (Moharram et al., 2024; Mykolaivna et al., 2024). These issues are further exacerbated by the lack of standardization in reporting practices, leading to inconsistent and non-comparable data that complicates investor assessments (Searcy & Buslovich, 2013; Seele, 2016).

The emergence of new technologies, such as Big Data (BD), Artificial Intelligence (AI), eXtensible Business Reporting Language (XBRL), and the Internet of Things (IoT), offers potential solutions to enhance ESG reporting processes by improving data accuracy, transparency, and resource optimization (Olanrewaju et al., 2024; Zeng et al., 2024). However, these technologies also present challenges, including data privacy concerns, technological integration complexities, and the need for robust risk management strategies (Markova-Karpuzova et al., 2024; Zeng et al., 2024). Despite the potential of these technologies, many companies continue to rely on manual processes, which limits the effectiveness of their ESG data management (McKinsey & Company, 2015; Skilton, 2018).

In Brazil, the first ESG report based on GRI guidelines was published by Natura in 2001, marking the beginning of a significant growth in ESG reporting among companies, particularly those listed on the B3 - Brasil Bolsa Balcão stock exchange, many of which utilize international reporting methodologies (Bandera, 2022). However, the lack of standardized reporting and regulatory frameworks poses significant challenges for investors who depend on these reports (Silva, 2023; Araújo, 2021). This situation highlights the need for enhanced ESG data management practices that incorporate automation and system integration to improve the reliability and comparability of ESG reports.

In light of these challenges, the present study seeks to explore the current state of ESG reporting in the Brazilian market, with focus on how companies manage their ESG data. The research aims to identify best practices for ESG data management that can enhance the accuracy, transparency, and comparability of ESG reports, ultimately supporting better decision-making and fostering sustainable business practices. The central question driving this research is: What underlies the current ESG reporting processes in the absence of automation throughout the ESG data management?

By addressing this question, the study aims to map the structures, processes, and spaces that companies are adopting to manage their ESG reporting processes, based on Lima & Lezana (2005)’s framework, as well as to understand how companies are overcoming their current challenges to enhance the reliability of their ESG data reporting.

1.2 Research objectives

1.2.1 Final objective

The final objective of this study is to map, describe and present the current ESG reporting scenario in the Brazilian market using 9 listed companies on ISE/B3 2023, including the main gaps and opportunities to enhance ESG data accuracy.

1.2.2 Specific objectives

1. Describe the structure of ESG departments, the process of ESG reporting and ESG data management and the spaces where relies the main cultural traits used to strategically implement ESG along the company;
2. Raise the main gaps and opportunities to better manage ESG reporting process;
3. Classify the companies within a maturity ranking regarding ESG data management process;
4. Develop a workflow to help companies to better navigate the ESG reporting process

2. METHODS

2.1 Project’s characteristics

This section outlines the research methodologies employed to explore and assess the ESG data management practices among 9 companies listed on the ISE. The study utilized a qualitative research approach, leveraging snowball sampling to identify and interview key participants with relevant expertise in ESG reporting. The primary data collection method involved semi-structured interviews, designed to capture in-depth insights while allowing flexibility for participants to discuss topics of particular relevance to their experiences.

The semi-structured questionnaire was carefully crafted based on the Lima & Lezana framework, ensuring that it addressed the most pertinent aspects of ESG data management, including structure, processes, and reporting practices. The interviews were transcribed using the artificial intelligence Sana.ai. Thematic analysis was subsequently applied to the interview transcripts, enabling the identification of recurring themes and patterns that reflect the current state of ESG data management within the sampled companies. This methodical approach ensured that the findings are both comprehensive and grounded in the lived experiences of professionals working directly in the field of ESG reporting.

2.1.1 Sampling and interviewing

To identify and recruit relevant participants, the snowball sampling technique was employed. This method was selected for its efficiency in accessing hard-to-reach populations and leveraging existing networks for participant recruitment (Goodman 1961). Snowball sampling facilitated the building of trust and rapport, which enhanced the quality of the data collected. It also allowed for adjustments in the sample size as the study progressed, providing flexibility in exploratory research. Additionally, some contacts were obtained through personal recommendations, further enriching the relevance and quality of the data.

Data were collected through recorded interviews, transcribed, and systematically organized using thematic analysis to identify key themes and patterns. This approach allowed for a detailed examination of the ESG data management processes, highlighting similarities and differences across the participating companies.

The interviews were anonymous due to participants' requests to protect company preferences. Anyhow, they were all recorded with the participants' agreement due to further assessment. Each interviewee signed a Term of Consent and Free Clarification (TCLE), ensuring informed consent and confidentiality. The term was approved by the PUC-Rio Ethics Committee, responsible for evaluating the ethical aspects of research projects conducted by professors, researchers, and students of the university. The consent document was prepared in accordance with the values and principles outlined in PUC-Rio's Reference Framework, Statute, and Bylaws.

Regarding the risks associated with participation, the consent form followed the guidelines of Resolution No. 510, April 7, 2016, which assures participants that they can act in accordance with this law in the event of any risks. To facilitate the process, the consent forms were sent to each participant via DocuSign, ensuring a secure and efficient method for obtaining informed consent. These measures ensured that participant confidentiality and data security were maintained throughout the study. The ethical considerations ensure the protection and respect of all participants.

The questionnaire was crafted to evaluate the current ESG reporting scenario, aiming to answer this research question. The semi-structured questionnaire (Kvale 2007) used in this study was designed to explore ESG data management practices among companies listed on the ISE. This approach combined predetermined questions with the flexibility to probe deeper based on participants' responses, allowing for detailed and nuanced insights. The questionnaire was structured around Lima & Lezana's framework, focusing on critical dimensions such as structure, process, and space of the ESG reporting processes that companies have been adopting. This structure ensured that essential topics were covered while accommodating new themes introduced by participants, thereby enhancing the richness and relevance of the data collected.

In developing the questionnaire for assessing ESG reporting and data collection processes, the framework proposed by Lima & Lezana was utilized as a guiding reference to assess an organizational action (Table 1). Lima & Lezana's framework delineates the following dimensions as critical ones when looking forward to improving performance and results.

The first one is the **structure** of organizational actions. It pertains to the division and coordination of work, which can be categorized as either vertical or horizontal (Lima & Lezana, 2005). Approximating the framework to ESG-related processes, this dimension encompasses factors such as materiality and its usability, the organizational structure of the ESG department, budget considerations, and the level of leadership and workforce engagement, including themes such as performance, department structure and the influences that leadership has on the workforce. For this study, the questionnaire was designed to probe these elements by including questions about the organization's materiality assessment practices, the structure of the ESG department, available budget resources, and the extent of

engagement from leadership and staff. Strong structures allow the development of strong processes.

A **process** is a set of interconnected activities. An activity differs from a task and forms the basis for the minimum critical specification of work. An activity has inputs, KPIs, responsible parties, and outputs. The integration of activities must be understood within the execution of the business strategy. The process needs to have a clear vision, proactive management, and a clear representation of how a set of activities relates to a common objective (Lima & Lezana 2005). This study focused on understanding how companies are dealing with their data considering the current lack of automation. As an outcome of it, based on all the process steps and best practices provided by each participant during the interviews, a workflow model of the ideal ESG data management process was built in order to represent the step-by-step it and help the companies to boost their ESG data management process.

The ESG Data Management Workflow model is a template to help companies to improve their data management in order to obtain more quality data. It presents all the steps needed to implement culture, communication and continue improvement within the process. Since it involves many stakeholders from different hierarchy levels, a well structured process is mandatory, mostly when there are few responsibles, short deadlines for a high demanding work. This Workflow is based on the companies' current reality. According to the systematization and automation trend of the process in the following years, it is recommended to reassess and adapt it.

The organizational **space** can be divided in three categories: the physical, for example the office, the virtual, such as meetings, emails and platforms and mental, like ideals and ideas. The main purpose of the space is to generate value and acknowledgement, through communication. In this study, this dimension addresses the tools and systems used to report ESG data, specifically the software and automation processes. Questions were included to assess the effectiveness of the software tools employed, the level of automation in data collection, and the integration of these tools within the organization's overall ESG reporting framework.

This structured approach guided the development of the questionnaire, ensuring that the interviews and data analysis comprehensively addressed each

Table 1: Interviews questions	
Lima G Lezana's reference framework dimensions	Questions
Structure	How strongly do you believe that the company's strategy aligns with and prioritizes materiality?
	How is the company's ESG department structured?
	How many people are in the ESG team? Do you consider this number suffcient?
	How engaged do you believe the company's leadership is with ESG issues? What about other departments? Why?
	In your assessment, is the budget allocated to sustainability aligned with the identified needs?
Process	How does the company's ESG reporting/data collection process operate?
	Do you think the process is solely centralized within the sustainability professionals?
	What are the main areas of focus you perceive in your company's data management process?
Space	Do you use a data management system? If so, which one?
	Do you still find yourselves relying on Excel spreadsheets? If yes, why?

dimension of Lima & Lezana's framework. By incorporating these elements, the study was able to thoroughly examine the ESG data management processes and derive insightful results and discussions. Although, the order of the questions presented in the table above is different from the order used to question the participants during the interviews.

To analyze the data, thematic analysis was employed, a method that involves identifying, analyzing, and reporting patterns (themes) within the data. This approach provides a detailed and nuanced account of the data, facilitating the understanding of key themes related to ESG data management (Braun & Clarke, 2006; Boyatzis, 1998). The data organization and coding process were systematically conducted using established qualitative data analysis techniques to ensure reliability and validity (Miles, Huberman, & Saldaña, 2014; Yin, 2015). The interviews were transcribed using an AI tool called Sana.ai. The process was conducted using an Excel

spreadsheet where the transcribed data were organized and consolidated. This organization facilitated the assessment of responses both by individual companies and by questions. In addition to the interviews, the sustainability reports of the companies were assessed to gather general information about the company, such as sector, size, the standards used in their reports, and a few data for analysis purposes.

Finally, a maturity assessment based on score was proposed aiming to put into perspective the stage in which each company finds themselves regarding their ESG reporting process. To achieve that, based on the processes described by the participants, a set of main elements were highlighted and a score was attributed to each company.

2.2 Company's characteristics

The sample for this study was composed of nine companies listed on the ISE as of May 2024. The ISE includes companies that voluntarily publish their sustainability reports, which contributes to their overall score on the index. This sample was chosen due to its accessibility and relevance to the research conducted in Brazil, where the ISE-B3 is the primary institution promoting sustainability reporting. Table 2 provides an overview of the companies included in the study, highlighting their diverse profiles. The table lists the 7 sectors each company operates in, such as Paper and Pulp, Rail Transport, Electric Power, and Telecommunications, among others. The sector with more representatives was the electric one. It also includes company sizes, since comprehending its size helps to understand the complexity of ESG integration and implementation. The main standards used in their ESG reports, such as GRI, TCFD and SASB. GRI, SASB and TCFD were presented in all of them and even sustainability reporting being a voluntary practice in Brazil, almost half of the sample presented the Integrated Reporting Framework. The type of materiality being employed was also assessed and, apparently, all of the participant companies are using the Double Materiality, and have assurance processes in place. Although, all of the companies present a high number of material topics. Additionally, the table provides the turnover rates, representing the firing and quitting indices, since it is a metric that seems to impact the ESG reporting process. Finally, it is shown the profile of the participants involved

in the study, indicating their educational background, years of experience in sustainability and their current role within the company. This table helps illustrate the varied landscape of companies engaged in ESG reporting within the ISE, providing a foundation for assessing their ESG data management practices across different industries.

Table 2: Sample's profile

	Theme/Company	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7	Company 8	Company 9
Company's profile	Sector	Paper and Pulp	Rail Transport	Electric Power	Energy	Electric Power	Oil and Gas (Upstream)	Consumer Goods and Agribusiness	Pharmaceutical Retail	Telecommunication
	Size (total of employees)	20.627	7.905	15.058	1.551	8.328	163	14.500	57.216	33.206
Report's profile	Type of materiality	Double materiality	Double materiality	Double materiality	Double materiality	Double materiality	Double materiality	Double materiality	Double materiality	Double materiality
	Amount of material topics	8	6	10	6	10	8	8	10	11
	Report Assurance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Turnover rate	13,71%	15,3%	16%	15%	22,90%	19,3%	21%	34,27%	16,1%
	Gender diversity within governance body (presence of women)	33%	30%	21,7%	0%	10%	37%	33,3%	27,3%	30%
Participant's profile	Graduation	Public Relations Social Communication	Biologist and Postgraduate in Environmental Management and Sustainability	Environmental Sciences	Chemical Engineering	Civil Engineering	Business Administration	Environmental Management	Forestry Engineer	Environmental Engineer with Postgraduate in Business Management and Strategy
	Period working with sustainability	15 years	5 years	2 years	4 years	7 years	14 years	14 years	12 years	12 years
	Role in the company	Sustainability coordinator	Sustainability coordinator	Sustainability analyst	ESG Analyst	Sustainability executive manager	Sustainability manager	ESG Manager	Sustainability Manager	Sustainability Manager

3. LITERATURE REVIEW

In the evolving landscape of sustainability and corporate governance, the integration of ESG reporting has become a pivotal area of research and practice. This literature review synthesizes key studies and perspectives on ESG reporting, focusing on the development, challenges, and technological advancements that shape current practices. The review begins by exploring the foundational theories and frameworks that underpin ESG reporting, including the impact of mandatory reporting regulations and the role of sustainability reports in enhancing corporate transparency and accountability. It then examines recent advancements in data processing and reporting technologies, such as XBRL, and their implications for improving the quality and efficiency of ESG disclosures. Additionally, the review addresses barriers to effective ESG integration and highlights innovative approaches to overcoming these challenges, drawing on a range of academic and practical sources. Through this comprehensive analysis, the review aims to provide a nuanced understanding of the current state of ESG reporting and identify future directions for research and practice in this critical field.

3.1.1 Historical context

In 2009, Rockström et al. (2009) highlighted that in order to maintain earth's stability, it's crucial to adhere to nine planetary boundaries. Unfortunately, by the time Rockström et al. published their study, three of them had already been exceeded due to human activities. More recently, in a new research from 2023, it was shown that six of the nine planetary boundaries are out of their safe zone (Richardson 2023). Scientists even propose that humanity has entered a new geological era, the Anthropocene, primarily characterized by the negative impacts caused by human actions (Crutzen 2016; Van der Leeuw 2008). This term has become more prominent around 20 years ago, but it has been recently voted against, since in order to establish a geological era, it has to have a marker. They are also assessing whether the Anthropocene is an “epoch” or an “event” (BBC 2024; The New York Times 2024)

Various studies highlighted the connection between companies' activities and negative socio environmental impacts, called negative externalities in economics (True Pricing 2014; Ziolo et al. 2019; WEF 2021; Pérez et al. 2022; Cruz & Matos

2023; Jaffar 2023). Such impacts usually are unaccounted costs that are typically overlooked when calculating a company's financial results. They affect people unrelated to a company's operations and often take place without their knowledge or consent. Consequently, it creates potential risk to investments and leads to significant financial losses in the long run. Examples of negative externalities include social and financial exclusion, widening income disparities, economic crises, and environmental degradation. (True Pricing 2014; Ziolo et al. 2019; WEF 2021; Pérez et al. 2022; Cruz & Matos 2023; Jaffar 2023).

3.1.2 Shareholder and stakeholder capitalism

Shareholder capitalism is the prevailing global economic system and it prioritizes the interests of shareholders—mainly focused on maximizing a company's profit without too much concern for the costs their actions create elsewhere in the social and environmental realms (Friedman, 2007). While this system has contributed to economic progress of many regions, it has also generated social and environmental downsides (WEF 2021).

In response to these adverse social, environmental, and economic effects, for the past few years a shift has been emerging in the global market. Stakeholder capitalism has gained momentum by focusing on the interests of all stakeholders essential to a business's sustainable operation (Klenow 2005; WEF, 2021). By integrating the stakeholder perspective into the organizational strategies, companies develop a more comprehensive understanding of their business operations. This approach not only generates shared value for stakeholders but also transforms potential risks and costly challenges into opportunities for innovation and sustainable practices.

Although the market appears to make progress towards stakeholder capitalism, it remains mostly influenced by the shareholders' interests. Nevertheless, the growing importance of sustainability in investment decision-making is undeniable. This shift has elevated discussions around market-related issues to mainstream corporate agendas (Saul & Kurlander 2022; Cruz & Matos 2023; Rabhi et al. 2023). Once companies start to better invest in ESG matters, they help to build a stronger

and more resilient market and contribute to the sustainable development of society (UNGC 2005; Porter & Kramer 2011; Pérez et al. 2022).

The first mention of the term ESG was in 2005 in UNGC's document *Who Cares Wins.* ESG means the set of best practices adopted by the market related to their impacts on the environment, society and the governance of the organization (UNGC 2005). For environmental best practices, examples include reducing and mitigating CO_2 emissions, minimizing waste throughout companies' processes, and improving water and energy efficiency consumption. In the social dimension, effective practices involve investing in workforce diversity and inclusion across all organizational levels, ensuring employee health and safety, and promoting wage equality between men and women. Regarding the governance best practices, examples include implementing policies and codes of conduct, conducting materiality assessment, and using these assessments to drive decision-making and strategic sustainability planning. Through these actions, companies are expected to create shared value to the investors and mitigate the existing business risks (UNGC 2005).

Although the term "ESG" was coined in 2005, it only gained significant traction in 2020, largely due to the COVID-19 pandemic. This period acted as a catalyst for ESG awareness, bringing attention to deep-rooted social issues, emphasizing the risks associated with climate change, racial justice, social inequalities, social responsibilities of businesses to address these challenges, along with vulnerabilities within the financial system (UNCG 2005; CFA 2020; Adams & Abhayawansa 2022). These factors have spurred the development of ESG metrics to better evaluate performance on key ESG material issues, leading to an increase in the number of ESG reports. Investors use these reports and associated data to evaluate companies performance on ESG into their business analysis and valuation processes (Kotsantonis & Serafeim 2019).

An indicative of this growing interest was the letter written by Larry Fink (2020), Chief Executive Officer of BlackRock, the world's largest asset manager, declaring that the integration of sustainability would become a pivotal consideration in its decision-making processes (BlackRock 2020). Subsequently to the letter, the entire market started moving towards the adoption of sustainability in business practices. In 2021, ESG and sustainable investments had a massive rise, hitting USD 40 trillion, with expectations to hit USD 53 trillion in 2025, making up a third of global AUM (Bloomberg 2021). This emerging segment of sustainability-minded investors

has been adding pressure upon the companies for better corporate sustainability information. As a consequence, the amount of published reports increased in 2020 and more reporting standards and frameworks were created aiming to enhance companies' precision, validity and consistency and provide investors with a clear, meaningful and measurable view of the company's performance (Cort & Esty 2020; EY 2021; Cruz & Matos 2023).

3.1.3 The history of ESG in Brazil

The first major sustainability event in Brazil was the Rio 92 conference, held in Rio de Janeiro. This landmark event marked the beginning of Brazil's sustainability journey, establishing important environmental agreements aimed at protecting the environment and society (Cordani et al. 1997). It was a pivotal moment that influenced environmental decision-making processes across cities, businesses and the society as a whole.

However, recent years have highlighted the severe financial burden of negative externalities such as droughts, floods and wildfires. In 2019 alone, these events were estimated to cost approximately R$ 22 billion, posing a severe threat to Brazil's economy, particularly affecting the agribusiness and energy sectors. The devastation reached its peak with the 2024 floods in Rio Grande do Sul, one of the country's most catastrophic disasters. The floods caused widespread destruction, resulting in 169 fatalities, 61 people missing, and approximately 2.1 million people affected, with 650,000 displaced and 71,500 left homeless and living in public shelters (Rizzotto et al. 2024).

Additionally, Brazil has faced major industrial disasters in recent years. Notably, the disappearance of an entire neighborhood in Maceió in 2018, attributable to the extractive activities of Braskem S.A., created numerous environmental refugees and led to substantial financial losses for the company. Similarly, the collapse of tailings dams, first in 2015 by Samarco - a joint venture between Vale S.A. and BHP - and again in 2019 by Vale S.A. itself, resulted in catastrophic consequences. The latter incident alone released 13 million cubic meters of mining waste into the environment and 270 fatalities (Freitas et al., 2019; Santos & Viegas, 2021; Feitosa & Romeiro, 2023). In response to these risks, the World Bank

advocates for the Brazilian market to focus on its potential for becoming a more sustainable green economy (World Bank 2023).

Despite setbacks, Brazil has made significant strides in its ESG agenda. As a pioneering initiative in Latin America and the fourth sustainability index globally, the ISE from B3 - Brasil, Bolsa, Balcão, the Brazilian stock exchange, was established by B3 in 2005, with initial funding from the International Finance Corporation (IFC), the financial arm of the World Bank. The index aims to serve as a benchmark for the average performance of the stock prices of companies recognized for their strong commitment to corporate sustainability. ISE-B3 aims to serve as an indicator of the average performance of the stock prices of companies selected for their recognized commitment to corporate sustainability, to support investors in making informed decisions and to encourage companies to adopt best practices in ESG criteria, which are essential for business longevity.

In 2021, Araújo (2021) reported that 100% of the listed companies on the ISE adhered to non-financial reporting, despite it being a voluntary practice. Orsolin (2023) analyzed reports from the five top-scoring companies on ISE, all of which achieved excellent results. In 2023, the world's fourth-largest ESG index saw remarkable growth, with a 38% increase in voluntary applications, resulting in 70 approved companies across 37 sectors and a market value of approximately R$2 trillion, representing 53% of the total market value. The index also enhanced its methodologies by incorporating assessments from external sources—CDP results for climate performance and RepRisk for reputational outcomes – indicating the increasing maturity of Brazil’s ESG performance evaluation (ISE-B3 2023; XP 2023).

3.2 Current State of ESG Reporting

3.2.1 ESG Reporting Context

Currently, the majority of large corporations have committed to Environmental, Social, and Governance (ESG) practices. This represents a significant shift, as these commitments are implemented through formal corporate policies, sustainability strategies, specific goals, and KPIs to measure progress. All of this information is consolidated into Sustainability or ESG Reports (Searcy & Buslovich, 2013). ESG reporting is a crucial element within the ESG movement, serving as the primary

means for companies to communicate their progress on ESG issues to all stakeholders. It involves the measurement, disclosure, and communication of information about the company's best ESG practices, encompassing its activities, risks, and policies. Without demonstrating their ESG-related progress, companies cannot effectively translate their efforts into verifiable results (CGI; Christensen et al., 2021).

Today, nearly all publicly listed companies publish ESG reports, and an increasing number of Small and Medium-sized Enterprises are following this trend (Seele, 2016). According to Mori et al. (2013), organizations all around the world are increasingly reporting their sustainability performance to communicate it to their stakeholders, but the level, shape, quality and integrity among them could vary a lot. The motivations for sustainability reporting can different from one company to the other. However, a major driving force behind this movement is the growing demand from investors, as ESG reports function as a risk management tool that mitigates financial and reputational risks. These reports play a vital role within companies, showcasing their commitment to sustainability, responsible governance, and long-term value creation. Furthermore, the purpose of these reports has evolved beyond merely serving as a risk management tool; they are now recognized as drivers of value creation, enhancing transparency, and fostering trust and communication with all stakeholders (Chopra et al., 2023; Mykolaivna et al., 2024).

3.2.2 ESG Standards, Frameworks, Ratings, and Indexes

Sustainability is a broad and interdisciplinary field, encompassing numerous aspects from various knowledge areas and hierarchical levels, such as climate change, human rights, diversity, ethics, and governance. These elements reflect the environmental, social, and ethical dimensions of a company’s activities. Given the diverse interpretations of sustainability, it is essential for companies to have clear guiding principles for the main ESG reporting topics. Without these principles, companies would likely report ESG information as they see fit, leading to inconsistencies (Chen, 2024; CGI).

These guiding principles can be divided into frameworks and standards. While ESG frameworks provide the foundational principles for reporting, establishing the groundwork, standards offer the technical specifics, with precision and detail. In other

words, frameworks focus on the structure of the reporting process, such as the strategies used and the organization of information, while standards emphasize specific requirements, including precise and tangible metrics for reporting, outlining specific criteria for each topic. The goal is that, through ESG frameworks and standards, companies' individual reports become coherent and comparable against each other (CGI). Examples of frameworks include the Task Force on Climate-related Financial Disclosures (TCFD), the International Integrated Reporting Council (IIRC), and the Carbon Disclosure Protocol (CDP), while examples of standards include the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) (Cruz & Matos, 2023).

In addition to frameworks and standards, ESG rating agencies play a critical role. Investors rely on these agencies to guide their investment decisions, while companies use them to receive external feedback on the effectiveness of their sustainability efforts. Examples include Sustainalytics, Morgan Stanley Capital International (MSCI), Institutional Shareholder Services (ISS), and Refinitiv, among others. Finally, sustainability indexes began to emerge among investment funds in the 1990s, starting with the Domini 400 Social Index, created by Kinder, Lydenberg, Domini and Co. in 1990. In 1999, the New York Stock Exchange introduced the Dow Jones Sustainability Index (DJSI). This was followed by the launch of FTSE4Good in London in 2001, by the Financial Times Stock Exchange (FTSE) a group of stock market indices managed by the FTSE Russell Group, which is a subsidiary of the London Stock Exchange, the Socially Responsible Index (SRI) in Johannesburg in 2003, and the Corporate Sustainability Index (ISE B3) in São Paulo in 2005.

The GRI, established in 1997 by the Global Sustainability Standards Board (GSSB), was the first guideline created in this domain. The motivation for its creation was the public outcry following the oil spill caused by the major company Exxon Valdez. GRI serves as both a framework and a guideline and is the most widely used worldwide (Fechner, 2019; GRI). Since then, there are currently over 10 standards and frameworks available in the market, each with different purposes and directed toward different stakeholders. All of them share the same goal: to standardize the disclosure of ESG information while offering precision, validity, consistency, and interoperability in an environment where ESG reporting is still largely voluntary (Cruz & Matos, 2023).

However, the reality is that the vast amount of ESG-required information, often referred to as the "ESG alphabet soup," frequently demands similar information in different ways, making it impossible to report the same information only once. This is leading to what is known as "reporting fatigue," where companies become overwhelmed and exhausted by the volume of information they must report, the limited time available to do so, the repetitiveness of standards, and the lack of integration and interoperability among them (Cruz & Matos, 2023).

3.2.3 Voluntary and Mandatory Standards

In 2022, a study revealed that 96% of the world's largest companies had been reporting on sustainability or ESG matters over the past decade (KPMG, 2022). Despite this high level of reporting, most ESG disclosures remain voluntary due to the lack of regulatory requirement mandating such transparency. As a result, companies report ESG data in various formats and styles, adapting KPIs to their specific contexts. This lack of standardization complicates assessment and comparison, and can also create opportunities for fraud and greenwashing, where reported ESG results do not accurately reflect a company's true performance (Searcy & Buslovich, 2013; Moharram et al., 2024). As a result, not all companies report on ESG matters, and those that do may not do so consistently.

This inconsistency is further highlighted in Kotsantonis & Serafeim (2019) research, where authors evaluated the social indicator "Employee Health and Safety" across 50 randomly selected publicly listed companies from various sectors. Their findings revealed over 20 different methods for reporting this data, with varying terminology and, most importantly, different units of measurement. Additionally, they found that 50% of the companies reported having a health and safety policy, while approximately 15% disclosed their lost time incident rates and workplace fatalities (Kotsantonis & Serafeim, 2019).

The predominant voluntary frameworks for sustainability reporting are the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) standards. However, the market is transitioning from a voluntary and qualitative practice to a mandatory and quantitative one. This shift is evidenced by the creation of initiatives such as the International Sustainability Standards Board

(ISSB), which is becoming mandatory in 168 jurisdictions, and the Corporate Sustainability Reporting Directive (CSRD), which is assessed through the European Sustainability Reporting Standards (ESRS) and is mandatory across the entire European Union (EU). Both initiatives aim to make sustainability reporting compulsory worldwide and more reliable, focusing on the information investors need (Searcy & Buslovich, 2013; KPMG, 2022; Chen, 2024). This shift represents significant progress in the ESG reporting, reflecting the growing demand for reliable and comparable ESG data, although the transition to mandatory reporting is still in its early stages (Seele, 2016; Chen, 2024).

Mandatory ESG disclosure is increasingly seen as essential for enhancing the quality, objectivity, and transparency of ESG information while reducing the potential for fraud, given the fragmented nature of available information (Visalli et al., 2023; Moharram et al., 2024; Mykolaivna et al., 2024). As a first attempt to implement a global standard, during the 26th Conference of the Parties (COP26), The UN Climate Change Conference, in 2021, the International Financial Reporting Standards (IFRS) announced the creation of the International Sustainability Standards Board (ISSB). The ISSB was established to develop a comprehensive, global, high-quality sustainability standard that aligns with the information investors need. This initiative was designed to be a collaborative effort among many existing investor-focused reporting initiatives, including the Climate Disclosure Standards Board (CDSB), the International Accounting Standards Board (IASB), the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD), the Value Reporting Foundation (VRF), and the World Economic Forum (WEF). It is supported by the International Organization of Securities Commissions (IOSCO) and its Technical Expert Group of securities regulators. The goal is to establish a global standard for sustainability disclosures in financial markets, which will be mandatory in 147 of the 168 jurisdictions where IFRS is applied, although the rules for reporting vary across jurisdictions (IFRS, [s.d.]).

Subsequently, in 2023, the Corporate Sustainability Reporting Directive (CSRD) was introduced, replacing the Sustainable Finance Disclosure Regulation (SFDR). Set by the European Financial Reporting Advisory Group (EFRAG), the CSRD is now a key instrument within the EU's legislative framework designed to advance the European Green Deal, which promotes a new green growth model in response to the outdated and unsustainable practices of the current fossil-fuel-based

economy. It represents a significant step toward a more transparent, accountable, and comparable standard, as it is now part of EU law (Ferehate et al., 2024; EC, [s.d.]). These transitions represent one of the most significant regulatory shifts in accounting history.

3.2.4 Structure of the ESG reports

The GRI is the most widely used framework for ESG reporting, guiding most companies in structuring their reports according to its requirements. First, a company must adhere to the eight reporting principles: accuracy, balance, clarity, comparability, completeness, sustainability context, timeliness, and verifiability. Second, the organization must report 100% of the "GRI 2: General Disclosures 2021," one of the three categories of the GRI universal standards. Next, the report must present the company's material topics and include "GRI 3: Material Topics 2021," the third category of the GRI universal standards. The fifth step in building the ESG report based on GRI requirements is to disclose the GRI Topic Standards for each material topic. For any information that cannot be disclosed, companies must provide a reason for omission, such as applicability issues, legal restrictions, confidentiality constraints, or information unavailable/incomplete, along with a detailed explanation. However, some indicators do not accept any reason for omission. Finally, the report must include a GRI content index at the end, which must follow a specific format and include a statement of use. Once the report is complete, the final requirement is to notify the GRI. All of this information can be found in "GRI 1: Foundation 2021," which provides a deeper explanation of each requirement (GRI, 2021).

Another influential framework that has been enhancing the quality of ESG reports is Integrated Reporting (IR), which primarily aims to explain to financial capital providers how an organization creates value over time. The IR structure is built around four main elements: Governance, Business Model, Risks and Opportunities, and Strategy and Resource Allocation. The guiding principles for an IR report include Strategic Focus and Future Orientation, which require insights into the organization's strategy and how it is connected to value creation in the short, medium, and long term. The report must also describe how the strategy is being implemented and its effects on the capitals. Connectivity of Information requires a

holistic view of the combination, interrelatedness, and dependencies between all factors that negatively impact the company's ability to generate value over time. Stakeholder Relationships focus on the nature and quality of the organization's relationships with its stakeholders. Materiality is another key principle, guiding the report toward matters that substantively affect the organization's ability to create value over the short, medium, and long term. The integrated report must also be concise, reliable, and complete, including all material matters—whether positive or negative—in a balanced manner and without material errors. Lastly, the report must be consistent and comparable over time (IIRC, 2019).

Both frameworks are different, but they equally employ materiality assessments as a primary step of the ESG report. Materiality assessment is a powerful tool for presenting the company's sustainability matters or topics over time to stakeholders. The term "material" refers to what is important or prioritized. A material ESG topic represents an impact that can be real or potential, positive or negative, and can affect people or the environment over the short, medium, or long term. The materiality assessment involves identifying the company's most significant outward impacts for its most significant stakeholders. This practice originates from the financial sector, where it is used to consider the most significant inward impacts, focusing on communicating them to creditors such as investors and lenders, and is presented in annual reports (Appelbaum et al., 2023; Nielsen, 2023). Sustainability materiality influences the decisions made by users of financial statements, presenting critical matters in financial reports and serving as a fundamental element of the audit report. However, determining what is truly material and what is not is a common challenge for auditors (Appelbaum et al., 2023).

Recent accounting regulations, such as the Corporate Sustainability Reporting Directive (CSRD) and International Financial Reporting Standards (IFRS), have introduced the concept of double materiality in sustainability reporting. This concept connects the financially driven ESG perspective with the socially focused Corporate Social Responsibility (CSR) perspective. In other words, double materiality assesses both how the company affects the world around it and how the world around it affects the company. This is a relatively new concept and still requires further assessment and evaluation (Nielsen, 2023).

Conducting a materiality process is crucial due to the prioritization of potential impacts on stakeholders. Additionally, disclosing materiality matters can help mitigate

potential risks associated with the company's value, as more sophisticated disclosure of materiality within the sustainability report better represents the management's efforts to identify ESG risks and opportunities accurately. Well-executed materiality assessments also assist investors in better understanding the greater risks that could affect their returns, thereby enhancing the company's value creation (Albuquerque et al., 2024; Eriandani & Winarno, 2024). On the other hand, Hehenberger et al. (2024) argue that impact and financial measurement, such as materiality assessment, is a subjective activity. The authors emphasize the importance of materiality in the context of Impact Management (IM), where those affected by the company's actions can also perceive and experience changes. Hehenberger et al. also add that this practice can be considered part of "multistakeholderism," which involves including a broader range of stakeholders in the decision-making process and adapting metrics to reflect what they value most (Hehenberger et al., 2024).

The last step of the ESG report is the assurance process. This stage aims to supply stakeholders with a more accountable and transparent document. By 2013, the assurance ESG reporting process wasn't mandatory and the amount of assured ESG reports were low with questionable methodologies, regarding the real efficacy in improving its accountability and transparency to key stakeholder groups (Mori et al. 2013). Ten years later, there is a notable increase in the number of firms issuing ESG reports and assuring them. The frameworks were a booster in this regard, once it helps to align metrics with specific measurement standards, making assurance easier and more cost-effective (Gipper et al. 2024). ESG reporting frameworks help in the assurance process once it provides a "common language", facilitating the communication and consistency in data reporting and assurance and preventing assurors of having to invent measurement standards and assurance procedures.

In order to enhance its reliability, assurance processes must be transparent themselves first, such as explaining what type of assurance process was used and which information within the report was actually assured, otherwise it can be considered just a bureaucratic activity (Mori et al. 2013). When done in the right way, assurance process can enhance credibility and trust, once it demonstrates commitment to transparency and accountability, it also helps to reduce information asymmetry, facilitate compliance and risk management and, finally, can help companies to improve their own internal performance by providing feedbacks, helping the organization to identify areas for improvement and implement best

practices within their strategies (Mori et al., 2013; Martínez-Ferrero & García-Sánchez, 2017; Maroun, 2022; Kao, 2023; Rakipi, 2023).

3.2.5 ESG Reporting in Brazil

In Brazil, as globally, non-financial reports are the primary source for evaluating companies' ESG performances. Silva (2023) interviewed 14 investors in the Brazilian market, finding that half rely on public information for ESG performance assessment, despite the absence of a standardized reporting methodology. This underscores the critical importance of high-quality corporate reports. However, investors express concerns about the lack of measurement, standardization, and regulations, indicating that the Brazilian market is in its early stages of integrating ESG performance with financial metrics (Araújo, 2021; Silva, 2023).

The first Brazilian company to publish an ESG report based on GRI guidelines was Natura in 2001. Since then, the number of Brazilian companies adopting ESG reporting has grown significantly. Bandera (2022) indicates that 86.7% of Brazilian companies listed on the B3 stock exchange report using international methodologies such as GRI or IR framework to combine financial and non-financial information (IIRC, 2013). Engagement with IR signifies a serious commitment to sustainability and the fact that only 15.5% of companies did not report highlights the advances in terms of ESG in the Brazilian market since ESG reporting still remains a voluntary activity (Seele, 2016; Ricardo, 2017). Although, not even the South American market is running away.

3.3 ESG data

Data refers to raw inputs that are transformed into information and subsequently into knowledge. With the advent of the internet, the daily volume of data has increased rapidly. Currently, humanity produces approximately 2.5 quintillion bytes of data per day, with predictions suggesting that this amount will only intend to grow (Forbes 2021). This vast, complex, and rapidly growing data is termed Big Data (BD). Processing such an enormous volume of information requires data scientists who are responsible for collecting and transforming raw data into useful

predictive and prescriptive insights. This process is feasible only with software tools, algorithms, and machine learning principles, as the human brain is incapable of processing such a large amount of information, evidencing the urge to automate the process of data management (Song & Zhu 2015; B3 2019; Baum 2021; Balusamy et al. 2021).

Businesses also generate large volumes of data that need to be transformed into actionable information, and ESG data constitutes a significant portion of this. The modernity of companies is increasingly measured by the integration of technology and sustainability. Many organizations are leveraging artificial intelligence (AI) to enhance their ESG initiatives (Herath & Herath, 2024). According to Chen (2024), AI and digital technology encompass advanced tools and techniques to collect, process, analyze, and communicate ESG data. These digital mechanisms include natural language processing (NLP), machine learning, data analytics, cloud computing, blockchain, and digital platforms. AI and digital technology are powerful tools for ESG reporters and users, as they automate and streamline ESG data collection and processing, enhance data quality and reliability, provide valuable insights and recommendations, and facilitate data disclosure and communication, thereby increasing the credibility and trustworthiness of ESG reports.

To better assess the vast amounts of ESG data generated by companies and enhance the reliability of investment decisions, tools are being developed to read ESG Big Data using Artificial Intelligence (BDAI). According to B3 (2019), BDAI can deliver concise, consistent, comparable, and timely information on business ESG performance. This technology is potent in assessing and understanding corporate impacts on sustainability and can analyze a broader scope of data sources, such as online media, academic articles, government data, non-governmental reports, social media, and self-declared information (B3, 2019; Olanrewaju et al., 2024). This burgeoning market is not only beneficial for investors but also for companies seeking to better assess their own performance and for investment managers making financial decisions.

Beyond enhancing transparency, AI can also improve ESG performance itself. In the environmental domain, AI optimizes resource use, reduces waste, and minimizes carbon footprints. It can also detect and mitigate pollution levels in real time, ensuring compliance with environmental regulations and promoting a healthier ecosystem. In the social domain, AI improves workplace safety and labor conditions,

fosters diversity and inclusion, and analyzes large data volumes to identify patterns of inequality or discrimination within organizations, providing insights for corrective measures. In the governance domain, AI enhances transparency, accountability, and compliance within corporate governance frameworks and drives risk management solutions by identifying and recommending mitigation strategies (Rane et al. 2024). In contrast to the advancements AI can bring to ESG performance and assessment, its development has been leading to a range of negative environmental effects. The deployment of AI technologies requires a substantial computational resource, resulting in an increase of energy consumption, carbon emission and environmental degradation associated with data centers and cloud computing (Naeeni 2023).

Another emerging technology in ESG reporting is the eXtensible Business Reporting Language (XBRL). XBRL is an Extensible Markup Language (XML)-based standard designed to define and exchange business information, particularly for reporting purposes. It has been used for financial reports since 2009. XBRL is considered an integrated reporting tool as it merges data management and reporting into a common data repository, allowing managers real-time access to data without the need for further processing or migration (Seele, 2016; XBRL, s.d.). XBRL reports are built using specific tags recognized by computer software, enabling users to extract and analyze data efficiently. This digital standard includes data validation capabilities, ensuring high-quality reports. XBRL tags travel with each piece of information through reporting chains, maintaining perfect accuracy between multiple organizations. When combined with rigorous management oversight and assurance processes, the data and insights derived from XBRL become more reliable (XBRL, s.d.).

This technology is now being adopted in the ESG sector to assess performance in real time (Seele, 2016; B3, 2019; Cort & Esty, 2020; Mousa & Ozili, 2022). According to Seele (2016), XBRL aids companies in making better decisions regarding the use of financial, natural, and human resources to achieve superior financial and non-financial performance. However, since XBRL is new to the ESG domain, companies have been using the twin-track approach to implement it within their reporting culture. This approach allows companies to produce XBRL reports based on their current reporting systems, enabling a gradual transition (Seele, 2016; Faccia et al., 2021).

XBRL has gained significant visibility recently, especially as major upcoming standards, such as the IFRS and the EFRAG, are set to make it a mandatory requirement. ESRS and IFRS Both standards will become mandatory worldwide in the coming years and will require the XBRL reporting format (EFRAG, s.d.; IFRS, s.d.).

The Internet of Things (IoT) is a sophisticated system, designed to interact with the physical world by integrating various devices and smart objects. It encompasses multiple technologies, such as identification, embedded sensors, intelligent management, protocols and data storage, processing, and analytics. Over the past few years, IoT usage has expanded significantly, increasing its applications and usability, and it is now becoming an integral part of daily human life. Current applications of IoT include enhancing public transportation logistics, developing smart cities, building smart homes, and even smart hospitals, employing sensors and applications to monitor the patients and the equipments in real time, being able to act more assertively when facing critical decision-making processes, such as someone's dying (Abdul-Qawy et al., 2015; Hosseinnezhad et al., 2016; Kılıç & Bayır, 2017; Rodrigues et al. 2019; Arslan et al., 2024).

If it's possible to use IoT to monitor someone's life, in real-time, through machines, why not use the IoT to monitor, in real-time, the impact of a company's activities in the various material topic realms? IoT acts as a bridge between the physical and digital realms, offering new opportunities for businesses to enhance their ESG data assessment, monitoring, and management. Employing IoT in managing ESG matters can significantly boost a company's environmental, social, and governance performance by enabling real-time data monitoring and analysis, optimizing resource use, enhancing production efficiency, and reducing energy consumption, since IoT can be used to sensor to track water and energy usages, allowing companies to optimize their operations and reduce waste (Zeng et al., 2024).

3.4 ESG reporting and data challenges

The ESG data landscape is evolving as investors increasingly refine their strategies for evaluating companies' ESG performance. However, companies worldwide continue to grapple with the reliability of their ESG disclosures (Searcy &

Buslovich, 2013; Seele, 2016; Faccia et al., 2021; Mousa & Ozili, 2022; Chen, 2024; Markova-Karpuzova et al., 2024; Olanrewaju et al., 2024; Zeng et al., 2024).

3.4.1 ESG Reporting Challenges

Despite advancements in regulations, achieving full compliance across the market will take time. The current reporting landscape poses challenges for delivering the information investor's needs, since the reports often lack comparability and reliability, with data frequently being insufficient, inaccurate, and inconsistent across companies and sectors (Moharram et al., 2024). Several factors contribute to this situation, such as diverse categories of investors with varying material priorities, questions, expectations, and data needs, tight timelines, resource limitations and the slow progress in making ESG reporting mandatory. These issues adversely affect ESG metrics and data standards, resulting in inconsistent data and placing investors in a vulnerable position due to a lack of data quality and comparability (Searcy & Buslovich, 2013; Maas et al., 2016; Cort & Esty, 2020; Tett, 2020; Howard-Grenville, 2021; Saul & Kurlander, 2022; Crus & Matos, 2023; Moharram et al., 2024).

In addition to external challenges, companies face internal issues such as differing purposes for report usage, varying interpretations of sustainability, distinct report development processes, insufficient efforts to instill a sustainability reporting culture among internal personnel, and data collection difficulties. The aforementioned factors lead to disparities in the final reports, complicating the assessment and comparison of results across companies (Searcy & Buslovich, 2013; Sabirali & Mahalakshmi, 2023). To improve ESG reporting, businesses must engage in continuous learning, adaptation, strategic integration into their culture, and develop strong data gathering and analysis capabilities (Mykolaivna et al., 2024).

3.4.2 ESG Data Challenges

There are many solutions waiting to enhance ESG reporting processes. Big Data holds immense potential to revolutionize ESG reporting by enhancing data accuracy, improving decision-making, increasing transparency, and optimizing resource use (Olanrewaju et al., 2024). XBRL facilitates progress in sustainability reporting by enhancing governance, transparency, data management,

cost-effectiveness, and economic value (Seele, 2016). Finally, the application of IoT technology to ESG best practices is revolutionizing the assessment of ESG performance.

Although, all of these solutions face similar issues, such as data source, access and quality, system integrations, automation challenges, data privacy and management, technological complexity, comparability, consistency and reliability, initial costs, cultural resistance, regulatory variability, and supply chain issues (Seele 2016; Nassar and Pereira 2022; Markova-Karpuzova et al., 2024; Olanrewaju et al. 2024; Plugge et al., 2024; Zeng et al., 2024). Addressing these challenges requires strategic investments, ethical practices, technological advancements, and transparency in reporting practices (Olanrewaju et al., 2024). Also, companies must adopt comprehensive strategies that include careful technology selection, robust risk management, ethical considerations, and ongoing employee training and engagement (Zeng et al., 2024). Gipper et al. (2024) highlight that firms need to enhance their internal information systems in order to have reporting numbers aligned with the specific measurement standards recommended by the reporting framework, because only with clear measurements, assurors can conduct meaningful assurance processes. Although, they also add that there is a considerable heterogeneity in which metrics are being assured, even within one only ESG report, different patterns of assurance and evolving assurance practices (Gipper et al. 2024).

It is paradoxical that, amidst the ongoing Fourth Industrial Revolution—an era characterized by the dominance of information, technology, and human-generated data—companies still face this issue. Unlike marketing, sales, and financial departments, which have rapidly evolved their data management processes and analytical methodologies, the ESG sector struggles with manual and disintegrated processes, hindering reliable data delivery (McKinsey & Company, 2015; Skilton, 2018; IMMGS, 2019; CMO Survey, 2021; Hubspot, 2023). This contradiction raises significant concerns about the feasibility of these new technologies in truly enhancing accuracy and transparency if the underlying data remains unreliable.

In summary, the literature on ESG data management and reporting reveals several significant findings. Companies worldwide are increasingly adopting ESG reporting practices, driven by investor demand and regulatory pressures. However, challenges related to data reliability, standardization, and integration persist. The

review highlights that despite the availability of advanced technologies to assess companies' reports, like Big Data, AI, XBRL, and IoT, companies still struggle with manual and fragmented processes, impeding the accuracy and transparency of ESG data (figure 1).

These insights underscore the critical need for robust ESG data management frameworks that integrate well-defined structures, clear processes, and conducive spaces, as emphasized by Blokdijk (2009) and Lima and Lezana (2005). Furthermore, the role of leadership commitment and employee engagement in fostering a sustainable organizational culture cannot be neglected, as noted by Eccles et al. (2012) and Mosher and Smith (2015).

Despite the progress in ESG reporting standards and the introduction of frameworks like the ISSB and CSRD, there remains a significant gap in the practical application of these standards. The ongoing challenges highlight the necessity for continuous learning, strategic integration, and investment in digital platforms to enhance data accuracy and comparability.

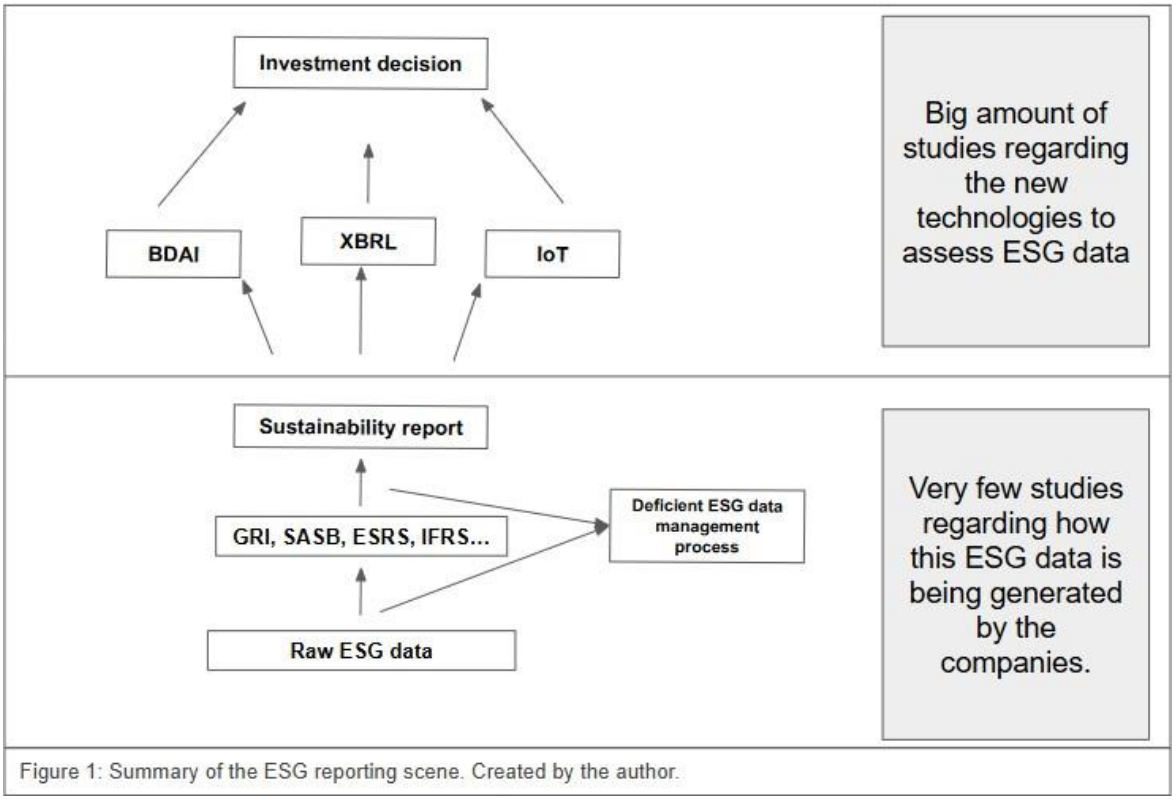

Figure 1: Summary of the ESG reporting scene. Created by the author.

Future research should focus on developing comprehensive methodologies for ESG data management, exploring the potential of new technologies to streamline processes, and investigating the impact of regulatory changes on reporting practices. Addressing these gaps will be crucial in advancing the reliability and effectiveness of ESG reporting.

This review lays the groundwork for the present study, which aims to identify best practices for a reliable ESG data management process. By bridging the gaps in current literature, this research seeks to contribute to the development of more accurate, transparent, and comparable ESG reports, ultimately supporting better decision-making and fostering sustainable business practices. Despite the availability of numerous resources, frameworks and technologies in the data era, ESG data management remains a neglected activity, lacking investment, efficient tools and integrations. Therefore, this research is driven by the crucial question:

What underlies the current ESG reporting processes given the lack of automation throughout the ESG data management?

By addressing this question, the study aims to uncover the current ESG reporting scenario, mapping the structures, processes and spaces that companies

are adopting to manage their ESG reporting process. The research also wants to show how companies are overcoming their current challenges and enhancing the reliability of their ESG data reporting in a reality of low level of automation in the process.

4. RESULTS

The results section of this dissertation presents the findings derived from the qualitative analysis of ESG data management practices across nine companies listed on ISE. These findings were obtained through semi-structured interviews, which were designed based on the Lima & Lezana framework. The interviews provided valuable insights into how these companies structure their ESG departments, manage their ESG data collection processes, and engage with their leadership and workforce in the sustainability reporting process. The data collected was then analyzed using thematic analysis, allowing for the identification of key themes and patterns across the companies. This section is organized around these identified themes, highlighting common practices, distinct approaches, and gaps within the companies' ESG reporting processes. The results are organized by the dimensions of structure, process, and space as outlined by the Lima & Lezana framework, offering a comprehensive view of the current state of ESG data management and reporting among these Brazilian companies.

4.1 Structure

1. *How strongly do you believe that the company's strategy aligns with and prioritizes materiality?*

When asked about the usability of the materiality assessment to drive the company’s business strategy, five out of nine participants reported that their company uses the materiality assessment beyond the report, including its elements and directions in the business strategy and goals. Company 1 (Paper and Pulp sector), Company 6 (Oil and Gas sector), Company 7 (Consumer Goods and

Agribusiness sector), Company 8 (Pharmaceutical Retail sector) and Company 9 (Telecommunication sector) have shared that the materiality assessment has been used to guide the company's strategy and commitments. Although, Company 6 (Oil and Gas sector) also continued saying that the topics receive different attention within the company, with a few of them being more incentivized than others. Company 2 (Rail Transport sector) and 5 demonstrated a low level of maturity in its materiality assessment implementation process. Finally, Company 4 (Energy sector) expressed that the materiality has no use outside the ESG department.

The 5 participants that reported using the materiality, differently described how the company makes use of the materiality. It was mentioned as relevant to the company's strategic planning, to drive the company's commitments and to guide the company's activities as a whole. Companies 3 and 8 said that the materiality assessment was used to conduct the sustainability strategy, giving the impression of having 2 different strategies within the company. Company 1 (Paper and Pulp sector) stated that the materiality assessment is one of the elements being used to drive the company's strategic planning. Company 3 (Electric Power sector) said that the company's sustainable strategy is guided by three main pillars: circular economy, biodiversity and climate change and all of them are material topics. Company 7 (Consumer Goods and Agribusiness sector) said that the materiality assessment is used to review the company's commitments that orient the company's strategy. Company 8 (Pharmaceutical Retail sector) used the materiality to drive the process of defining the 2030 commitments. They also completed saying that the sustainability strategy is intimately connected to the business one. Finally, Company 9 (Telecommunication sector) shared that each material topic is addressed to a different department, meaning that is not the ESG department that manages them. They added that the company is capable of taking actions that come from the strategy department and cascade until the products and services. "The company is in constant transformation. All of the company's activities are being executed considering its risks and opportunities."

2. *How is the company's ESG department structured?*

Four out of nine participants mentioned the presence of an ESG Committee supporting the company's board and representing the ESG department. Six

participants mentioned the presence of a vice president level and five mentioned a directive level. All participants mentioned a management level that was usually divided between environment, social and governance (Table 3). This result does not necessarily mean that the company doesn't have all of the hierarchical level, it just means that it wasn't mentioned during this question. Company 6 (Oil and Gas sector) mentioned that the committee is formed by the same person that occupies the management role. Only companies 1 and 7 mentioned the presence of a department focusing on data assessment. Company 1 (Paper and Pulp sector) allocates it as a management area called "data and processes". Company 7 (Consumer Goods and Agribusiness sector) has a different structure, mentioning the presence of a transversal management area called "Intelligence and Sustainability management", that is responsible for the company's data.

Table 3: Structure of the ESG departments within the companies

	Board/Committee	VP	Director	Manager
Total	5	6	5	9
Companies	5, 6, 7, 8 and 9	1, 3, 5, 7, 8 and 9	1, 2, 3, 4, 5, 7 and 9	1, 2, 3, 4, 5, 6, 7, 8 and 9

3. *How many people are in the ESG team? Do you consider this number sufficient?*

The average number of people managing the ESG report process in all of the companies was 3. When asked if this amount of people was sufficient, six out of nine participants answered that it was not (table 4). Companies 3, 4, 5, 6, 7 and 8 shared that there is a large volume of demands for a small team, being a painful process, they brought attention to the fact that the ESG team doesn't just handle reporting and that is a very manual process to deal with over 250 people and more than 50 areas. Company 6 (Oil and Gas sector) even added that the entire ESG reporting team is the entire company's ESG team.

This suggests that increasing the number of personnel dedicated to sustainability reporting would likely enhance its efficiency and effectiveness,

considering the lack of automation in the process workflow. Of the three participants who answered that it was a sufficient number, one shared that it was sufficient for now, but with the upcoming regulations, it might not be, and another said it was sufficient due to their strong partnership network, such as external sustainability consultants.

Table 4: Companies' and ESG departments' description and characteristics

	About the company		About the ESG department		
	Sector	Nº of employees	Nº of employees in the ESG department	Nº of employees working on the sustainability report	Enough people?
Company 1 (Paper and Pulp sector)	Paper and Pulp	20.627	10	4	Yes
Company 2 (Rail Transport sector)	Rail Transport	7.905	13	2	No
Company 3 (Electric Power sector)	Electric Power	15.693	8	2	No
Company 4 (Energy sector)	Energy	1.551	5	5	No
Company 5 (Electric Power sector)	Electric Power	8.328	21	4	Yes
Company 6 (Oil and Gas sector)	Oil and Gas (Upstream)	163	3	3	No
Company 7 (Consumer Goods and Agribusiness sector)	Consumer Goods and Agribusiness	14.500	N/D	2	No
Company 8 (Pharmaceutical Retail sector)	Pharmaceutical Retail	57.216	17	2	No
Company 9 (Telecommunication sector)	Telecommunication	33.206	15	3	Yes

4. How engaged do you believe the company's leadership is with ESG issues? What about other departments? And why?

Question 4 was the first question made during the interview. From the start, the majority assured having an engaged leadership and workforce. Company 6 (Oil and Gas sector) mentioned having a partially engaged leadership, since they were not attending to all of the materiality topics. Only Company 4 (Energy sector) declared a disengaged leadership body and, consequently, also the workforce. They said

> *"There isn't much engagement from the other departments. Data collection is quite complicated. It's not part of the culture. It doesn't affect data transparency because the report is audited, so a thorough review of the data is conducted. But it significantly delays the process."*

As it follows, when answering if the workforce was engaged, the majority also answered yes. Usually, the companies connected the workforce engagement to the leadership one, implying that if the company has a leadership that includes ESG topics within their speeches and that puts effort to implement ESG in the company's culture, the workforce will respond with the ESG engagement.

After questioning whether the leadership and the workforce were engaged or not, they were asked what makes them think that their leadership or workforce are engaged in sustainability matters. The analysis was aiming to understand the concept of leadership and workforce engagement through the ESG professional's eyes. The answers raised by each participant differed but were also very similar. The main reasons mentioned by the participants turned around four main aspects**:** culture and metrics (table 5).

The aspect culture could be noticed within Company 1 (Paper and Pulp sector) and 8's statements. They shared the perception that ESG is a transversal agenda within the company a

and that it is not a matter only to the sustainability sector, but for every sector of the company, implying that the leadership body has tapped ESG into the company's

Table 5: Aspects of an engaged leadership and workforce.			
Theme	Description	Mentioned to describe the leadership	Mentioned to describe the workforce
Culture	ESG within company's purpose ESG as a transversal agenda ESG used as a strategic tool ESG within the CEO speeches	5	6
Metrics	ESG metrics tied to variable remuneration	7	5

culture. For Company 1 (Paper and Pulp sector), having ESG as a transversal agenda is:

> *"Transversality means recognizing that this responsibility is not concentrated solely within the ESG department; it permeates various areas of the organization. We observe this spread across different departments, including through formal practices, policies, internal controls, and procedures that address socio-environmental risks and opportunities. Additionally, there is clear involvement from multiple areas within this governance structure. It's more than just seeing departments discuss these topics—it's about identifying formal practices that confirm this shared responsibility throughout the company."*

Company 3 (Electric Power sector), 7 and 9 also mentioned that a sign of an engaged leadership is the inclusion of ESG into the company's purpose. Company 7 (Consumer Goods and Agribusiness sector) even added that the ESG is used as a strategic tool. Company 9 (Telecommunication sector) was the only one that mentioned that ESG is an integral part of the CEO's speeches, adding that when the CEO brings attention to a topic it speeds up its inclusion within the company's culture.

The aspect metrics was the most mentioned one to describe the leadership engagement. This topic was cited for 6 out of 9 companies pointing that one possible explanation for the leadership engagement is the fact that the executives' variable remuneration, which means the bonuses, are tied to the company's ESG metrics. From these 5 companies, 4 mentioned that this strategy extends to the workforce body. A few participants were asked if they were there before this existed or if they arrived in early stages of the implementation and a few of them answered. Among those who watched this strategy being implemented, all of them could notice an improvement in the way sustainability was treated within the company and in its implementation, also enhancing the data quality provided.

5. In your assessment, is the budget allocated to sustainability aligned with the identified needs?

When asked if the budget available to sustainability matters was compatible with the sustainability issues within the company, 5 out of 9 participants disagreed, commonly pointing to lack of budget for projects, team, site inspection, and topics management. Company 8 (Pharmaceutical Retail sector) pointed out that they have set long-term metrics but they could not see the budget being addressed to these matters. They also stated that the right direction is to implement an ESG budget within each department, not just in the ESG department. Anyhow, Company 7 (Consumer Goods and Agribusiness sector) observed that the budget is not enough now, but they can notice an improvement in the budget and that it is growing during the years. Companies 1, 2 and 9 stated that the budget redirected to ESG matters were enough. Although companies 1 and 9 showed concerns about the future needs regarding new regulations and digitalization of the process.

4.2 Process

6. How does the company's ESG reporting process operate?

Six out of nine companies considered their ESG data management process decentralized, affirming that the other departments are very aware, participate a lot in the process and are owners of their own data with the ESG department only consolidating and managing the process. The processes described varied in many terms, such as its periodicity, its level of implementation within the company's culture

and the way they engage their workforce. Although they were different, all of them were also complementary and almost all of them had only one thing in common: the processes were still very manual. Only Company 3 (Electric Power sector) showed a more digitized ESG data collection process.

Based on all of the steps and best practices mentioned by the participants, a comprehensive workflow for the ESG reporting process has been developed, since visual representation can translate complex processes into more understandable and accessible information, aiding in organizational effectiveness assessment and defining the scope and boundaries of the organizational system (Lima & Lezana, 2005). This workflow consists of four steps: 1. Getting Ready to Report, 2. Process Updates, 3. Data Collection, and 4. Reporting and Assuring (Figure 2). The cyclical nature of the workflow illustrates the continuous nature of ESG activities and decisions (Munk et al., 2013). Each step specifies its periodicity, stakeholders involved, and sub-steps required for its completion. This visualization aims to assist organizations in identifying gaps in their processes and improving them, while also clarifying the roles of stakeholders.

4.2.1 Getting Ready to Report (3 months | Apr - Jun)

The initial step in the workflow is to ensure that each new cycle of reporting surpasses the previous one in quality. To achieve this, feedback must be collected from stakeholders involved in the process, including data providers/validators and the suppliers who contributed during the last cycle. By assessing this feedback, the ESG report coordinator can identify key process gaps and develop action plans to facilitate a smoother subsequent cycle. A feedback-oriented environment promotes improved performance, as feedback is integral to the performance management process. It encourages stakeholders to concentrate on primary goals and explore alternative collaborative approaches. Furthermore, feedback can enhance efficiency by highlighting employees' strengths and areas needing improvement (London & Mone, 2014; Tseng et al., 2019).

Feedback assessment presented on the workflow is divided into two parts: 1. Gathering input from data providers/validators through a form that includes questions about suppliers, and 2. Requesting an assurance report from the assurance supplier

to evaluate the status of the data provided, identifying which data were accurate and which areas need improvement. This assurance report helps assess the maturity of each department, aiding the ESG report team in identifying data providers/validators requiring additional support. Together, these processes constitute a two-tiered feedback approach: the first phase collects input from individuals involved in the project, incorporating their perspectives and experiences, while the second phase evaluates the outcomes or products of their work, providing guidance on improvement areas. This approach not only captures participant feedback but also directs them on enhancing their performance and outcomes.

Based on the feedback assessment, a set of action plans will be developed, assigned to responsible individuals, and communicated to them. These action plans must be implemented across departments throughout the year, until the next data collection process. The marketing team will support internal communication, and the human resources team will assist in tracking performance and implementation. Effective communication and clearly defined roles and responsibilities foster employee engagement, especially when linked to a broader mission, which enhances ESG outcomes (Gill et al., 2023). This step should last approximately one month.

4.2.2 Process update (4 months | Jul - Oct)

The second step is crucial due to the inherent volatility of businesses and high employee turnover rates. Volatility is driven by factors such as geopolitical risks, potential pandemics, economic uncertainties, and natural disasters (Asgharian et al., 2023; Khan et al., 2023; Zhang et al., 2023; Montero et al., 2024). High turnover, often attributed to organizational issues like coordination problems, reduced motivation, company size, and efficiency, being a pain that many large companies face (Hausknecht et al., 2009; Garsaa & Paulet, 2022). Research results indicate that turnover rates were frequently mentioned as a concern in the ESG data collection process.

To address volatility, global standards recommend regular reviews of materiality assessments, which should occur annually or biannually in order to keep the materiality up to date to the company’s current reality and priorities (GRI; SASB;

IIRC; TCFD). Regarding turnover, the ESG report team must maintain close coordination with the human resources department to ensure the process remains current with the right data providers/validators. New data providers/validators require additional training and engagement. As materiality dictates the KPIs to be reported and data providers/validators are responsible for supplying this information, all changes must be reflected in the ESG data management software. This step should take about four months and requires collaboration with the HR department and system providers. Depending on where the materiality assessment is managed, it may also involve the strategy department.

4.2.3 Data Collection (3 months | Nov - Jan)

With the primary data and process gaps identified and addressed (or partially addressed), data providers and validators updated and the system completed, the next step is the data collection. This phase should commence with an engagement session, marking the second and final meeting with data providers during the process. The purpose of this meeting is to ensure that all stakeholders understand the information they need to report and are trained to navigate the process's software. These engagement sessions should be organized and communicated by the marketing and HR departments as a campaign and scheduled one or two weeks before the data collection period begins.

At the start of the cycle, all data providers and validators should be clear about their reporting requirements, the location of evidence to support the provided information, how to use the collection system/process, and the specifics of their KPIs. All data must be provided and validated by the responsible individuals and sent to the ESG department for consolidation. Concurrently, some KPIs must be addressed through interviews with executives. The data collection period can range from one to two months, depending on the company's size, complexity, or the maturity of data providers.

4.2.4 Reporting and Assuring (4 months | Feb - May)

When the final step arrives, it means that ESG data has been already gathered, evidenced, and validated by each department and consolidated by the ESG reporting team. Assuring and auditing the ESG report is crucial for enhancing its reliability and transparency to financial stakeholders (Nielsen, 2023). Assurance significantly influences company reputation and enhances stakeholder perception of the report's credibility (Ulvtorp, 2024). According to IFRS, external assurance of ESG reports is a top priority (IFRS, 2021).

The assurance process requires the ESG reporting team to coordinate with all data providers and assurance representatives to ensure that all collected data is accurate and trustworthy. This process may take several weeks due to scheduling conflicts and unforeseen events. All participants had their reports assured by a third-party entity, indicating a high level of ESG reporting maturity in a developing country where reporting remains voluntary (Poltroniere et al., 2018).

Following the assurance process, the ESG team can forward the report information either to the marketing team, if the report is developed in-house, or to external report suppliers, such as sustainability consultancies and external marketing teams, if the report is created externally. If the company has a well-implemented system, this entire process can be managed within it. This final step should last approximately four months and involves all data providers/validators, software, assurance, and reporting suppliers.

An analysis of the participants' responses revealed a greater focus on the data collection step, suggesting that elements such as feedback, communication, turnover, and materiality were less emphasized. This does not imply that these steps were neglected, but rather that participants did not view them as integral to the data collection process when describing it. For instance, while all participants assured their reports, only four companies mentioned the assurance step in their explanations of the ESG reporting process.

The main challenges identified in the ESG data management process are "low automation" and "low engagement from data providers/high turnover rates." Ulvtorp (2024) highlights that assurance is crucial for proving report credibility, but data integration within software can support and strengthen assurance practices. Markova-Karpuzova et al. (2024) suggest that tech-based ESG reporting platforms facilitate the ESG data collection and aggregation process from internal and external sources, producing more comprehensive reports and better reflecting current

sustainability performance. The mentions for each activity were different. Each participant described their own process in a different way, but all of the processes were also complementary to one another. The most mentioned part was the step referring to the ESG data collection.

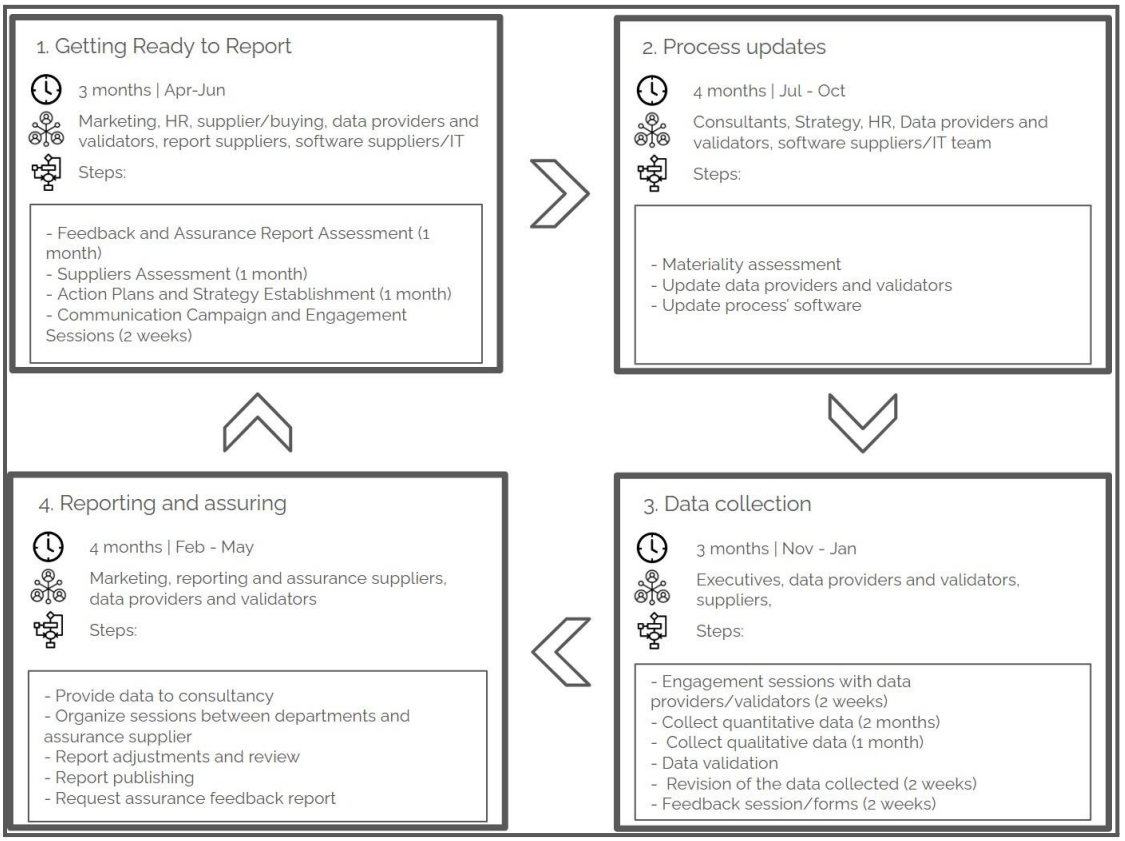

Figure 2.: ESG reporting management workflow model. Created by the author.

The steps mentioned varied from one company to another, with updated and data collection being the most commented ones (table 6).

Table 6: ESG Data Management Workflow Based on the Current Practices of Companies and the Implementation of Each Step

Stages/Tasks	Duration	Stakeholders Involved	Description	Companies Implementing
Getting ready for the next reporting season (3 months | Apr - Jun)				
Feedback Sessions/Forms	2 weeks	Data providers, validators	Conduct feedback sessions to identify gaps and prepare for the next reporting cycle.	2
Feedback and Assurance Report Evaluation	1 month	Data providers, validators, report suppliers	Collect and analyze feedback and assurance reports to enhance data collection and reporting processes.	1
Supplier Assessment	1 month	Procurement department	Evaluate current suppliers' performance based on feedback and decide on continuation or replacement.	1

Action Plan and Strategy Development	1 month	ESG department	Identify gaps, prioritize them, and develop action plans and strategies to improve the next reporting cycle.	2
Engagement Sessions	2 weeks	Marketing department, HR department	Communicate changes and goals to stakeholders, integrating updates into the company culture.	3
Getting ready for the next reporting season (3 months | Apr - Jun)				
Materiality Assessment Review	1 - 4 months	ESG department, strategy department	Regularly review and update materiality assessments and KPIs to ensure alignment with the company's current situation.	2
Data Provider and Validator Review & Integration	2 months	ESG department, HR department	Review and integrate new data providers and validators through training and engagement.	6
System Updates	2 months	IT team, software suppliers	Update the data management system or spreadsheets with new KPIs and KPI owners.	4
Process updates (4 months | Jul - October)				
Engagement Sessions for Data Providers/Validators	2 weeks	Executives, data providers and validators	Conduct training sessions to onboard new personnel and refresh existing data providers and validators.	2
Quantitative Data Collection	2 months	Data providers, validators, suppliers	Gather quantitative data, ensuring accuracy and completeness.	7
Qualitative Data Collection	1 month	Data providers, validators	Collect qualitative data through systems and executive interviews.	4
Data Review	2 weeks	Data providers and validators	Review and validate consolidated data, ensuring all necessary evidence is included and accurate.	2
Reporting and assuring (4 months | Feb - May)				
Provide Data to Consultants and Report Preparation	4 months	ESG department, reporting suppliers, marketing team	Compile the sustainability report, verify data quality through assurance providers, and prepare the report for publishing.	1
Organize Sessions Between Departments and Assurance Providers	1 month	ESG department, assurance providers, data providers, validators	Coordinate schedules between departments and assurance representatives.	4
Adjustments and Review	1 month	ESG department, assurance providers, data providers, validators	Finalize information and incorporate inputs from the assurance process.	1
Report Publishing	1 week	ESG department, marketing department, reporting suppliers	Validate the final report and provide it to the marketing department for publication.	0
Request Assurance Report	1 week	Assurance providers	Request the final assurance report, including adjustments and areas for improvement.	1

The ESG reporting approaches described by the companies also varied in terms of maturity of the process. The maturity of the companies processes were assessed by a set of elements that were mentioned by the companies during the interview when answering about their own ESG reporting processes (table 7). For

each element was given a score between 1 and 3, with 1 meaning that this element was in a basic level of maturity, 2 meaning an intermediate level and 3 corresponding to an advanced level (table 8). The scores were attributed based on 1. if the element were never mentioned along the entire interview; 2. if the element were mentioned in another part of the interview; and 3. if the element was mentioned in the proper question (table 9). The element scores were summed and it resulted in a radar chart with each company's total score (figure 3). The closer to the center, the less mature the company is. The companies who got a score between 10 and 19 were considered having a basic ESG reporting process, between 20 and 24 were considered intermediate and between 25 and 30 were considered advanced.

Table 7: Elements used to assess companies' maturity level

Elements	Explanation
Ongoing Process	Continuous updates and improvements to the reporting process throughout the year.
Internal Feedback Mechanism	Incorporates stakeholder feedback to enhance the process.
Assurance Report Evaluation	Includes an evaluation to validate the report's accuracy.
Strategic Planning	Planned and organized process to address gaps and implement improvements.
Process Decentralization	Involves all departments, not just the ESG team.
Process Updates	Regular updates to materiality assessments, KPIs, and data management roles.
Process Automation (Software Utilization)	Automation level, including software use for data collection and reporting.
ESG Data Integration/Culture	Integration of ESG data into the company's culture.
Data Granularity	Depth and detail of data management.
Departmental Independence	Departments' autonomy in managing their data.
Engagement Sessions	Training sessions to engage departments in ESG reporting.

Table 8: Maturity ranking level

Elements/Company	Company 1 (Paper and Pulp sector)	Company 2 (Rail Transport sector)	Company 3 (Electric Power sector)	Company 4 (Energy sector)	Company 5 (Electric Power sector)	Company 6 (Oil and Gas sector)	Company 7 (Consumer Goods and Agribusiness sector)	Company 8 (Pharmaceutical Retail sector)	Company 9 (Telecommunication sector)
Ongoing Process	3	1	3	1	1	1	3	1	3

Internal Feedback Mechanism	3	1	1	1	1	1	3	1	1
Assurance Report Evaluation	3	3	3	3	3	3	3	3	3
Strategic Planning	3	1	1	1	1	1	3	1	3
Process Decentralization	3	3	3	1	3	2	3	1	3
Process Updates	3	3	1	1	3	1	3	1	1
Process Automation (Software Utilization)	2	2	3	2	2	1	2	2	2
ESG Data Integration/Culture	3	1	3	1	2	2	3	1	3
Data Granularity	2	1	3	1	1	1	1	1	2
Departmental Independence	3	3	3	1	3	2	3	1	3
Engagement Sessions	1	1	1	1	1	3	3	1	3
Total	29	20	25	14	21	18	30	14	27

Table 9: Companies' maturity level

Maturity level	Score range	Company
Advanced	25 - 30	1, 3, 7 and 9
Intermediate	20 - 24	2 and 5
Basic	10 - 19	4, 6 and 8

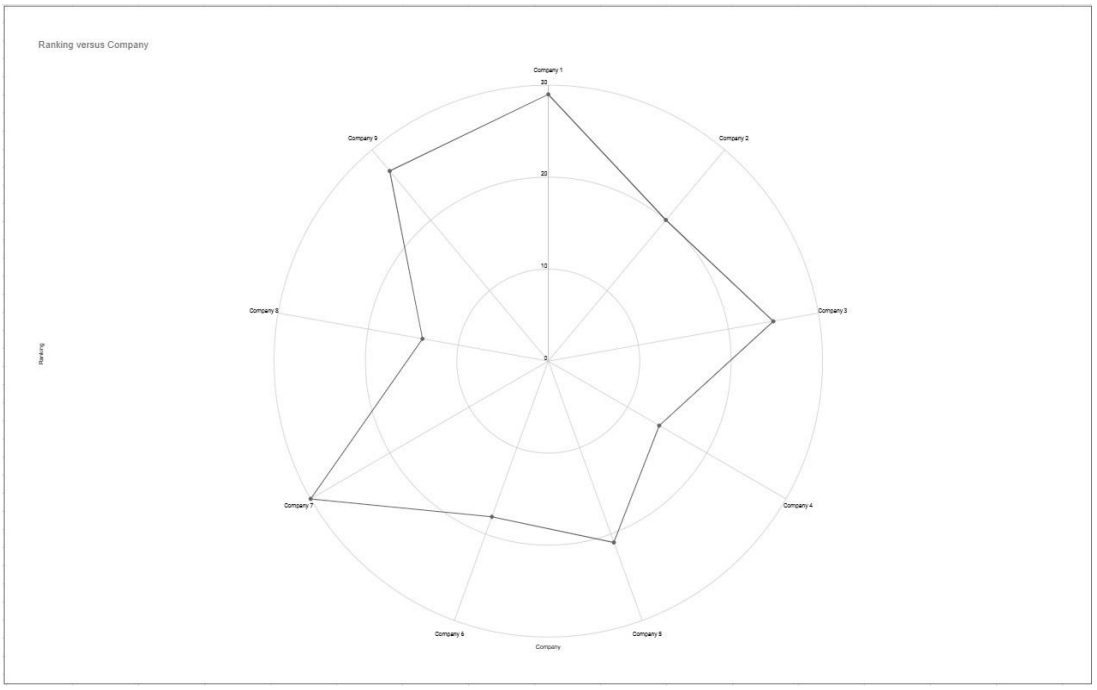

Figure 3: ESG reporting process maturity score variation

7. What are the main areas of focus you perceive in your company's data management process?

Regardless of the maturity level, when they were asked for the main critical points of the current ESG reporting process they are adopting, the answers were very similar and turned around similar topics. The most mentioned one was **“low level of automation and traceability”**, appearing in the answers of the companies 2, 4, 5, 6, 7, 8 and 9. Even though Company 1 (Paper and Pulp sector) didn’t mention this topic as an issue in this question, they shared having traceability issues when talking about their internal system. Companies 4 and 8 admitted that they trust in the data that arrives to them. Company 8 (Pharmaceutical Retail sector) even adds that "The sustainability department is not responsible for the information it receives. It cannot analyze and guarantee the source of all the information that goes into the report. We are a means of communication, but we cannot be held accountable for the quality and accuracy of this information." Company 2 (Rail Transport sector) shared the need of a central data center because, since the process is still very manual, gathering the data becomes really challenging. Finally, Company 7 (Consumer Goods and Agribusiness sector) raises key questions that must receive some attention from companies. They said “how to make it easier? How to have a more intelligent view of overall data management and governance, moving away from relying on people, as this is what brings the greatest vulnerability to the process?”

The second most mentioned topic was **“workforce engagement and high turnover rates”**, being brought up by the companies 3, 4, 5, 7, 8 and 9. Company 3 (Electric Power sector), 8 and 9 mentioned the cultural issue as a point of attention for the reporting process, impacting on the workforce engagement when it comes to the report. Company 9 (Telecommunication sector) said “Cultural challenge, because even though the departments are engaged, the volume of information they need to provide is very large, and it’s difficult to ensure that this isn’t negatively impacting the departments. Engagement is a significant issue because, even though the departments are willing to help, they also have their own challenges that impact the business. It is difficult to engage people when the situation is creating more work for

the departments, under the premise that this demand is to make the company more sustainable, when in reality, it's just because a stakeholder requested this information.” Company 3 (Electric Power sector) said “the challenge is to make people see the relevance of the data they are inputting, ensure they pay more attention to what they are submitting, and conduct a deeper analysis. The respondents are already well trained in the system, but there are still cases where data is provided without proper analysis.” This affirmation corroborates with what Company 4 (Energy sector) shared regarding issues with certain indicators due to lack of evidence and attention from the respondents. Company 5 (Electric Power sector) and 7 mentioned that one of the main pain is the turnover rate of the company, which makes them have to train the person all over again, retarding the progress of a real ESG implementation.

The other factors mentioned by the participants were **“short and challenging deadlines’’** and **“New emerging standards anticipation** , cited by Company 1 (Paper and Pulp sector), 4 and 9, **and adaptation and lack of synergy between them”**, cited by companies 7 and 9 (table 10). Company 1 (Paper and Pulp sector) answered “Short and challenging deadlines, and the trend is for them to become even tighter with the movement to publish the sustainability report together with the financial report.”. Company 9 (Telecommunication sector) reported

> “The speed required to address all the demands generated by the number of standards... 'Today we have to respond to more than 12 evaluators, including rating agencies, indices, etc. They have indicators with more than 5 versions. It’s the same raw data, but it changes based on units of measurement, scope interpretation, and several other factors.' This variety, while also ensuring an appropriate narrative. Addressing this with the necessary speed, meeting deadlines, and ensuring it doesn’t negatively impact the company in the short, medium, or long term.”

Table 10: Key concerns highlighted by participants regarding deficiencies in ESG data collection processes

	Short and challenging deadlines	Low level of automation in processes	Low engagement from data providers and high turnover rates	Lack of synergy between frameworks and indices	New emerging standards anticipation and adaptation
Total	3	7	5	1	2

4.3 Space

8. Do you use a data management system? If so, which one?

For 8 out of 9 companies, the space in which the ESG reporting process happens is inside a software. Only Company 6 (Oil and Gas sector) has not acquired an ESG data management system yet. They said "I believe that current ESG data management systems are good for tracking respondents. They are marketed as if the company will have much less work, but in practice, this doesn't happen because if the teams aren't engaged, the struggle remains the same. Excel ends up being easier." Company 1 (Paper and Pulp sector) and 5 have a system provided by internal resources. The reasons for opting to have an *in-house* platform for Company 1 (Paper and Pulp sector) was the lack of flexibility from *System as a Service's* (SaaS) platforms and for Company 5 (Electric Power sector) was due to the presence of a research center within the company that could build a system focusing exactly on what the company needs. The other six companies shared their providers and the main appearances were TBL, Climas, Report and Sygris.

9. Do you still find yourselves relying on Excel spreadsheets? If yes, why?

Seven out of eight companies that already use a system, shared that still need to use the excel for some reason. The main factors mentioned by the participants to explain why the presence of excel spreadsheet remains within the process were:

1. Other departments still prefer to manage data within excel spreadsheets
2. System's limitations for specific needs, such as calculation or KPI format;
3. Don't have all company's data systematized within the system

4. Lack of integration with other systems, forcing the information to arrive in excel format

5. The system they use is with a cloud excel interface.

All answers available in **Attachment 1**.

5. DISCUSSION

The discussion focuses on addressing the central research question: What underlies the current ESG reporting processes, given the lack of automation throughout ESG data management? This section critically analyzes the findings to uncover how companies are managing their ESG reporting efforts in the Brazilian market, with particular emphasis on the challenges posed by low levels of automation. The themes explored include the role of materiality assessments, organizational structures, data management workflows, and leadership engagement. By mapping these factors, this discussion aims to provide insights into how companies can overcome existing barriers and enhance the reliability of their ESG data reporting processes, ultimately guiding best practices for the Brazilian market.

Materiality assessment is vital for embedding sustainability across a company and, consequently, within the ESG report. Mosher & Smith (2015) advocate for a gradual integration approach, beginning with a few key issues and expanding as each is effectively addressed. However, the number of material issues reported by companies ranged from 6 to 11, suggesting that emerging topics may not be receiving sufficient attention. This is evident in the fact that nearly half of the research sample is struggling to integrate materiality into their business strategies. For example, Company 6 (Oil and Gas sector) identified eight material topics, but, according to the interview, these topics are only partially addressed. Similarly, Companies 2 and 5 reported 10 material topics each, though their materiality implementations remain in the early stages. When not taken seriously, materiality assessments can undermine the quality of sustainability information provided to investors (Mosher & Smith, 2015).

To effectively integrate material issues into operations, companies must first understand how these issues impact various business functions. This understanding

can be achieved through mapping the business model and engaging with different functional units to identify relevant impacts and opportunities. Additionally, sustainability professionals should prioritize material issues and communicate them in business terms that resonate with and motivate colleagues. Recognizing the influence of material issues on different roles and functions is crucial for embedding them into corporate strategy and establishing appropriate goals and targets (Mosher & Smith, 2015). Companies 1, 3, 7, 8, and 9 demonstrated greater progress in materiality integration, with Company 1 (Paper and Pulp sector) utilizing it as a tool for strategic planning. Companies 7 and 8 employ materiality to set corporate commitments, while Company 9 (Telecommunication sector) is the only one to highlight the direct impact of materiality assessments on its services and products.

In recent years, the concept of double materiality has emerged as a significant development in materiality assessment (Nielsen, 2023). New standards and regulations, such as ESRS and IFRS, are adopting this approach to evaluate material topics. Interestingly, despite these regulations not yet being implemented in Brazil, 100% of the companies in the research sample have already adopted the double materiality assessment. Additionally, only 4 out of the 9 companies are in the early stages of materiality implementation, and all participants had their reports assured by third-party entities. This suggests a relatively high level of ESG reporting maturity, especially in a developing country where such reporting remains voluntary (Poltroniere et al., 2018).

The companies surveyed generally described their ESG departments as comprising a committee, a vice-presidency or superintendency, directors, and managers overseeing various areas. Notably, 100% of the research sample reported the presence of a management level, and half mentioned the existence of an ESG board or committee. The disparity between the number of participants mentioning a management level versus a board level could be attributed to the fact that those who reported the presence of a board-level committee were themselves in management roles, likely closer to decision-making processes and thus more aware of its existence

The presence of an ESG committee within the board is crucial for ESG integration and implementation throughout the company, as it enhances accountability and oversight of corporate strategies and initiatives. This ensures that

the board addresses material topics effectively, improves ESG performance, facilitates the integration of ESG into corporate governance, and strengthens stakeholder engagement and trust. The committee serves as a representative body for ESG matters within the decision-making framework of the company (Birindelli et al., 2018; Baraibar-Diez & Odriozola, 2019; Cheung & Lai, 2023; Wu, 2023). Additionally, the committee can positively influence decisions regarding report assurance, thereby further enhancing overall ESG performance (Martínez-Ferrero & García-Sánchez, 2017).

The management teams were generally divided across major sustainability topics such as human rights, environmental impact, biodiversity, climate change, and strategy. Only Companies 1 and 7 mentioned having a dedicated team focused on ESG data. Company 1 (Paper and Pulp sector) even said:

"We have a process and data management team that is working on systematizing all of the company's data to improve traceability. Imagine data that comes from the industry, gets written on paper, then transferred to an Excel spreadsheet before it reaches the system. By the time the data arrives, it's almost worthless."

According to Baum (2021), the large volume of data involved requires assessment by data scientists to extract insightful and valuable information. Song and Zhu (2015) further emphasize that data science encompasses the subjects needed to address big data challenges, relying on three pillars: data, technology, and people (Song & Zhu, 2015; Baum, 2021). While data is abundant, and technologies are increasingly available, there remains a shortage of professionals who possess both the critical thinking skills and technical expertise needed to work with big data technologies effectively (Song & Zhu, 2015). In this context, one possible explanation for the absence of ESG data teams is the lack of qualified experts in the market, as both ESG and data science are relatively new fields.

The absence of an ESG data science team is a cause for concern, as the participants interviewed are not data experts, making it clearer that companies must invest in such departments to effectively process and analyze ESG information across the organization. Data science requires a variety of software tools, algorithms, and machine learning techniques to generate valuable insights. Without proper data

management and oversight, data science efforts may be limited to a small team, restricting their integration and growth throughout the organization (Baum, 2021). The fact that only 2 out of 9 companies mentioned having ESG data teams indicates that, despite advancements in materiality assessments and assurance, ESG data analysis is still in its early stages of implementation. The lack of a specialized data analytics team to manage ESG data may be a key factor contributing to the difficulties companies face in providing accurate information. However, it is expected that ESG data analytics teams will expand in the coming years with the introduction of regulations and mandatory reporting requirements (Baum, 2021; ESRS; IFRS).

Almost all companies identified a specific management team responsible for the ESG report, with an average team size of three people. When asked if this number was sufficient, six out of nine participants expressed dissatisfaction, citing challenges such as "large volume of demands for a small team," "the team doesn't just handle reporting," "painful process," and "very manual process to deal with over 250 people and more than 50 areas." These comments reflect significant challenges related to both team size and workload for those managing ESG data. This aligns with Baum's (2021) assertion, raising concerns about the lack of ESG data scientists who should be managing ESG data and reports. The concerns expressed about the number of people working on ESG reports are further highlighted when considering the ESG data collection process. Preparing an ESG report is a dynamic, year-long activity involving numerous stakeholders, which adds to the complexity and demands placed on small teams.

The lack of personnel and ESG data teams within ESG departments can be attributed to the relative novelty of ESG in the market, as many companies have only recently begun to prioritize these matters. Despite nearly five years passing since the Covid-19 pandemic—a pivotal period for ESG market growth—the development of ESG reporting teams remains sluggish, which may be affecting the quality of reports. This issue is further compounded by insufficient budgets allocated to sustainability, as noted by half of the participants. This situation aligns with studies that highlight a lack of investment, limited funding, and high initial costs as significant barriers to sustainability implementation (Nassar & Pereira, 2022; Orsolin, 2023; Tuteja et al., 2024). Challenges related to ESG data management are global in nature, with common issues such as data gaps, poor data quality, and increasing reporting pressures complicating integration systems (Ulvtorp, 2024).

Ultimately, organizational sustainability must be seen as an ongoing process of continuous actions and decisions, undergoing constant development and transformation and integrated within organizational processes, considering people as the central actors. According to Blokdijk (2009), in order to achieve transformation of businesses, three pivotal elements must be developed: people, processes, and technology. People are responsible for implementing strategies, processes facilitate these implementations through structured activities, and technology aids in automation.

This perspective aligns with Lima and Lezana's (2005) framework, which posits that successful organizational actions require well-defined structures, processes, and conducive spaces. Specifically, structures pertain to vertical coordination (organizational hierarchy), processes refer to horizontal coordination, and spaces relate to the tools and cultural context in which actions occur. Within this framework, the ESG report constitutes a significant organizational action, with the data collection process being a critical component for its realization. Applying Lima and Lezana's framework reveals that a well-defined structure, clear processes, an appropriate platform for ESG reporting, and an ESG-driven culture are crucial for an effective reporting process. When discussing structure, assert that leadership commitment is a key component in creating a sustainable company and reframing its identity, by integrating sustainability into business practices. Concurrently, employee engagement is essential for codifying this new identity. This indicates that both the company's leadership and its employees play central roles in implementing sustainability within the organization (Eccles et al. 2012; Mosher and Smith 2015).

Despite challenges such as limited personnel, budget constraints, and the nascent implementation of materiality assessments, most participants reported that their companies had engaged leadership and workforce. The primary factors influencing their views were the company's culture and overall performance. Building a robust culture of ESG integration requires strong leadership support, as workforce engagement is closely tied to the behavior and commitment of the leadership team. According to Eccles et al. (2012), culture is a fundamental element in embedding ESG within a company's identity. This assertion is reinforced by the positive responses from participants regarding the influence of leadership on workforce engagement. Company 1 (Paper and Pulp sector) exemplified this relationship, stating:

“When this type of movement occurs, you inevitably see it cascading through the various levels of the company. As a result, you can generally observe departments taking on projects aimed at addressing these sustainability ambitions.”

Without executive support, long-term ESG integration becomes significantly more challenging, and securing resources for ESG initiatives is more difficult (Integrate ESG, 2017; Harter et al., 2021). Ultimately, embedding ESG into business practices requires a continuous process of learning, adaptation, and strategic integration, which heavily relies on leadership commitment (Mykolaivna et al., 2024). Participants highlighted several cultural aspects of leadership engagement, including the incorporation of ESG topics into executive communications and the alignment of ESG considerations with the company’s brand, values, and behavioral norms. They also noted that ESG is treated as a transversal issue within the organization, with executives actively involved in ESG-related decision-making processes. However, simply aligning ESG with the company’s values, commitments, and public statements is insufficient if the ESG data is not taken seriously; otherwise, it risks becoming mere greenwashing.

KPIs are essential tools for organizations to assess their performance data. They should accurately reflect the current state of the business and guide the company toward optimal growth and development (Blokdijk, 2009). In essence, metrics have the potential to drive business performance, meaning that ESG metrics can significantly influence ESG outcomes. Effective ESG performance not only communicates the company’s ESG standing to investors but can also enhance employee satisfaction, thereby strengthening the company's talent pipeline for long-term success (Malhotra & Pachauri, 2023).

A study conducted with Brazilian companies affiliated with the Brazilian Association for Business Communication (ABERJE) revealed that only 15% of the companies analyzed had not yet implemented ESG-related metrics. Among those that did, the metrics served as tools to communicate sustainable performance to stakeholders, guide business decision-making, and establish organizational goals for performance and growth (Nassar & Pereira, 2022). Metrics have the potential to boost a company’s performance, with high ESG performance enhancing competitiveness, attracting stakeholder engagement, and creating sustainable value (Ulvtorp, 2024).

The importance of performance is so significant that companies are increasingly linking ESG performance to variable remuneration and incorporating ESG-specific indicators, under the assumption that this will promote high-quality ESG analysis and decision-making (ESG Integrate, 2017). This emphasis on performance likely explains why this theme was the most frequently mentioned by the companies. Six companies identified metrics and variable remuneration as key factors contributing to leadership engagement, while five companies cited these factors as crucial for workforce engagement. When asked about the impact of this strategy on ESG performance, all participants affirmed its positive effect. Company 9 (Telecommunication sector) emphasized that linking variable pay to ESG indicators serves as a form of literacy for both executives and the workforce.

Although metrics and culture were the most frequently mentioned elements for assessing leadership engagement, they are not the only criteria. Other factors, such as ethical orientation, incentives for innovation, diversity within the leadership body, and adaptability—considering the dynamic nature of ESG and investment—are also relevant (Kim & Thapa, 2018; Cambrea et al., 2023; Dong, 2023; Zhu & Huang, 2023). Some participants briefly mentioned these elements during the interviews, such as ethical orientation, policies, innovation, and adaptability, though these were not widely discussed.

When reviewing the companies' reports, it became clear that diversity rates within governance bodies are notably low, with the presence of women ranging from 0% to 33%. Moreover, nearly all participants stated that their budgets for sustainability initiatives were insufficient, raising questions about the true level of leadership engagement. Similarly, while most companies considered their workforce to be engaged, a significant portion of participants cited "lack of workforce engagement" as a major concern during the ESG reporting process. One possible explanation for this contrast is that the question about workforce engagement was the first asked during the interviews, potentially reflecting any bias.

Regarding processes, Business Process Management (BPM) evidence that a product is the outcome of various activities performed. Business processes are fundamental in organizing these activities, establishing relationships among them, and improving effective collaboration between the stakeholders involved. This also facilitates the design and realization of flexible information systems. BPM has been gaining more attention from two different sectors: business administration and

computer science. From an administrative perspective, BPM is used by companies to increase customer satisfaction, reduce business costs, and establish new products and services at low costs. From a technological perspective, BPM can provide a robust and scalable software system, as integrating existing information systems is key to achieving technical realization (Weske, 2012).

Weske (2012) also explains workflow as a part of a business process, describing two types of workflows: system and human. Workflow software automates the data entry process, making time-consuming tasks easier to achieve and ensuring that data reaches the right place. This minimizes the possibility of errors within the business process, as much of it is performed without human intervention, ensuring more accurate and reliable data (Blokdijk, 2009; Weske, 2012). Therefore, it could be an excellent alternative for automating and analyzing ESG data processes (Plugge et al., 2024).

Various business management processes are described in the literature, but few propose a management process for implementing ESG within companies, much less a process for managing ESG data. In a systematic literature review on corporate sustainability practices, Sabirali and Mahalakshmi (2023) do not mention articles that specifically address process or data. However, Mosher and Smith (2015) propose a pathway for integrating sustainability into business, aiming to create greater value for society and the environment while ensuring business success. They recommend incorporating sustainability into the business model, utilizing materiality assessments, applying a sustainability lens to products and services, embedding sustainability into the organizational culture, and leveraging transparency, which comes from clear and trustworthy data.

Focusing on the spatial dimension, Poltroniere et al. (2018) suggest that achieving high sustainability performance requires investment in an Integrated Management System (IMS). Such a system enhances resource utilization, internal communication, cost reduction, employee motivation, process streamlining, and data reliability, thereby improving sustainability reporting. Similarly, Plugge et al. (2024) underscores the critical role of digital platforms in supporting ESG initiatives and proposes a framework for a digital platform ecosystem to manage ESG matters. This framework involves setting goals and targets, selecting and importing data, reviewing and approving data, calculating metrics, tracking metrics against goals and targets, reviewing summarized annual data, and creating corporate responsibility reports.

Companies exhibited two types of ESG processes: centralized and decentralized. Centralized processes are managed exclusively by the ESG department, where ESG representatives are responsible for the entire ESG reporting process, with minimal input from other stakeholders. In a centralized ESG structure, all ESG functions and responsibilities are handled by dedicated ESG representatives. These functions typically include conducting materiality assessments, providing analysis to project managers, and addressing ESG-related issues. Within this fully centralized model, the ESG team operates independently from the investment team (ESG Integrate, 2017; Chen, 2024).

In contrast, decentralized processes involve multiple stakeholders, with various departments managing their own data. This approach reduces the burden on ESG representatives and distributes responsibility across the organization. In this scenario, the ESG department focuses on managing and coordinating the ESG report rather than validating the information provided. This division of labor is practical, given that ESG reporting is still largely a manual process and encompasses a broad range of topics, including climate change, human rights, diversity, ethics, and governance. These topics reflect the environmental, social, and ethical dimensions of a company’s activities, making it essential for specialists in different departments to manage their own areas (Chen, 2024). In a decentralized structure, ESG responsibilities are distributed among analysts and project managers throughout the company, with investment teams assessing ESG performance, conducting materiality assessments, and researching sector-specific trends (ESG Integrate, 2017).

The majority of companies interviewed reported having a decentralized ESG reporting process, indicating that the culture of ESG reporting is gaining traction within companies. The descriptions of ESG reporting and data collection processes varied among companies in terms of both elements and depth. This variation can be attributed to the different roles participants play within their respective processes; for example, a manager's perspective on a process is often quite different from that of an analyst. To provide a clearer understanding of each company's ESG process maturity, a maturity ranking was established.

Nearly half of the companies are considered advanced in the ESG reporting process. Companies 1, 3, 7, and 9 achieved the highest scores, demonstrating consolidated ESG data management and reporting processes as well as a

well-structured culture of ESG implementation. Despite differences in size, ranging from 14.500 to 33,206 employees, and operating in different sectors, these companies displayed maturity in ESG reporting. Companies 3 and 9 are part of European-based holdings, and given the significant shift in ESG reporting standards in Europe, it is likely that improvements made there have positively impacted their Brazilian operations.

In the case of Companies 1 and 7, both rely heavily on natural resources for their operations, which may explain their high ESG reporting scores, as companies in this sector often need to be more accountable for their information. Conversely, Companies 4 and 6, both in the energy and oil & gas sectors, received the lowest scores—this is particularly critical given the importance of these sectors in sustainability efforts, the transition to clean energy, and the need for clear, accountable ESG data to support such transitions. Companies 2 and 5 received intermediate scores, operating in different sectors but exhibiting similar sizes and stages of materiality implementation.

Regardless of the maturity of ESG processes in the market, it is crucial for companies to become more rigorous in managing their own processes to mitigate errors in a low-automation environment and ensure smoother ESG implementation. Given this, a workflow is proposed outlining each step of the ESG reporting process could be a powerful tool for companies that are just beginning their ESG journey. Such a tool could help them navigate challenges related to limited personnel, a lack of ESG data specialists, and insufficient automation.

The ESG reporting process is highly dynamic, given the numerous stakeholders involved and the vast amount of information that must be gathered across the organization. It is therefore advisable to begin by reviewing any gaps from the previous reporting cycle and addressing these with actionable plans for improvement. To support the implementation of these improvements, a feedback session with all stakeholders should be conducted to gather insights on communication, suppliers, timelines, management, and other relevant factors.

Additionally, the data gaps identified by assurance professionals, as outlined in the assurance report, are critical for understanding the key areas for improvement in data quality. These gaps also help assess the maturity of the departments and stakeholders responsible for providing the data. By evaluating the level of maturity

and engagement of each stakeholder, the ESG reporting team can better allocate their efforts and focus on the stakeholders who need the most attention.

With these two elements—stakeholder feedback and assurance report insights—the ESG reporting team will be better equipped to make informed decisions aimed at improving data accuracy. Finally, the updates and improvements must be communicated to the stakeholders involved, either through meetings, workshops, or via email. When describing their processes, only 2 companies reported the presence of feedback with the departments, companies 1 and 7 and only one reported using the assurance data report to improve their data quality which was Company 1 (Paper and Pulp sector).

While improvements are being implemented by each stakeholder and managed by the ESG reporting team, the second stage of the ESG reporting workflow focuses on "organizing the house." This involves addressing any changes that may have occurred from one year to the next, such as alterations in the company’s structure, employee turnover, or updates to material topics, which in turn affect the reported KPIs. The duration of this stage can vary depending on whether the materiality assessment is conducted annually, biennially, or triennially.

Conducting materiality assessments annually is becoming more common, and this trend aligns with the concept of the Brittle, Anxious, Nonlinear, and Incomprehensible (BANI) world, an acronym introduced by Jamais Cascio in 2018. BANI highlights how traditional approaches to planning, leadership, and strategic thinking are becoming less effective in addressing today's challenges. The concept calls for more adaptive, flexible, and resilient strategies to navigate a world characterized by fragility, anxiety, complexity, and confusion, and therefore the need to assess recurrently the state of the company (Cascio, 2020). This step was mentioned by a bigger number of participants, such as companies 2, 3, 4, 5, 7 and 8, with emphasis in the update of data providers and validators. This result can be a reflection of high turnover rates potentially impacting the ESG reporting process.

The third stage is the core of the process, where all required data is collected. It begins with engagement and training sessions to ensure that all stakeholders are informed and capable of using the necessary tools, such as the data collection software, and to encourage compliance with ESG norms and requirements. This step is crucial because ESG data comes from various departments, and each department may have its own unique culture, mindset, knowledge base, management software,

data type, and maturity level (Denison, 1991; Hofstede et al., 1990; Sackmann, 1992). Consequently, the data provided may pass through different processes, levels of compliance, and validation, as the system is not fully automated, and much of the data collection is still manual. This stage typically lasts between two and three months, depending on the company. This stage received the most attention from participants, likely because it serves as the pivotal point of the entire process.

The final stage involves building and assuring the ESG report. The report may be created in-house by the marketing team or handled by ESG consultants, but the assurance process must be conducted externally. In recent years, the demand for third-party assurance has risen significantly, as stakeholders have become more aware of ESG issues and now expect credible, reliable information (Rakipi, 2023). Reflecting this trend, all of the participating companies had their ESG reports externally assured. Although 100% of the companies have their report assured, only 2 companies mentioned it as part of the reporting process.

The role the ESG reporting process plays varied across companies, with some participants using it to address internal gaps, while others struggled to collect reliable data from providers or validators. For instance, Company 7 (Consumer Goods and Agribusiness sector) has leveraged the ESG reporting process to identify and address internal gaps, whereas Company 4 (Energy sector) has faced challenges related to the data quality provided by their workforce. Company 7 (Consumer Goods and Agribusiness sector) highlighted the value of the process, stating:

“It goes beyond the report. It’s the moment when they can map out opportunities for the evolution of their own departments. Through the data collection process, they can already identify improvements that the teams need to implement.”

Company 4 (Energy sector) reported:

“Regarding the effluent indicator, the ESG department relies on the 'common sense' of other departments. However, we are now facing numerous issues because the data is being submitted with incorrect units, leading to unrealistic values. As a result, we need to gather additional evidence to make corrections. The most time-consuming part is reviewing the data, a task that should have been performed by each department. Engagement from those responsible for responding to data

requests is very low—they have been providing data without care and without properly validating the information."

In et al. (2019) highlight the distinction between a measurement that measures what it is intended to measure and the reliability of that measurement. They assert that a measurement is valid if "it measures the right thing," but it is reliable only if "it measures the thing right," such as ensuring the correct units are used. Currently, companies often fail to measure data correctly, which results in a lack of comparability and contextual relevance. The absence of key qualities like validity and reliability makes it increasingly difficult to assess the quality of the ESG data provided (In et al., 2019).

Organizational spaces create opportunities for social interactions and value generation through the development of organizational competencies. These spaces can be physical, virtual, or mental, each offering an unique perspective for recognition. Physical spaces include offices or business premises; virtual spaces encompass emails, calls, or platforms; and mental spaces involve ideas or shared experiences. The organizational space is where communication occurs, making it essential to create environments that facilitate this process (Lima & Lezana, 2005).

It is evident that the market still has significant progress to make in terms of ESG reporting processes and data accuracy. However, the vast majority of interviewees reported using software to manage ESG data, indicating a positive step toward addressing these challenges. Both Companies 1 and 5 have opted for in-house software solutions, driven by the complexity of their operations and the need for integration with other platforms, such as public data centers. Interestingly, both companies also highlighted "lack of traceability" as a weakness in their systems, which impacts the accuracy of the assurance process. This may suggest that ESG data management software should be developed and provided by suppliers specializing in this service.

In contrast, almost all of the companies investing in ESG data software reported still depending on Excel spreadsheets. The reasons reported varied, like Company 2 (Rail Transport sector) found that its external software lacked the flexibility needed to manage specific data, like waste KPIs, requiring them to track this information outside the software. Company 4 (Energy sector) alleged having all of their information gathered within the system, although the mensual management is

made outside of it. Company 7 (Consumer Goods and Agribusiness sector) reported a heavy dependence on manual data entry, while Company 8 (Pharmaceutical Retail sector) noted that much of its data comes from other platforms in Excel format. Company 9 (Telecommunication sector), for instance, uses software with an Excel interface. This interface is already part of the main tool used by the entire company, which facilitated the process of collection. They agree that it is still not ideal, but at the same time, it was a quick solution to increase the trustworthiness of the data provided, since Excel is linked to a cloud and engages all of the users, since it is the same software for everyone.

Company 3 (Electric Power sector) was the only one affirming not using Excel anymore to manage their ESG data. This fact can be explained either by the presence of a focal point responsible for the software implementation within the company, which successfully integrated it into the company's culture, or because it was the only foreign software mentioned, developed in Europe. This might imply that the maturity level of ESG data management software providers in Europe is more advanced than in Brazil due to newer regulations. Company 6 (Oil and Gas sector) is an exception, opting to rely on Excel spreadsheets for ESG data management. Their preference for spreadsheets stems from dissatisfaction with the solutions provided by software vendors, citing that:

"While the software effectively tracks information, the issue still remains the same if there is no workforce engagement."

This statement contradicts the earlier assertion that the company's workforce was engaged in sustainability matters. One possible explanation for the lack of a management software requirement is that Company 6 (Oil and Gas sector) is the smallest company interviewed, with only 163 employees, as company size significantly influences the need for ESG system integration. The more complex a company, the greater the need for ESG integration (Poltroniere et al., 2018).

Visalli et al. (2023) categorize data sources into primary and secondary. Primary data sources represent raw ESG data from the company, while secondary data sources include ESG data providers or validators who manually collect, systematize, and analyze ESG attributes from primary sources. Secondary data sources are often slow, untimely, and provide limited subsets of manually compiled

ESG data, underscoring the need for automation and integration of primary data sources (Visalli et al., 2023). In et al. (2019) also note the lack of common criteria to assess the quality of the data provided, with most data being incomparable and lacking context. The widespread use of Excel may signal the low maturity of ESG data software currently available in the market. While accountability techniques began developing in the 19th century and financial software emerged in the 1950s, the primary standards for sustainability reporting only began to take shape in the 1990s (Sherman, 2019; GRI; MSCI).

Not only are software providers in the early stages of developing tools for ESG data management, but the entire market is still learning how to handle the inherently multidimensional nature of ESG data. Currently, it is evident that companies continue to rely on secondary data sources to manage their ESG data, underscoring the significant gap in automation within the ESG data management process. Although secondary data sources are inherently slower and more limited, Koutsantonis & Serafeim (2019) argue that data providers must streamline best practices in ESG data management and become more transparent about the methodologies they use to supply this information (Koutsantonis & Serafeim, 2019; Visalli et al., 2023). The lingering question is why the market continues to struggle with technological issues in managing ESG data when we are in an era of unprecedented technological advancement and innovation (Roser, 2023).

The lack of automation is a major concern among ESG reporters. While digital platforms are essential for supporting ESG initiatives, challenges remain in the selection, import, review, and approval of data. One proposed solution to these challenges is the design and development of automated workflows for collecting and analyzing ESG data (ESG Integrates, 2017; Plugge et al., 2024). Previous studies have highlighted similar issues, emphasizing the manual effort required to upload ESG information and the impact on employee performance and engagement. Since ESG data collection involves various departments—including HR, legal, and finance—process integration and automation are critical for ensuring transparent reporting (Ulvtorp, 2024). Unsurprisingly, “low automation” was the most frequently mentioned issue when identifying key concerns within the ESG reporting process.

The second most frequently cited concern was **“workforce engagement and high turnover rates”**, which contradicts responses to the question about overall workforce engagement. For example, Company 9 (Telecommunication sector) linked

the lack of engagement to the overwhelming volume of information employees are required to provide, which is impacting the functioning of their own departments—departments that are also vital to the company's operations. This could indicate that the workforce is experiencing "reporting fatigue" (Cruz & Matos, 2023). Even Company 3 (Electric Power sector), the most automated one, reported having issues with workforce engagement. They stated:

“Ensure that people understand the relevance of the data they are entering, and encourage them to pay more attention to what they are submitting by conducting a deeper analysis. Although respondents are already well-trained in the system, there are still cases where data is provided without thorough analysis”

On the other hand, Company 4 (Energy sector) stated that

"They don't feel this affects the transparency of the data, but it does delay the process. The report is audited, so the data goes through a thorough review.".

Culture is also part of the spatial dimension and is crucial (Lima & Lezana, 2005). Munk et al. (2013) highlight that attracting and developing people based on sustainability principles helps embed these principles into the organizational culture. Eccles et al. (2012) and Mosher and Smith (2015) similarly emphasize the importance of culture in implementing ESG within a company. To cultivate a clear understanding of the market's ESG performance, companies must invest significantly in implementing an ESG culture that fortifies their ESG processes and analyses. Additionally, organizational leadership should take ESG more seriously, perceiving it as an opportunity for innovation and actively engaging with all stakeholders, especially their workforce (Hart & Milstein, 2003; Eccles et al., 2012; Eccles & Serafim, 2013; Zadek, 2014).

Turnover rates were highlighted by Companies 5, 7, and 8, which reported respective turnover rates of 22.9%, 21%, and 34.27% in 2023. According to Ma (2023), a healthy employee turnover rate typically falls between 5% and 10%, drawing attention to the elevated rates not only for the companies that flagged it as a concern but also for all the companies that participated in this research. The company closest to this healthy threshold was Company 1 (Paper and Pulp sector),

with a turnover rate of 13.71%. This figure is particularly notable given the company's size (20,627 employees), as larger companies tend to experience higher turnover rates (Hausknecht et al., 2009).

High turnover rates can negatively affect the consistency and effectiveness of ESG reporting by diverting employee priorities and reducing commitment and expertise toward the reporting process (Pascoe et al., 2021). Elevated turnover can lead to a loss of institutional knowledge related to ESG practices (Ferri et al., 2023). Interestingly, Garsaa & Paulet (2022) suggest that disclosing ESG performance can have a positive impact on reducing turnover, as increased transparency enhances the workforce's trust in the company. This highlights a bidirectional relationship between ESG reporting and turnover (Garsaa & Paulet, 2022).

The turnover problem in the ESG reporting process is likely exacerbated by the lack of automation. A potential solution to mitigate the negative impact of high turnover on ESG reporting would be automating the entire process. As Company 7 (Consumer Goods and Agribusiness sector) put it:

"Eliminate the need for people, as that is what brings the greatest vulnerability to the ESG reporting process."

Another indicator of the presence of the "reporting fatigue" phenomenon is the frequent mention of "New emerging standards anticipation and adaptation." This makes it increasingly difficult for companies to anticipate and adapt to new standards in a timely manner. Companies 7 and 9 specifically raised concerns about this issue. Additionally, the challenge of "tight deadlines" was another key concern highlighted by participants. ESG reporting requires the collection of vast amounts of data from across the company, yet companies often face a shortage of personnel, low departmental engagement, a lack of automation, and insufficient investment in ESG implementation.

In conclusion, the challenges highlighted throughout this discussion—ranging from the lack of automation and workforce engagement to the complexities of adapting to new ESG standards—underscore the need for companies to prioritize structural and technological improvements in their ESG reporting processes. As ESG becomes increasingly central to corporate governance and stakeholder engagement, it is crucial for companies to not only streamline their data management systems but

also cultivate a culture of accountability and collaboration across departments. By addressing these issues, companies can enhance the reliability and transparency of their ESG reports, ultimately driving more meaningful sustainability outcomes and aligning with evolving global standards.

6. CONCLUSION

This conclusion addresses the core research question: **What underlies the current ESG reporting processes, given the lack of automation throughout ESG data management?** The research highlights several critical insights into the state of ESG reporting within Brazilian companies. It examines how materiality assessments, automation, departmental collaboration, and resource allocation impact the effectiveness of ESG initiatives. The findings offer key recommendations for companies aiming to enhance the credibility and strategic value of their sustainability reporting processes.

The findings of this research highlight several critical aspects of ESG reporting within Brazilian companies. First, it became evident that materiality assessments need more attention and should be integrated into the overall corporate strategy. The current trend of addressing too many topics dilutes focus; it is essential to prioritize quality over quantity to ensure that material issues truly align with the company's long-term sustainability goals.

Moreover, while ESG departments are gaining prominence within organizations, with the creation of committees and clear hierarchies, it is also clear that ESG reporting teams are still in the early stages of development. This nascent stage emphasizes the need for a dedicated ESG data science department to address significant data gaps that current ESG teams struggle to manage independently.

A core insight is that culture and metrics alone are insufficient to drive sustainability efforts. Without adequate budget and structure, companies cannot fully engage with ESG initiatives, including key elements such as diversity and inclusion. The integration of HR and marketing departments is crucial, as the ESG department cannot function in isolation and must work collaboratively across the organization to achieve its objectives.

Automation within the ESG reporting ecosystem emerged as the number one priority. Without automation, the integrity of metrics and the accuracy of reported data are compromised, undermining trust in the company's ESG efforts. A systematic push toward automating ESG data collection and reporting processes is imperative for ensuring reliability and transparency in the data shared with stakeholders.

In conclusion, this research underscores the importance of aligning materiality with strategy, building stronger ESG reporting infrastructures, fostering collaboration between departments, and prioritizing automation. These steps are critical for advancing the credibility and impact of ESG reporting within the Brazilian market.

Future studies could investigate the perception of other departments and stakeholders into the ESG reporting process, beyond sustainability teams. It would be valuable to explore how different departments, such as finance, human resources, marketing and supply chain, contribute to ESG data management by participating in materiality assessments, data collection, and the implementation of sustainable initiatives. By gathering insights from these various stakeholders, it would be possible to obtain additional perspectives on the ESG reporting process and identify further opportunities for improvement. Another area of interest could involve investigating the cultural and leadership dynamics within companies, analyzing how these factors drive sustainable practices at different organizational levels and their impact on the maturity of ESG data management processes.

6.1 Limitations of the method

This study faced several limitations that may have impacted the results and interpretations. Firstly, while the sample included nine companies from the ISE-B3, it may not fully represent all industries or company sizes within the index, potentially limiting the generalizability of the findings. Secondly, the use of semi-structured interviews, while providing flexibility, introduced variability in data collection, as not all participants answered every question, affecting consistency and comparability. Not all companies answered every question, and some questions emerged during interviews. Thirdly, the diverse roles of participants within their ESG departments led to varied perspectives, influencing the responses. Additionally, the study relied on self-reported data, which may introduce bias as participants could present their

practices in a more favorable light. Technological constraints, such as using Excel for data analysis, might not capture thematic relationships as effectively as advanced qualitative analysis software. Moreover, limiting the interviews to ESG stakeholders without including other process stakeholders restricted the breadth of insights. Also, the workflow provided a broader view of the process, but may need further adaptation to align with the automation process. Finally, factor time was also a challenge. Acknowledging these limitations is crucial for understanding the study's context and guiding future research.

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ATTACHMENT 1

To access all participant’s answers, click here.

Methodological Note:

During the development of this dissertation, I utilized ChatGPT, a language model developed by OpenAI, as a tool to support the construction and refinement of texts. The tool was employed to assist in the organization of ideas, preliminary drafting, and revision of specific parts of the text, always under my supervision and with careful verification of the information generated.