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ESG IMPLEMENTATION IN COMPANIES:

The Importance of Measuring Waste Generation

IMPLEMENTAÇÃO DE ESG EM EMPRESAS:

A Importância de Mensurar Geração de Resíduos Sólidos

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Academic paper presented for the course CV955 - Final Project II, by the Civil Engineering Department of the State University of Campinas - UNICAMP, taught by Professor Dr. Ana Paula Bortoleto.

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ABSTRACT

With population and economic growth, the urgency to set strategic actions on human and economic impact on the environment was brought to the mainstream. In 2004, the term ESG - Environment, Social, and Governance - was created by the United Nations (UN) to integrate companies' impacts on the environment and social groups with the capital market. According to the IBM IBV (International Business Machines Institute for Business Value), ESG is a top priority for 48% of Companies' CEOs, showing its relevance for shareholders and stakeholders (IBM IBV, 2022). The E of ESG focuses on environmental challenges, such as climate change, natural resource scarcity, increased pollution, and loss of biodiversity. Therefore, metrics were created and have been used to understand, measure, and quantify companies' impacts on the ecosystem (WEF, 2020). However, the focus is on Greenhouse Gases (GHG) emissions, leaving waste management in the background. This study aimed to map and validate the strategic importance of measuring solid waste generation within companies. The approach involved collecting data from interviews with large companies with global supply chains and then benchmarking the results with the information available online by the top 10 best ESG companies in 2022, as identified by Nasdaq. It was concluded that, even though companies know about ESG and sustainability, it is difficult to find accurate data from standardization organizations and internal reports. In addition, 50% of companies analyzed do not treat solid waste generation in the company's entire life cycle as a priority, even though it is considered so in 75% of the interviews and 90% of the best ESG companies. Thus, there is a need for confluent and trustworthy information on methodologies of measuring and implementing ESG, especially for waste generation. Life Cycle Assessment (LCA) was a valuable tool for mapping sustainability in the organization's processes and supply chain.

Key Words: Environment; Sustainability; ESG; Waste; Life Cycle Assessment (LCA)

RESUMO

Com o crescimento populacional e econômico, a urgência de estabelecer ações estratégicas sobre o impacto humano e econômico no meio ambiente foi levada à corrente principal. Em 2004, o termo ESG – do Inglês, Environmental, Social and Governance (em Português, *Ambiental, Social e Governança*) - foi criado pelas Nações Unidas (ONU) para integrar os impactos das empresas no meio ambiente e nos grupos sociais com o mercado de capitais. Segundo o IBM IBV (Instituto de Valor Empresarial da IBM), o ESG é uma prioridade para 48% dos CEOs das empresas, mostrando sua relevância para acionistas e partes interessadas (IBM IBV, 2022). O E do ESG concentra-se em desafios ambientais, como mudanças climáticas, escassez de recursos naturais, aumento da poluição e perda de biodiversidade. Portanto, métricas foram criadas e têm sido usadas para entender, medir e quantificar os impactos das empresas no ecossistema (WEF, 2020). No entanto, o foco está nas emissões de gases de efeito estufa (GEE), deixando a gestão de resíduos em segundo plano. Este estudo teve como objetivo mapear e validar a importância estratégica de medir a geração de resíduos sólidos dentro das empresas. A abordagem envolveu a coleta de dados de entrevistas com grandes empresas com cadeias de suprimentos globais e, em seguida, comparando os resultados com as informações disponíveis online pelas 10 melhores empresas ESG em 2022, conforme identificado pela Nasdaq. Concluiu-se que, embora as empresas tenham conhecimento sobre ESG e sustentabilidade, é difícil encontrar dados precisos de organizações de padronização e relatórios internos. Além disso, 50% das empresas analisadas não tratam a geração de resíduos sólidos no ciclo de vida completo da empresa como uma prioridade, embora seja considerado assim em 75% das entrevistas e 90% das melhores empresas ESG. Assim, há uma necessidade de informações confluentes e confiáveis sobre metodologias de medição e implementação de ESG, especialmente para geração de resíduos. A Avaliação do Ciclo de Vida (ACV) foi uma ferramenta valiosa para mapear a sustentabilidade nos processos da organização e na cadeia de suprimentos.

Palavras-Chave: Meio Ambiente; Sustentabilidade; ESG; Resíduos Sólidos; Análise de Ciclo de Vida (ACV)

SUMMARY

1 INTRODUCTION

In recent decades, the climate has undergone significant changes caused by anthropogenic hazard, leading to environmental challenges of unprecedented scale and complexity as well as a profound impact on economies. In the United States of America (USA), the economic damages of climate change are projected to be large, standing to lose 0.1% to 1.7% of the Gross Domestic Product (GDP) at 1.5°C increased temperature (Hsiang et al., 2017). According to Warren et al. (2018), it is projected that the global economic damages caused by climate change will be less severe if the warming is limited to 1.5°C compared to 2°C by the year 2100. Specifically, the mean net present value of the costs of damages resulting from global warming in 2100, which includes expenses related to climate change-induced market and non-market impacts, due to rising sea levels, and impacts associated with significant discontinuities, are estimated to be $54 trillion for a 1.5°C warming scenario and $69 trillion for a 2°C warming scenario, relative to the period from 1961 to 1990. In addition, in the default configuration of the Dynamic Integrated Climate-Economy (DICE) model, proposed by Cai et al. (2016) and Lemoine and Traeger (2016), the social cost of carbon - the marginal cost of the impacts caused by emitting one extra tonne of carbon emissions - increases from $15 per ton of CO2 to an average range of $93 per ton of CO2.

Severe climate events have become more apparent, with rising temperatures, extreme weather events and rising sea levels directly threatening municipalities' infrastructure, agriculture, and natural resources. These challenges reverberate across sectors, affecting productivity, employment, and overall economic growth. Furthermore, the compounding effects of climate change often exacerbate existing socioeconomic disparities, making it imperative to understand how financial stressors manifest. According to the Intergovernmental Panel on Climate Change (IPCC, 1996), the challenge is not just to find the best policy today for the next century but to select a prudent strategy and to adjust it over time in the light of new information. Valuation of environmental impacts is increasingly recognized as the most efficient and effective way of incorporating as much relevant contextual information as possible to provide estimates of actual impact, rather than simply measures of output as is the case with most quantitative environmental metrics (WEF, 2020).

In response to the growing worldwide demand for more sustainable and socially responsible investments, in 2004, the United Nations Principles for Responsible Investment (UN PRI) in their report “Who Cares Wins”, presented the term ESG - Environmental, Social and Governance - as set of sustainable criteria for the private market (UN, 2004). In recent years, ESG considerations have gained significant traction, with a growing number of companies incorporating its practices into their business strategies, with regulatory bodies, stock exchange and investors starting to emphasize ESG reporting and disclosure requirements, encouraging greater transparency and accountability regarding sustainability practices. Despite the growing interest and adoption of the ESG framework, there is still a lack of comprehensive and standardized studies on its adoption performance and impact. It is also challenging to find specific metrics and criteria that represent ESG policies and to compare performance across sectors. In addition, waste management is a critical and often overlooked aspect, relegated to the fringe despite its significant environmental impact.

2 LITERATURE REVIEW

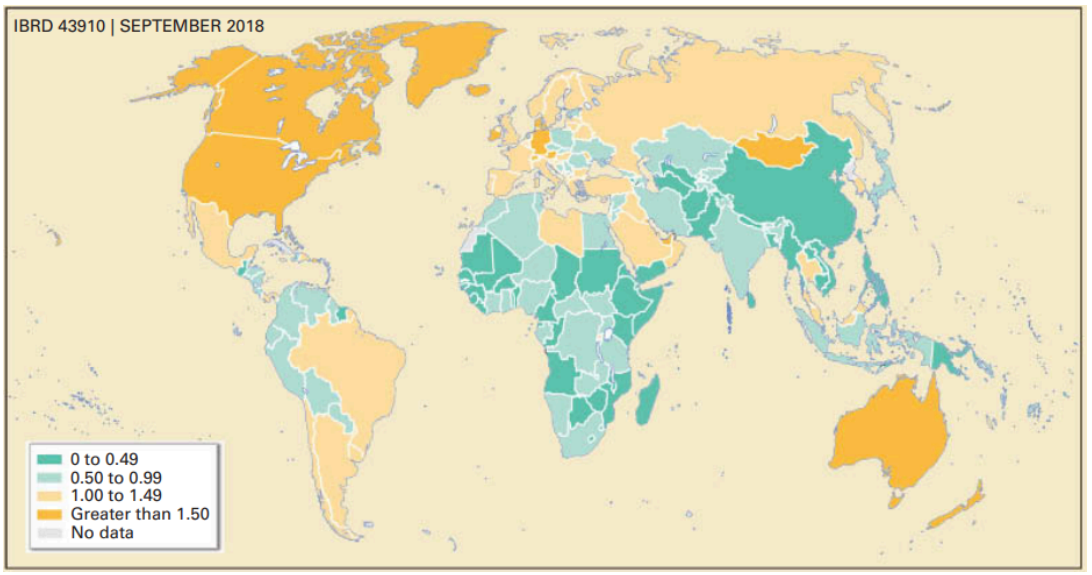
2.1 SOLID WASTE

Waste is an inevitable emission of human activities, and it poses significant challenges, particularly in the context of large groups like companies and industries. Its definition can be brought through the lenses of different institutions. The German Waste Act (1972) defined waste as “portable objects that have been abandoned by their owner(s)” or “requiring orderly disposal to protect the public welfare” (Bilitewski et al., 1996). The United States (US) defined waste in the Resource Conservation and Recovery Act (1976), as *“any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities”*. The New Zealand Waste Strategy (Ministry for the Environment, 2002) defines waste as “any material, solid, liquid or gas, which is unwanted and/or unvalued and discarded or discharged by its owner” (Seadon, 2006).

The Brazilian Law 12.305/2010 on the National Solid Waste Policy (PNRS - *Política Nacional de Resíduos Sólidos)*, defines solid waste as the materials resulting from human activities, which are solid or semisolid, such as non-treatable liquid effluents (Brasil, 2010). It also represents industrial waste as derived from research activities and the transformation of raw materials and organic or inorganic substances into new products through specific processes, as well as those derived from mining and extraction activities, assembly and handling of finished products, and those generated in utility, support, storage, and administrative areas of industries and similar activities, including waste from Water Treatment Plants - WTPs and Sewage Treatment Plants - STPs.

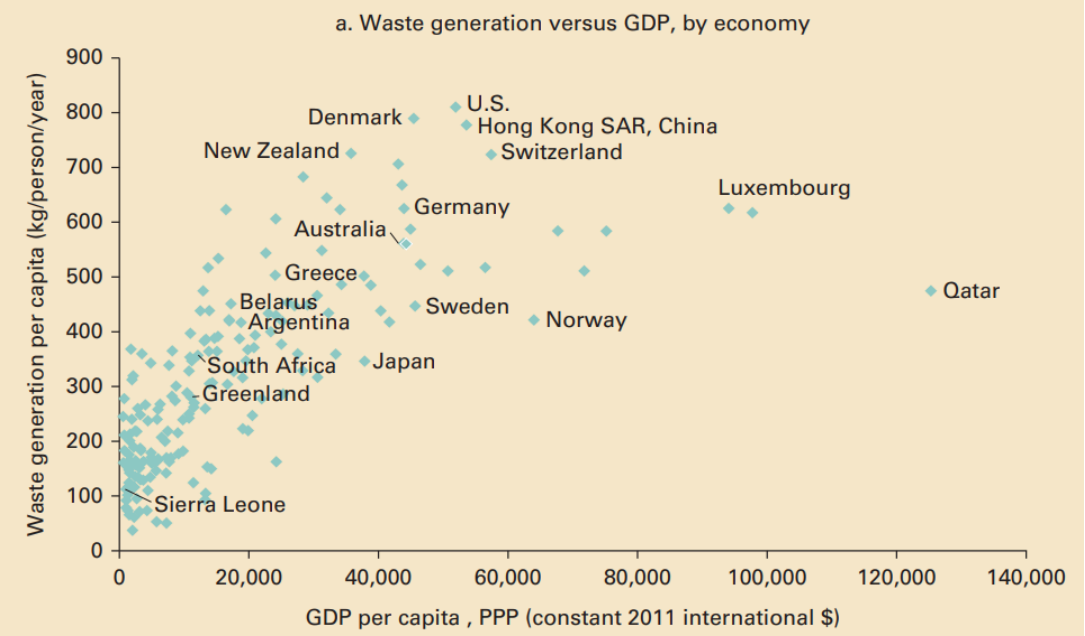
According to a World Bank Report, the world generates 0.74 kilograms of waste per capita per day (**Figure 1**), and waste generation volumes are positively correlated with population growth and GDP - gross domestic product (**Figure 2**) (Kaza et. al, 2018).

Figure 1 - World Map: Waste Generation per capita in kilograms



Source: Kaza et. al, 2018

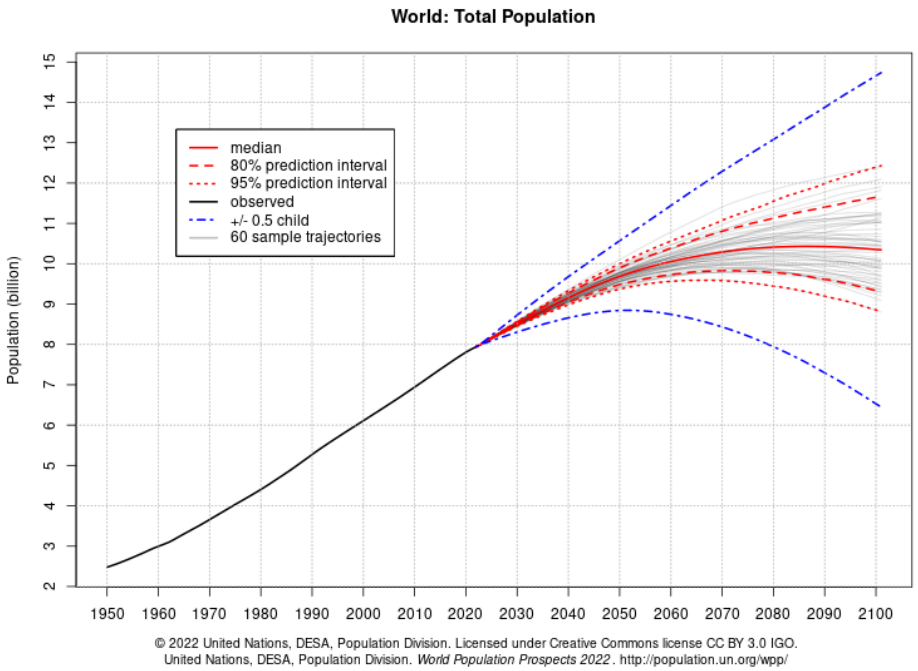
Figure 2 - Waste Generation per capita and GDP per capita, by country



Source: Kaza et. al, 2018

In addition, driven by improved healthcare, reduced mortality rates, and increasing life expectancy, the world's population continues to grow, achieving 8 billion in 2023 and 10 billion by 2060 (UN, 2022) (**Figure 3**). With increased GDP and population growth, waste generation is expected to increase exponentially.

Figure 3 - World Population Prospects 2022



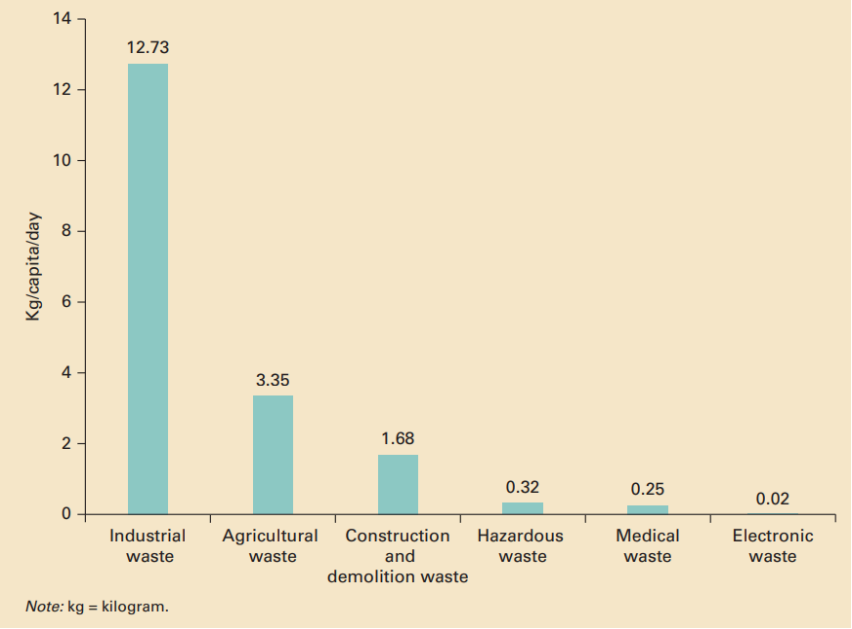
Source: UN, 2022

2.1.1 CURRENT PROBLEM IN THE INDUSTRIAL SECTOR

The current capitalist economic system, characterized by private ownership, profit-driven markets, and competition, has played a significant role in shaping global economies and driving economic growth, which also implies an increase in waste generation. However, this pursuit of economic growth within a capitalist framework has also contributed to escalating levels of waste generation (Tam et al., 2018).

Industries generate more waste - about 18 times higher than municipal solid waste - and, consequently, higher impact and responsibilities (**Figure 4**). It is estimated that 1.6 billion tons of carbon dioxide equivalent greenhouse gas emissions (CO2 eq.), about 5% of global emissions, were generated from solid waste treatment and disposal in 2016, driven primarily by open dumping and disposal in landfills without landfill gas capture systems. In that year, about 37% of waste was disposed of in some type of landfill, 33% was openly dumped, 19% underwent materials recovery through recycling and composting, and 11% was treated through incineration. Solid waste related emissions are anticipated to increase to 2.6 billion tons of CO2 eq. per year by 2050 if no improvements are made in the sector (Kaza et. al, 2018).

Figure 4 - Global Average Special Waste Generation



Source: Kaza et. al, 2018

According to the same report, Brazil is the 4th largest producer of plastic waste worldwide, generating 11.3 million tons per year. It ranks behind only the United States, China, and India. Out of this total, approximately 91% was collected, but only 1.28% was recycled (Kaza et. al, 2018).

At the municipal level, Brazil, out of the 224 thousand tons of Municipal Solid Waste (MSW) generated daily, 60.5% had proper final disposal (ABRELPE, 2022) and, the Brazilian waste treatment sector emitted 29,487 Gg of CO2 eq. in 2012, which corresponds to an increase of over 75% compared to the values measured in 1990 (Arruda et al., 2022).

2.1.2 CLASSIFICATION

Solid waste is classified by analyzing its physical, chemical, and biological properties. It involves understanding the composition, origin, and characteristics to facilitate appropriate waste management strategies (ABNT, 2004). The PNRS, defines it as a material, substance, object, or item discarded due to human activities in society, which must be disposed of in solid or semi-solid states, alongside gases in containers and liquids with properties preventing their safe disposal in public sewage systems or bodies of water, necessitating solutions that may be technically or economically unfeasible with current technology (Brasil, 2010).

There are differences between macro - such as PNRS' classification - and micro classification of solid waste. Wen et al. (2014) define the difference as follows:

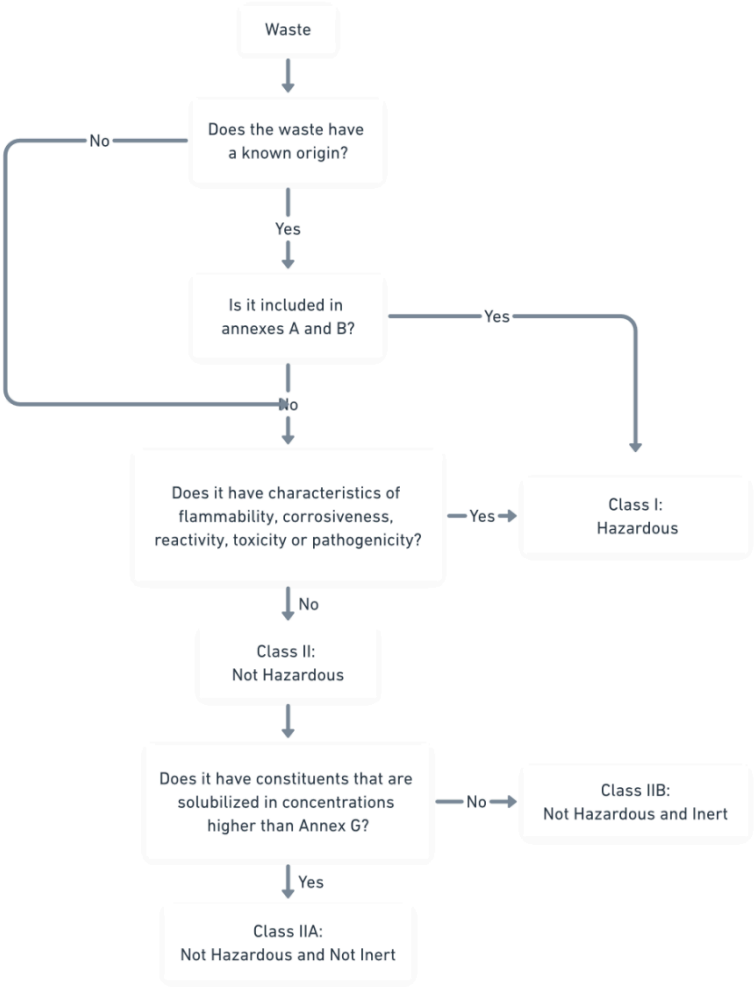
> The macro-level refers to waste classified by macro industrial structures, environmental risks, or management responsibilities of state administrative organizations. At the same time, the micro-level is the detailed classification system under the macro-level and is used for daily environmental management for waste generators, such as declaration and registration and waste transportation. Each classification is used for different approaches. For instance, governments commonly use micro-classification in integrated waste management, where waste is classified by its composition: paper/board; glass; vegetables/fruits; wood; plastics/rubber; metal; textiles; etc. (McDougall et al., 2001).

By characterizing solid waste, it is possible to better understand disposal methods, recycling initiatives, and environmental policies aimed at minimizing the waste generation from the source and regarding national and international standardization, it is important to classify waste with macro-level lenses. Wen et al. (2014) present the classification of solid waste for collection and transportation on a macro level in the countries quoted. China classifies based on the generation source

(industrial or municipal) and hazardous characteristics. Similarly to the US, the EU divides into non-hazardous waste and hazardous waste by hazardous properties. In Japan waste is classified by its source: industrial or municipal (Wen et al., 2014).

The Brazilian Association of Technical Standards (in Portuguese, *Associação Brasileira de Normas Técnicas* – ABNT), in its NBR 10004/2004 on solid waste classification (Brazilian Standard 10004, 2004), classifies solid waste as Class I: hazardous; Class II: not hazardous; Class IIA: not hazardous and not inert; and Class IIB: not hazardous and inert, based on the comparison of waste databases, called as annexes A (hazardous waste from non specific sources), B (hazardous waste from specific sources), and G (standards for solubilization testing) as shown in Figure 5.

Figure 5 - Waste Characterization and Classification



Source: Translated from ABNT NBR 10004/2004

The NBR 10004/2004 also defines hazardous waste. Hazardousness of a waste: Characteristics presented by a waste that, due to its physical, chemical, or infectious properties, may offer a) risk to public health, causing mortality, disease incidence, or exacerbating its rates; b) risks to the environment when the waste is managed inadequately. Toxicity: The potential property of a toxic agent to cause, to a greater or lesser degree, an adverse effect because of its interaction with the organism.

Examples of waste shown in the Brazilian standard are: Class I - fluorescent lamps (containing mercury), lubricating oils, greases, and chemicals; Class IIA - wood residues, fiberglass, food scraps, textile materials, uncontaminated equipment, gypsum, among others; Class IIB - Typically recyclable and do not contaminate the soil or water; and Inert Waste - stones, debris, sand, styrofoam, rubber, scrap iron, and steel.

Another important analysis of waste is its capacity to be recycled. Recyclability can be measured according to the level of contamination and homogeneity of the materials in recyclables, having “good,” “fair,” and “poor” recycling values. However, it is important to note that, if there is no separation, most waste cannot be classified as having “good” recycling values. Product manufacturers/packagers and waste generators alike have important roles to play in enhancing the recyclability of materials, as well as their treatment process (Chung and Poon, 2001).

2.2 ENVIRONMENTAL DISCUSSIONS

Governments and the private market started realizing their impacts on the environment. The discussions were brought to the mainstream in 1972 during the United Nations Conference on the Human Environment in Stockholm. The conference was the first world conference to highlight the environment as a significant issue. The participants adopted a series of principles for the sound management of the environment including the Stockholm Declaration, the Action Plan for the Human Environment, and several resolutions. Also, the United Nations Environment Programme - UNEP was created (UN, 2022).

In the Stockholm Declaration, the United Nations stated:

> It placed environmental issues at the forefront of international concerns and marked the start of a dialogue between industrialized and developing countries on the link between economic growth, the pollution of the air, water, and oceans and the well-being of people around the world. The Action Plan contained three main categories: Global Environmental Assessment Programme; Environmental management activities; and international measures to support assessment and management activities conducted at the national and international levels. In addition, these categories were broken down into 109 recommendations. (UN, 2022)

This conference forecasted the development of plans and research on environmental issues related to human activities and behavior. In 1988, the Intergovernmental Panel on Climate Change (IPCC) was created by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide policymakers with regular scientific assessments of climate change, its implications, and probable future risks, as well as proposing options for adaptation and mitigation. Currently, the IPCC has 195 member countries. Succeeding, in 1992, after the United Nations Conference of the Parties (COP), which took place in Rio de Janeiro, Brazil, the United Nations Framework Convention on Climate Change (UNFCCC) was created as a response to the threat of global climate change (UNFCCC, 2023). The Brazilian Law 12187/2009 - National Policy on Climate Change (in Portuguese, *Política Nacional sobre Mudança do Clima – PNMC*) imposes, on the 3rd article, paragraph III, that measures taken must consider the different socioeconomic contexts of their implementation, distribute the burdens and costs arising from them equitably and balanced among the economic sectors and communities concerned, and weigh the individual responsibilities regarding the origin of emission sources and the effects caused on the climate (Brazil, 2009). Also, the government must establish, aligned with the PNMC, sectoral mitigation and adaptation plans on climate change, aiming to consolidate a low-carbon economy. These plans propose gradual and quantifiable targets to reduce anthropogenic emissions, considering the specificities of each sector, through the Clean Development Mechanism and the Nationally Appropriate Mitigation Actions.

International goals, standards and indexes established by reliable organizations, aligned with methodologies for monitoring are the primary foundation for the possibility of measuring and benchmarking companies regarding sustainability, understanding their impacts on the environment, society and economy

and providing a guideline on creating strong and efficient governance to manage those impacts. It also promotes transparency and accuracy in environmental marketing. These standards ensure businesses substantiate their sustainability claims with credible evidence, avoiding “greenwashing” – misleading or exaggerated claims on sustainable practices (Manning et al., 2012).

2.2.1 GLOBAL DISCUSSIONS

Sustainable Development Goals

As a broader overview, not only focusing on environmental concerns, the United Nations created the Sustainable Development Goals (SDG) in 2015 as a universal call to action to end poverty and protect the planet (UNDP, 2023). The SDGs are a set of 17 targets established to address the most pressing global challenges and achieve sustainable development by 2030, representing a turning point for sustainable initiatives. They encompass a wide range of interconnected issues, including: poverty and hunger eradication; good health, well-being and education; gender equality; sanitation, clean water and energy; decent work and economic growth; investment in innovation and infrastructure; reduce inequalities; achieving sustainable cities and communities; responsible consumption and production; climate actions; preservation of life on water and land; peace, justice and strong institutions; and partnerships for the goals (**Figure 6**). Waste and its management are enclosed in Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production), and Goal 13 (Climate Action).

Figure 6 - UN’s Sustainable Development Goals

Source: UNDP, 2023

During COP-26, held in November 2021 in Glasgow, Scotland, the Brazilian government made significant commitments to environmental preservation. It agreed to adhere to two essential international agreements for the protection of the Amazon and the reduction of greenhouse gasses: to reduce methane emissions by 30% by 2030 (based on 2020 parameters), and to achieve zero deforestation by 2030.

United Nations Global Compact

The United Nations Global Compact (UNGC) is the world's largest corporate sustainability initiative. It is divided into four spheres and provides ten principles related to Human Rights, Labor, Environment and Anti-Corruption. The ten principles are: 1) Businesses should support and respect the protection of internationally proclaimed human rights; 2) ensure that they are not complicit in human rights abuses; 3) Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining; 4) work towards the elimination of all forms of forced and compulsory labor; 5) strive for the effective abolition of child labor; 6) work towards the elimination of discrimination in respect of employment and occupation; 7) Businesses should support a precautionary approach to environmental challenges; 8) undertake initiatives to promote greater environmental responsibility; 9) encourage the development and diffusion of environmentally friendly technologies; and 10) Businesses should work against corruption in all its forms, including extortion and bribery, for businesses to incorporate into their strategies, policies, and procedures (UNGC, 2018). UNGC is widely used by companies who are part of the compact and measures their sustainable performance to deliver on the Sustainable Development Goals.

2.2.2 STANDARDS

Establishing sustainable reporting standards has helped the development of corporate transparency and accountability, and it is considered an important element of the growth of capital markets and the efficient allocation of capital in an economy, in addition to also promote transparency and accuracy in environmental marketing (Grewal et al., 2021). However, corporate sustainability performance is voluntary and thus prone to interpretation and even greenwashing tendencies – misleading or exaggerated claims on sustainable practices (Hahn et al., 2014). To

overcome this problem, entities such as the Sustainability Accounting Standards Board (SASB), the Global Reporting Initiative (GRI) and the International Organization for Standardization (ISO), aligned with the Task Force on Climate-Related Financial Disclosures (TCFD), have played mainstream roles in shaping these standards, providing reporting guidelines to report positive and negative aspects of an organization's sustainability performance.

In late 2023, the federal Brazilian government, through the Ministry of Development, Industry, Commerce, and Services (in Portuguese, *Ministério de Desenvolvimento, Indústria, Comércio e Serviços - MDIC*), is planning to incorporate the "*Selo Verde* Brasil" (free translation: Green Seal Brazil) as a standard for sustainable practices to facilitate the relations with international markets, enhancing the country's competitiveness. The government aims for the certification to encompass all sustainable benchmarks, lowering certificate costs. Companies would be required to show/demonstrate their impacts through the entire life cycle of their processes (Estadão, 2023). The "Selo Verde" follows the intensification of regulations on sustainability, such as the 2023 EU regulation on deforestation-free products, which prohibits the importation of certain products (meat, coffee, soy, wood and rubber) that have deforestation on its supply chain (European Commission, 2023) and is a response to emerging global sustainable discussions.

Sustainability Accounting Standards Board (SASB)

The widely used sustainability reporting standard, the SASB, a nonprofit organization founded in 2011 by the International Sustainability Standard Board (ISSB), helps businesses and investors develop a common language about the financial impacts of sustainability. SASB Standards are designed to identify and standardize disclosure for the sustainability issues most relevant to investor decision-making in each of the 77 industries (SASB, 2023). The industries are divided into 11 large groups: Consumer Goods; Extractives & Minerals Processing; Financials; Food & Beverage; Health Care; Infrastructure; Renewable Resources & Alternative Energy; Resource Transformation; Services; Technology & Communications; and Transportation.

According to a SASB industry standard on Solar Technology & Project Developers (2023), SASB Standards include:

1. Industry descriptions: help entities identify applicable industry guidance by describing the business models, associated activities and other features that characterize participation in the industry.

2. Disclosure topics: describe specific sustainability-related risks or opportunities associated with the activities conducted by entities within a particular industry.

3. Metrics: accompany disclosure topics and are designed to provide information regarding an entity's performance for a specific disclosure topic.

4. Technical protocols: guide definitions, scope, implementation, and presentation of associated metrics.

5. Activity metrics: quantify the scale of specific activities or operations by an entity and are intended for use in conjunction with the metrics referred to in point 3 to normalize data and facilitate comparison.

Global Reporting Initiative (GRI) Standards

Similarly, the GRI Standards cover topics on finance, biodiversity, waste, emissions, diversity and equality to health and safety. The GRI Standards, created in 1997, by the Global Sustainability Standard Board (GSSB) as the first global for sustainability reports, comprises an interconnected set of standards designed as a modular system. These standards are organized into three series: the GRI Universal Standards, which apply to all organizations; the GRI Sector Standards, tailored for specific sectors; and the GRI Topic Standards, outlining disclosures pertinent to subjects. Organizations can make strides toward sustainable development by utilizing these standards to identify material (relevant) topics (GRI, 2022).

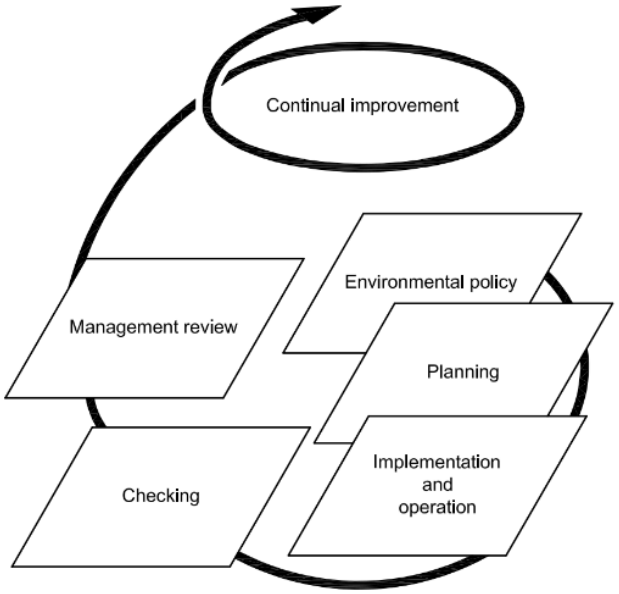
According to Pizzi (2022), the main difference between SASB and GRI is that SASB endorses a methodological approach based on financial materiality, while GRI encourages adopting a more holistic approach based on double materiality - companies must consider how their actions impact both people and the planet, but also how sustainability issues can affect their financial-wellbeing.

International Organization for Standardization (ISO)

ISO (International Organization for Standardization) is an independent, non-governmental international organization consisting of 168 national standards bodies. Founded in 1947, ISO operates as an entity dedicated to developing international standards to establish consensus-based standards that enhance efficiency, safety, and quality across different sectors, by bringing together experts worldwide. ISO's standards encompass various aspects such as specifications, guidelines, processes, and best practices. They are not legally binding but are widely recognized and adopted by organizations and industries worldwide to demonstrate their commitment to quality, safety, environmental sustainability, and other essential aspects of their operations (ISO, 2023).

When it comes to environmental matters the series ISO 14000 provides a framework for organizations to establish and implement effective environmental management systems (EMS) to identify and manage environmental risks, pollution, resource efficiency, and foster a culture of environmental responsibility (Morris, 2004). The first document, *ISO 14001 – Environmental Management Systems: Requirements with guidance for use*, brings only those requirements that can be objectively audited and is divided into general requirements, environmental policy, planning, implementation, and operation, checking and management review for a continual improvement on EMS (**Figure 7**).

Figure 7 – Environmental management system model ISO14001



Source: ISO 14001, 2004

A 2020 report by the World Economic Forum (WEF) and the auditing and consulting firm PwC (PricewaterhouseCoopers), concluded that $44 trillion of economic value generation – over half of the world's total GDP – is moderately or highly dependent on nature and its services (WEF, 2020). ISO 14007 – Environmental management: Guidelines for determining environmental and ISO 14008 – Monetary valuation of environmental impacts and related environmental aspects, cover valued impact in monetary terms, indicating the scale of impacts in units that organizations can readily understand and compare across impact areas and with financial figures. While ISO 14007 enables organizations to determine and communicate the costs and benefits associated with their environmental aspects, impacts, and dependencies on natural resources to help organizations carry out cost-benefit analyses for different environmental options, ISO 14008 specifies a methodological framework for the monetary valuation of those environmental aspects, including releases and use of natural resources, and impacts, including impacts on human health, and on the environment (ISO, 2019).

Task Force on Climate-Related Financial Disclosures (TCFD)

Alongside sustainable standards, the Financial Stability Board created the Task Force on Climate-related Financial Disclosures (TCFD) to improve and increase reporting of climate-related financial information, creating a framework on what companies should disclose to support investors, lenders, and insurance underwriters in appropriately assessing and pricing risks related to climate change, facilitating transparency and accuracy. TCFD's disclosures are organized into four key areas that reflect corporate operations: governance, strategy, risk management, and metrics and targets. These four recommendations are interconnected and complemented by 11 suggested disclosures, which elaborate on the framework by providing details. These disclosures aim to assist investors and other stakeholders comprehend how reporting entities perceive and evaluate climate-related risks and opportunities (TCFD, 2023).

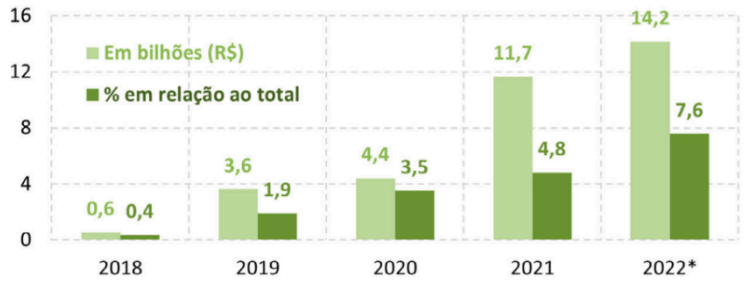
2.2.3 INDEXES

In response to growing global concerns about sustainability, the private market has created comprehensive metrics for evaluating companies' maturity in these areas. Recognizing the significance of this matter in investment decisions,

private market players, including asset managers, rating agencies, and institutional investors, have collaborated to establish indexes, encompassing a wide range of criteria, from carbon emissions and resource management to labor practices, diversity, and ethical governance, using established standards such as GRI, SASB and ISO. By quantifying these aspects, the market provides investors with a comparable way to assess companies' performance. This fosters greater corporate accountability, reduces risk, and empowers investors to make more informed decisions, encouraging businesses to adopt sustainable practices.

In Brazil, the Brazilian Central Bank established new resolutions, considering additional socio-environmental risks, expanding the requirements for credit approval, which can be seen in Figure 8 by the increase in the emissions of "Green, Social and Sustainable" credits, and implementing monitoring tools such as the Report on Social, Environmental, and Climate Risks and Opportunities (BCB, 2022).

Figure 8 – Emission amount of "Green, Social and Sustainable" Credits and its percentage on the total in Billions of Reais



2022 up to August *
Source: Brazilian Central Bank (BCB), 2022

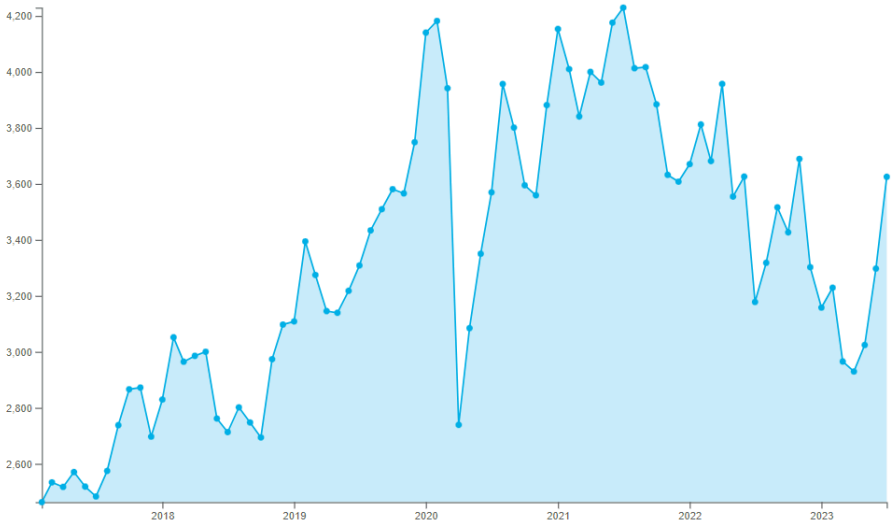
ISE B3 – Brazilian Corporate Sustainability Index

The Brazilian Market Exchange created the Corporate Sustainability Index (in Portuguese, *Índice de Sustentabilidade Empresarial* – ISE B3) within the Seventeenth Portfolio of the Corporate Sustainability Index, comprising companies holding the 200 most liquid shares on B3 (Brasil, Bolsa e Balcão) - the Brazilian stock exchange. The ISE B3 showed similar behavior as the Bovespa Index (Ibovespa, the main index for the companies in the B3) when launched, however, its performance has been inferior when compared to Ibovespa over the past five years (see **Figures 9** and **10**), representing the challenges faced transitioning to a new strategy in Brazil.

The ISE B3 questionnaire of eligibility has 259 questions divided by 98 topics on five main dimensions with consecutive themes:

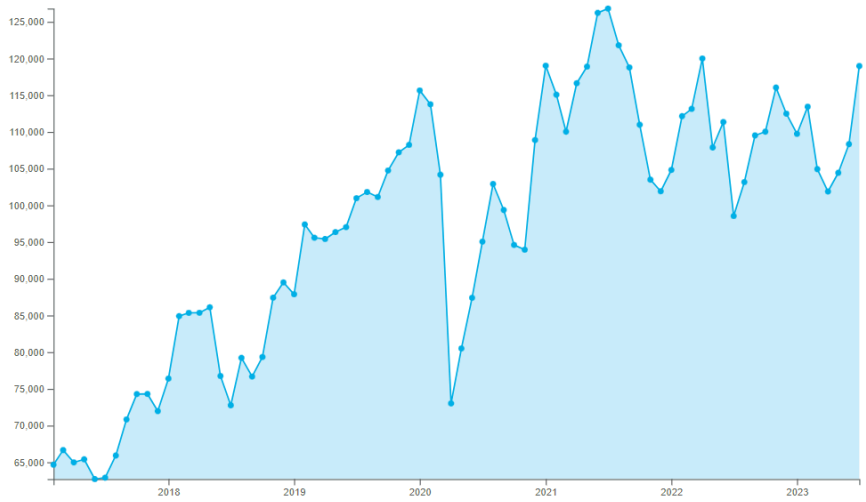
- Human Capital: labor practices, occupational health & safety, employee engagement, diversity, and inclusion.
- Corporate Governance and Senior Management: fundamentals of corporate sustainability management, risk management, corporate governance policies, business ethics, competitive environment maintenance, legal and regulatory management.
- Business Model and Innovation: business model sustainability, product design and life cycle assessment, resource efficiency and sustainable finance.
- Social Capital: human rights and community relationships, private social investment and corporate citizenship, technical and economic accessibility, product quality and safety, sales policies and product labeling, customer well-being, customer privacy, and data security.
- Environment: environmental management policies and practices, ecological impacts, energy management, water and effluents management, waste, hazardous waste management, and air quality.

Figure 9 – ISE B3 Historical Performance in the past 5 years



Source: Brazilian Stock Exchange – B3, 2023

Figure 10 – Ibovespa Historical Performance in the past 5 years

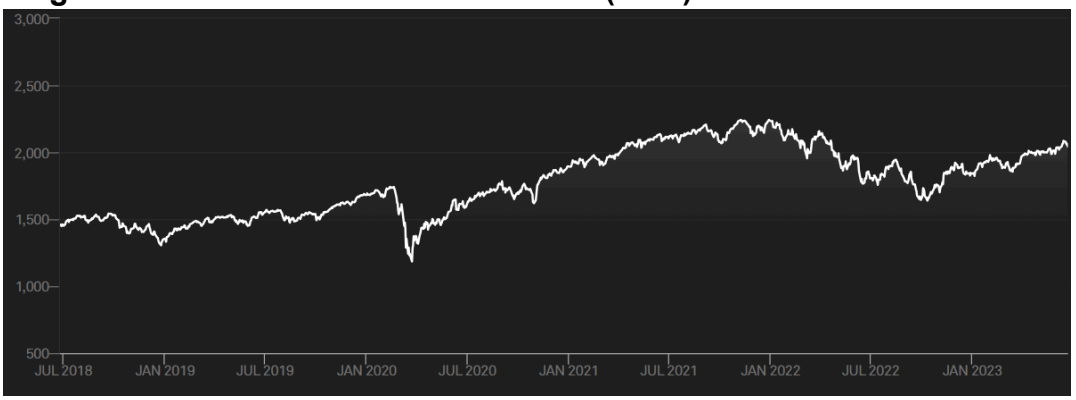


Source: Brazilian Stock Exchange – B3, 2023

Dow Jones Sustainability World Index (DJSI) – American Corporate Sustainability Index

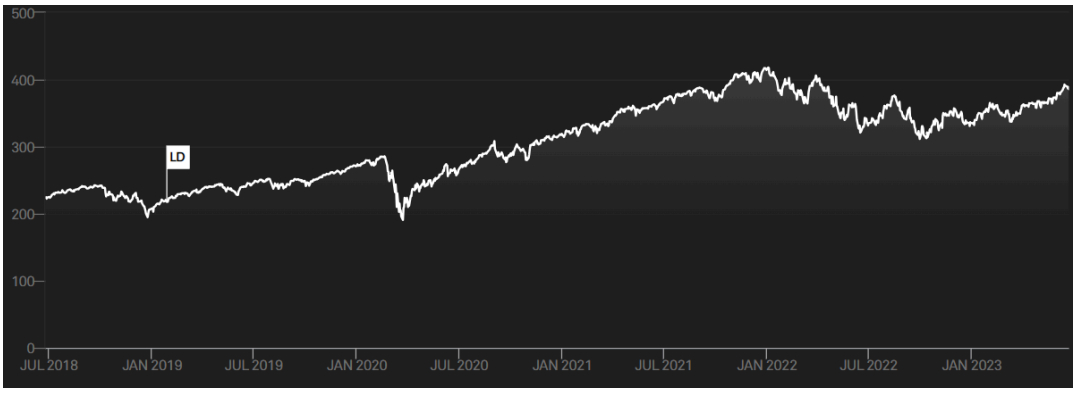
In the United States (US), the Dow Jones Sustainability World Index (DJSI) comprises global sustainability leaders as identified by S&P Global (Standard & Poor's Global) - north american provider of financial intelligence solutions - through the Corporate Sustainability Assessment (CSA). It represents the top 10% of the largest 2,500 companies in the S&P Global Broad Market Index (BMI) - set of global indexes - based on long-term economic, environmental, and social criteria. Also, launched on January 28th, 2019, the S&P 500 ESG Index is designed to measure the performance of the best large-cap US companies meeting sustainability criteria. The S&P 500 ESG Index showed the best performance from 2018 to 2023, 11.18%, when compared to S&P 500 (best single gauge of large-cap US equities), 9.56%, and the DJSI, 6.65% (**Figures, 11, 12** and **13**).

Figure 11 – Price Return in US Dollars (USD) DJSI from 2018 to 2023



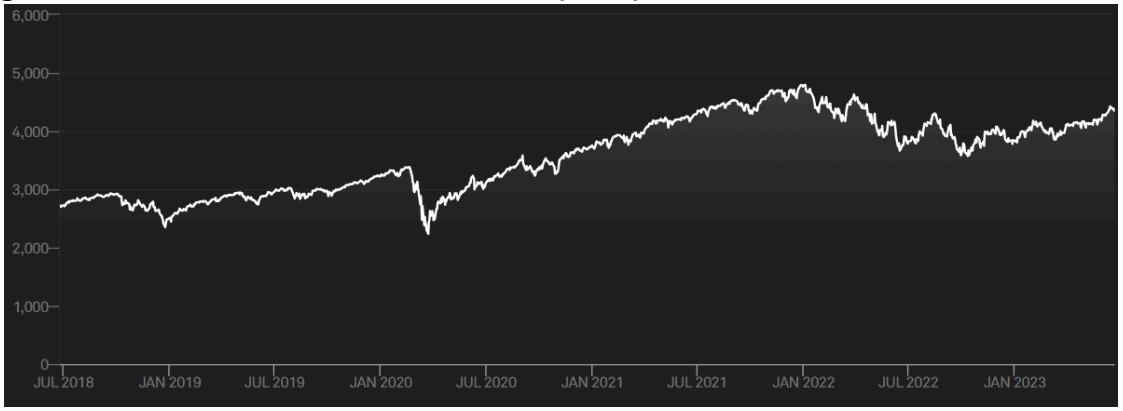
Source: S&P Dow Jones Indexes: Dow Jones Sustainability World Index, 2023

Figure 12 – Price Return in US Dollars (USD) S&P 500 ESG Index from 2018 to 2023



LD: Launch Date (before LD, the numbers are estimated)
Source: S&P Dow Jones Indexes: S&P 500 ESG Index, 2023

Figure 13 – Price Return in US Dollars (USD) S&P 500 Index from 2018 to 2023



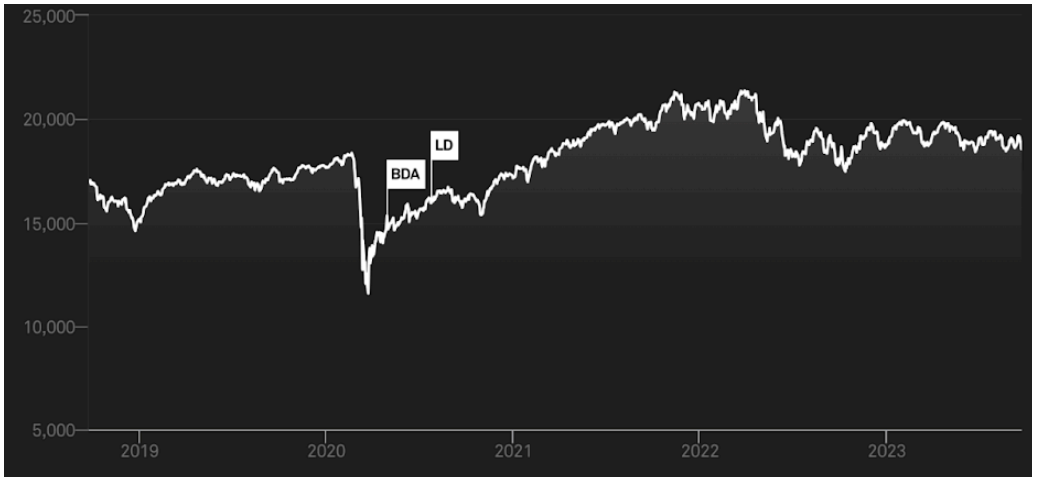
Source: S&P Dow Jones Indexes: S&P 500®, 2023

S&P/TSX Composite ESG – Canadian Corporate Sustainability Index

In Canada, the Toronto Market Exchange Group (TMX Group) has a list of sustainable indexes divided in: S&P/TSX Renewable Energy and Clean Tech Index; S&P/TSX Composite ESG; S&P/TSX 60 ESG; Carbon Efficient Series; Carbon Price

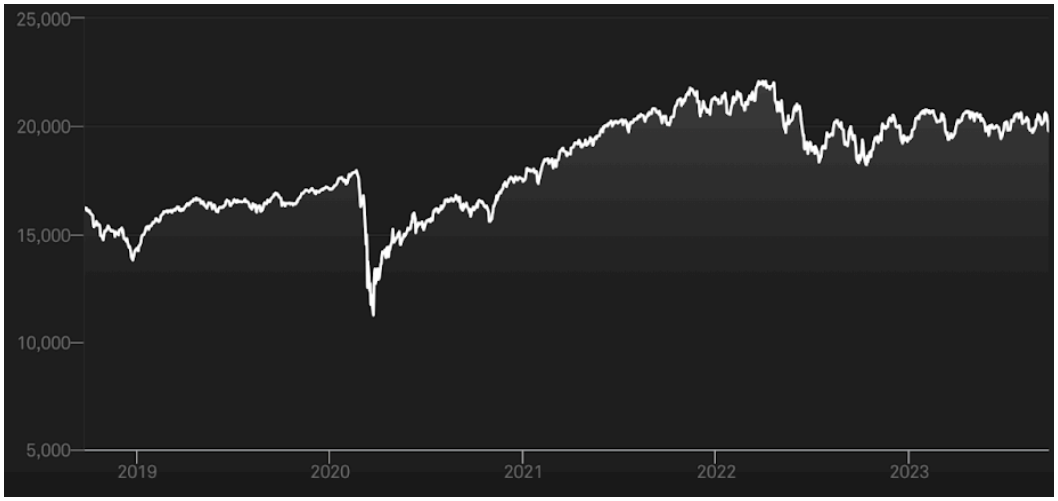
Risk Series. Specifically, the S&P/TSX Composite ESG is a market capital index designed to measure the performance of securities meeting S&P sustainable criteria, and it can be benchmarked with the S&P/TSX Composite index, which is the headline index for the Canadian equity market (see **Figures 14 and 15**). The ESG index performed worse than the regular index, 1.68% and 4.04%. However, it was more predictable, having lower risk when compared to the same index, 15.20% and 16.00% (S&P, 2023). Figure 16 shows the sectors in the Canadian ESG index, mostly Financials, Industries, Energy and Materials.

Figure 14 – Price Return in Canadian Dollars (CAD) S&P/TSX Composite ESG Index from 2018 to 2023



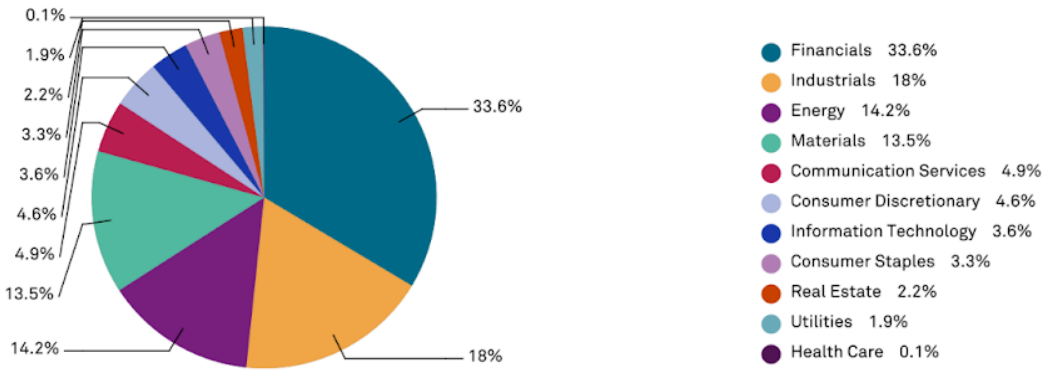
BDA: Backward Assumption Date
Source: S&P Dow Jones Indexes: S&P/TSX Composite ESG, 2023

Figure 15 – Price Return in Canadian Dollars (CAD) S&P/TSX Composite Index from 2018 to 2023



Source: S&P Dow Jones Indexes: S&P/TSX Composite, 2023

Figure 16 – S&P/TSX Composite ESG sector breakdown



Source: S&P Dow Jones Indexes: S&P/TSX ESG Composite, 2023

S&P Global ESG Score

The critical factor in selecting constituents for the DJSI and S&P 500 ESG is a company's S&P Global ESG Score, calculated under the S&P Global Corporate Sustainability Assessment (CSA) and its methodology covers three main dimensions (CSA Handbook, 2023):

- Economic: transparency, governance, materiality, risk management, ethics in business, policy influence, supply chain management, tax strategy and cybersecurity.
- Environmental: policy and management systems, emissions, resource efficiency, waste, water, climate strategy, and biodiversity.
- Social: labor practices, human rights, human capital development, talent attraction and retention, customer relationship management, occupational health & safety, and privacy protection.

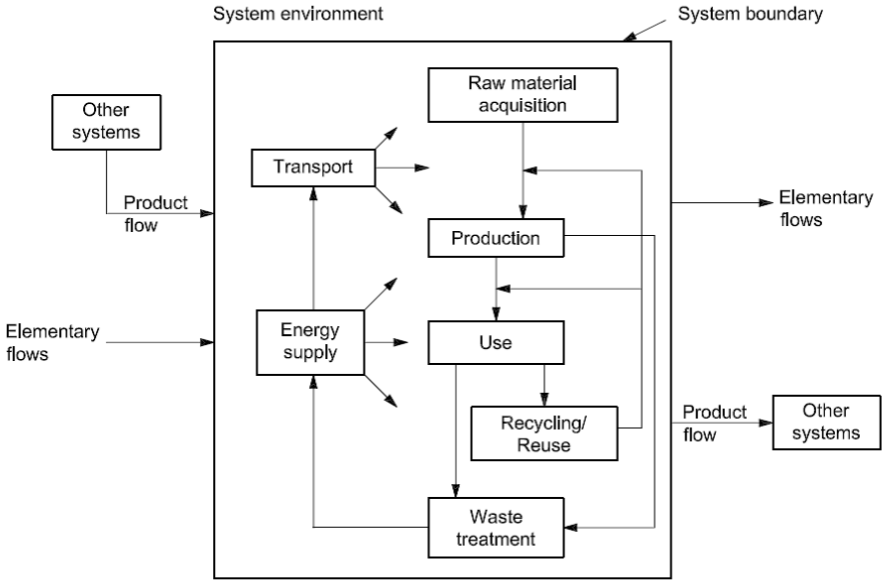
These standards and indexes ensure businesses substantiate their sustainability claims with credible evidence, avoiding "greenwashing" – misleading or exaggerated claims on sustainable practices.

2.3 LIFE CYCLE ASSESSMENT

Life Cycle Assessment (LCA), described in *NBR ISO 14040 – Environmental management – Life cycle assessment – Principles and framework*, equivalent to ISO 14040:1997, involves a study of all environmental impacts, along the value chain, of a product, process, or system, systematically evaluating from raw

material production to waste management (**Figure 17**) by compiling an inventory of relevant inputs and outputs of a product system, assessing potential environmental impacts associated with these inputs and outcomes and interpreting the results from the inventory analysis and impact assessment phases in relation to the study objectives (ABNT, 2006). It can help in identifying opportunities to improve the environmental aspects of products at various stages of their life cycle, in decision-making within industry, governmental or non-governmental organizations (e.g., strategic planning, setting priorities, product or process design or redesign), in selecting relevant indicators of environmental performance, including measurement techniques; and in marketing (e.g., highlighting environmental attributes, eco-labeling, environmental claims) (ABNT, 2001). The inventory, objective, and scope definitions comply with the respective requirements of ISO 14041, the impact analysis is described in ISO 14042, and the data interpretation of the assessment adheres to ISO 14043 (ABNT, 2006).

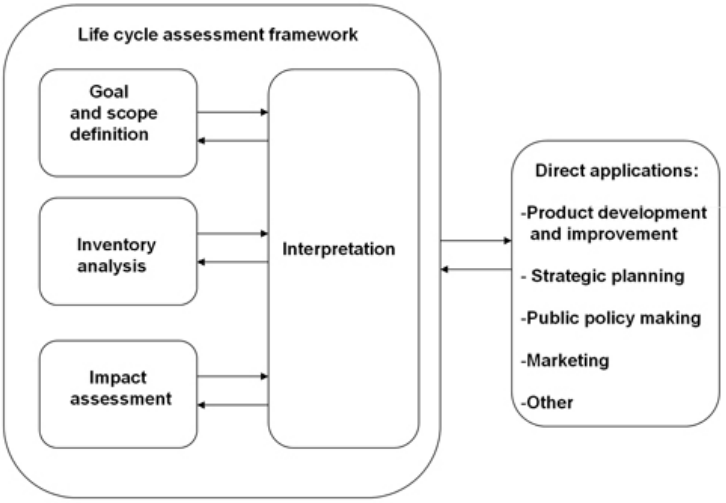
Figure 17 – Example of a Life Cycle Assessment System



Source: Oil & Gas Portal, 2016

LCA methodology is divided into four pillars: I. Scope and Objective Definition; II. Inventory Analysis; III. Life Cycle Impact Assessment; and IV. Data Interpretation, as shown in Figure 18.

Figure 18 – LCA framework



Source: Translated from ABNT, 2001

I. Scope and Objective Definition: First, the objective of the study is defined. The scope of the LCA involves determining specific product or service systems and their extent, specifying the types of impact to be evaluated, and determining the methodology for impact assessment and subsequent interpretation of the findings. The scope definition also entails stating the data requirements and necessary input data for the study, addressing any assumptions made during the analysis, acknowledging inherent limitations in the study or its methodology, ensuring the quality of initial data meets the necessary requirements, identifying the type of critical analysis to be conducted if applicable, and finally, specifying the expected type and format of the study's final report.

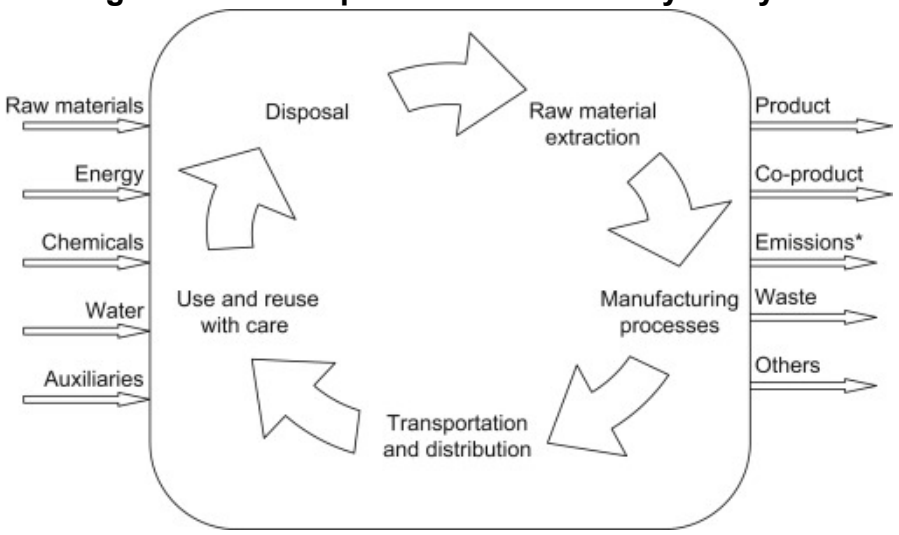
II. Inventory Analysis: Inventory analysis involves collecting data and calculating procedures to quantify a product system's relevant inputs and outputs. These inputs and outputs may include using resources and releases to the air, water, soil, and waste associated with the processes (**Figure 19**).

III. Life Cycle Impact Assessment: The impact assessment phase of LCA is aimed at evaluating the significance of potential environmental impacts, using the results of the life cycle inventory analysis. It includes categorization by impact; characterization and modeling of data; and weighting.

IV. Data Interpretation: Data interpretation is the phase in which the inventory analysis and impact assessment findings are combined with the defined objective and scope, aiming to reach conclusions and recommendations, providing a

more accurate and comprehensive environmental overview of the product/service for decision-makers.

Figure 19 – Example of a LCA Inventory Analysis



Includes air, water, and land emissions*
Source: Muthu, 2020

2.4 ENVIRONMENT, SOCIAL AND GOVERNANCE

ESG describes, from a financial perspective, the quality of a company's social, environmental, and governance performance. The environmental aspect of ESG refers to the company's environmental impact. It includes factors such as carbon emissions, climate change, energy efficiency, waste management, pollution, use of natural resources, etc. The social aspect focuses on how a company manages its relationships with stakeholders, including employees, customers, suppliers, communities, and society. It encompasses factors such as employee diversity and inclusion, labor practices, human rights, consumer relationships, and community engagement. Finally, governance deals with the systems and structures that govern a company's operations and decision-making processes. It brings factors such as board composition, executive compensation, transparency, risk management and corporate ethics. Every action and policy on an ESG agenda must pass through the governance (ABNT, 2023).

In 2020, the Big Four accounting firms (Deloitte, PwC, KPMG, and EY) presented a set of standardized indicators to assess the ESG performance of companies, defining standards and specific indicators of the SASB, which established ESG priorities, with specific indicators for each sector, for over 70 economic sectors (WEF, 2020). According to the IBM IBV (International Business

Machines Institute for Business Value), in 2022, ESG will be a top priority for 48% of Companies' CEOs.

Following the trend global agenda, the ABNT, in December 2022, launched the *ABNT PR 2030 standard – ESG – concepts, guidelines, assessment model, and guidance* (in Portuguese, *ABNT PR 2030 – ESG – Conceitos, Diretrizes e Modelo de Avaliação e Direcionamento para Organizações*) in Brazil. This is a pioneering work that serves as guidance on the measurement, evaluation, and implementation of ESG issues in all interested organizations and institutions, including small and medium-sized enterprises. It aligns key ESG concepts and principles on the necessary steps to incorporate them within an organization. Additionally, it proposes ESG criteria to be aligned with the organization's culture, strategic definitions, market trends, technological and financial capacity, among other factors (ABNT, 2023).

The ESG adoption operates independently and voluntarily without direct government regulations or incentives. Instead, it relies solely on market pressure driven by stakeholders such as customers, investors, and other key actors. It is important to note that despite the growing interest and adoption of the ESG framework, there is still a lack of comprehensive and standardized studies on its adoption performance and impact. It is also challenging to find specific metrics and criteria that represent ESG policies and to compare performance across sectors, since different organizations and industries may prioritize various aspects of ESG by its materiality, which is the most important sphere to be addressed by the company.

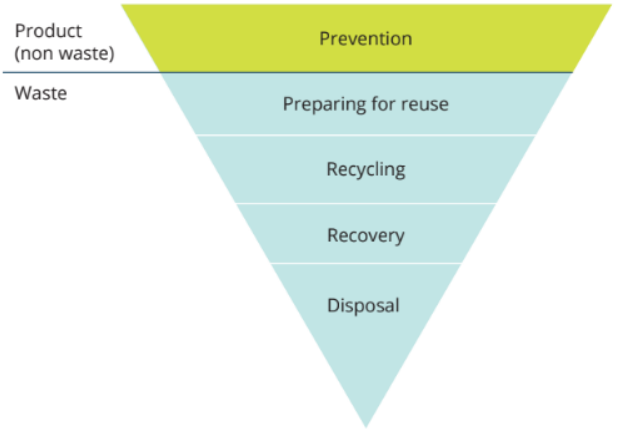
However, within ESG policies, waste management is a critical and often overlooked aspect, relegated to the fringe despite its significant environmental impact. The consumption of products (including their production, transport, and distribution) represents nearly 50% of emissions contributing to climate change (EWWR, 2015). Overall, sustainability requires society to achieve more significant mitigation and reuse levels throughout our economies (WEF, 2020). If not transferred into reuse schemes, these products will eventually become waste that needs to be managed, requiring more collection and treatment infrastructures and investment, putting a strain on the budgets of local and regional public authorities. It is, therefore, of crucial importance to reduce waste at the source.

2.5 WASTE PREVENTION

The actions implemented in the European Week for Waste Reduction address the “3Rs”: Reduce waste, Reuse products, and Recycle material. Yu et al. (2021), bring a more comprehensive term, adding Recover to the actions. In the EU, the Waste Framework Directive (WFD 2008/98/EC) established the waste hierarchy as the overarching principle of waste policies in the EU and EU Member States, presenting waste disposal with the “4Rs” in the process (**Figure 20**). The terms reduce, preparing for reuse and reuse are also defined in the WFD:

> Waste prevention encompasses all actions that prevent products, substances or materials from becoming waste (e.g. reducing the number of materials used in products; increasing the efficiency with which products are used; and extending the lifespans of products); Reuse means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived; Preparing for reuse means checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be reused without any other pre-processing. (EU, 2008)

Figure 20 – EU Waste Hierarchy



Source: EU, 2008

Similarly, focusing on a natural biome, the NGO focused on deforestation in the Amazon forest, Black Jaguar Foundation, states that the sustainability path for private sector organizations should address three pillars: (1) Measure impact - gaining an objective perspective on the emissions caused at all levels of their activities; (2) Reduce impact - which is the most effective decarbonization measure and it should be done while considering the balance between impact and their business model; and (3) Mitigate the remaining negative impact by taking actions that have a positive effect. These actions may include restoring biomes, conserving

forests, and promoting the responsible use of resources associated with the processes (Arruda et al., 2022).

These are the tools to reduce the adverse implications of retailing and manufacturing on the environment and represent the options that should be considered when elaborating a waste management strategy. According to Bortoleto (2015), "*throughout the years, waste managers have massively relied on technological means to tackle waste generation*". Although technological innovation has been helpful in the efforts to treat waste and decrease hazardous waste and volume, waste generation is still increasing mainly because of the weak engagement of individuals and institutions in waste prevention policies. The efforts thus far have not produced the expected outcome in reducing the overall amount of solid waste generated. Conservative measures that do not require a reduction in municipal waste can only prevent 1% to 3% of the total waste generation (Salhofer et al., 2008). As highlighted in the item 2.1.1., the industrial sector holds significant responsibility. Manufacturing companies, for instance, should prioritize preventive actions as an integral part of product design, enabling the analysis of impacts at each stage of the product's life cycle (Capelini, 2007).

When implementing a waste prevention plan, it is important to define indicators. By using LCA as an evaluation tool, it is possible to assess the environmental impacts of these actions and their impacts on natural resources, consumption, energy, and effluents by its emissions, treatment, and disposal. For example, Table 1 shows a list of impact indicators for evaluating Waste Electrical and Electronic Equipment (WEEE) prevention programs (Bortoleto, 2014).

Table 1 – Impact Indicators for Prevention Programs

Impact	Indicators	Definition
Economic	Reduced Costs in WEEE Management	Costs avoided due to the reduction in the quantity of WEEE (collection, treatment, final disposal)
	Reduced Costs Due to Replacement Instead of Purchase	If preventive action has prevented the acquisition of products, raw materials, or services, allowing for the reduction of total costs
	Economic Balance of Preventive Action	Balance between costs, costs avoided, and profit generation
Environmental	Impact Related to Preventive Action	Sum of all environmental impacts related to preventive action
	Impacts Avoided Linked to Lesser Quantity of WEEE to Be Managed	The impacts that would have occurred if the avoided generation of WEEE were treated and disposed of
	Impacts Avoided Due to Replacement Induced by Preventive Action	Preventive action can replace a product/raw material/service or a process that would have had an environmental impact; this indicator refers to that avoided impact
Social	Job Creation	Numbers and types of jobs created through the implementation of preventive action

Source: Translated from Bortoletto, 2014.

These elements ensure precision and consistency in evaluation and provide key indicators for monitoring, diminishing the chance of greenwashing. Additionally, integrating waste prevention as part of a waste management plan is essential in an ESG strategy. It not only addresses environmental concerns but also enhances social responsibility and governance practices. It helps minimize environmental impact, reduce operational risks, and demonstrate commitment to sustainability, aligning with ESG principles.

3 OBJECTIVES

This study aims to enhance understanding of ESG practices implementation within organizations. It seeks to achieve this by mapping and comparing the presence and maturity of ESG strategies across companies, while also examining the availability of material support for their adoption. Additionally, given waste is often left on the fringe when it comes to environmental issues, this study aims to focus on the environmental sphere, validating the strategic importance of measuring solid waste generation of the company's process/product/service to be implemented in the sustainable data set for decision-makers.

4 METHODOLOGY

This research's methodology consisted of a bibliographic review of the materials available, from 1972 to date, on sustainable discussion and practices within companies and international and national standards, certificates, reports, metrics, and indexes. Search engines - Google, ScienceDirect®, Web of Science™, Scopus® - were used, employing key terms such as "Waste", "Environment*", "Sustainab*", "ESG", "Life Cycle Assessment", "Waste Prevention", applied across disciplines including Environmental Studies, Public Administration, and Business & Economics.

After this process, a questionnaire was prepared to better understand the presence of ESG policies within both markets - national and international - with a focus on the Environmental aspect. The questionnaire (Appendix I) used in the interviews was divided into two main sections:

- ESG: map the presence of ESG within the company's strategy, why it was adopted and why it is important; establish the materiality; understand the maturity of the company regarding ESG policies, using NBR PR 2030's criteria (**Table 2**) and what is used to support decisions (certifications, standards, reports, metrics, and so on); understand the internal governance behind ESG, who make the decisions and how is this process structured;

- Waste Management: understand internal and external environmental initiatives and the presence of Local Solid Waste Management Plan (LSWMP); relevance in the company's annual budget; importance for overall strategy; map LCA's knowledge, usage, and the importance of measuring solid waste generation.

Table 2 – Levels for company's maturity in ESG

Level of Maturity	Description
1 - Elementary	ESG practices are addressed solely to meet legal requirements
2 - Non-integrated	ESG practices are scattered and not integrated into operations and management
3 - Managerial	ESG practices have operational focus and structured processes
4 - Strategic	ESG is part of the company's strategy and leadership
5 - Transformative	ESG is the foundation of the business model, and the company works to impact and influence the market

Source: Translate from ABNT NBR PR 2030/2022

Ten companies were chosen and invited for the interviews, based on their size, presence in the international market, and seniority level of the company's contact. Out of those, five companies accepted the invitation and two interviewees worked in an environmental department. The interviews were conducted using the questionnaire and preserving all companies' and interviewees' data, in compliance with Unicamp's Ethics Committee. The interview results were benchmarked against information available online from the top 10 best ESG companies in 2022, according to Nasdaq (2022). This included Annual Reports, Sustainable Reports, and Corporate Social Responsibility Reports, using keywords such as ESG, Standards, Metrics, GRI, SASB, ISO, Environment, Waste, Governance, Lifecycle, and LCA. Following the interviews, the same methodology used for the top 10 ESG companies was applied to the companies interviewed to guarantee more complete answers to the questions. "Yes" or "No" questions were only filled if the answer was positive. It was not assumed "No" to avoid biased answers, considering it can be a lack of information or knowledge.

5 RESULTS

An article published by Nasdaq in 2022, rating the top 10 stocks listed in the North American stock exchange based on their ESG policies, showed that "the goal of ESG investing is to build a portfolio of companies that have demonstrated a commitment to corporate responsibility as well as to shareholder profits (Nasdaq,

2022). Although it is increasing the importance and discussion on the roles of the private market in the transition to a more sustainable economy, and more than US$22 trillion in assets under management use sustainability data in portfolio construction (GSIA, 2016), it is difficult to find accurate information regarding sustainability within companies. This challenge arises from the usage of different methodologies, where 44% of companies cite an “inability to define prioritize material ESG issues for disclosure” as one of the top challenges for measuring and reporting ESG performance (Accenture, 2022), or due to lack of transparency in the market (Hahn, 2014).

In this study, the ten companies, considered as the top 10 ESG companies by Nasdaq, chosen can be found in Table 3 - in descending order of performance from the top to the bottom. For the 5 companies participating in the interviews, Table 4 shows the companies' description, interviewee department, and interview focus - internal (questions answered based on the company itself); and external (questions answered based on companies' clients) - preserving data confidentiality.

Table 3 – Top 10 Best ESG Companies

Company	Company's Description
Linde (LIN)	Gas production and distribution
Accenture (ACN)	Management consulting, technology and outsourcing
Microsoft (MSFT)	Software
Salesforce (CRM)	Cloud software
Nvidia (NVDA)	Computer graphics technology
Adobe (ADBE)	Computer software
J.B. Hunt (JBHT)	Transportation and logistics
Best Buy (BBY)	Computer electronics
Xylem (XYL)	Water technology and solutions
Texas Instruments (TXN)	Semiconductors and integrated circuits

Source: Nasdaq, 2022

Table 4 – Description, Interviewees' Department and Focus of companies that participated in the interview

Company	Company's Description	Interviewee Department	Focus
1	Automotive Systems and Components Manufacturer	Environmental	Internal
2	Bank	Operations	Internal
3	Energy Management	Information Technology	Internal
4	Sugar-energy	Sustainability	Internal
5	Sustainability Consulting and Marketplace Firm	Operations	External (market average)

Source: authored by the author (2023)

5.1 ESG

As the demand for integration of sustainability ESG data in investment management has increased exponentially over the past decade (Amel-Zadeh & Serafeim, 2018), the initial questions aimed to understand the role of ESG within the organization, the motivations and importance behind the transition towards the implementation of sustainable principles. According to the interviews, companies 3 (energy management) and 4 (sugar-energy) replied that ESG (or Sustainability), is part of the companies' strategy, culture and core values of innovation and efficiency for their inherent concern in providing energy. On the other hand, the companies 1 and 2 (automotive systems and bank) replied that adopting such policies results from external events and outside pressure by stakeholders and society, as highlighted by Christensen et al. (2021). When asked about their maturity, using the NBR PR 2030's, companies with ESG in their core values showed higher maturity levels than those that adopted it as an outcome of external factors (**Table 5**).

Table 5 - Companies' maturity in ESG using NBR PR 2030 criteria

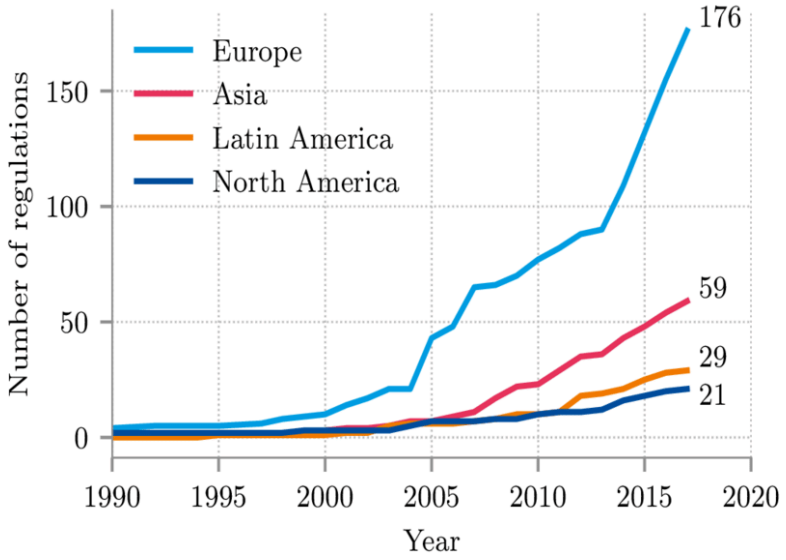
Company	Maturity
1	2
2	2
3	5
4	4

Source: authored by the author (2023)

There is a difference in ESG presence and maturity when comparing regions worldwide. The Sustainability Consulting firm, with more than 100,000 clients, stated that Europe is ahead in ESG policies, followed by North America and Latin America - similar patterns can be found in the number of regulations with the same focus, analyzed by Drei et al. in 2019 (**Figure 21**). The reason for this,

presented in the interview, is that Europe has higher preconditions than the rest of the world, thus creating pressure on other markets to adapt as needed. Regarding company maturity, the firm considered most of its clients to be level 3 or 4, a large number in level 2 and only a few in level 5. This affirms that most companies, mainly having environmental materiality, look for their consulting services as a consequence of conformity to the demands of customers and their supply chain.

Figure 21 - Number of "sustainable" regulations per region



Source: Drei et al., 2019

For the top 10 ESG companies, the importance and motivation behind adopting sustainable practices must be clarified in their reports. Similarly, without an internal overview of the company's strategy and business model, it was impossible to evaluate its maturity level in ESG using the NBR PR 2030 criteria. Therefore, statements on sustainable development in the reports were gathered and analyzed in a Word Cloud, to understand possible common values for ESG adoption. The words "Work," "Sustainability," "Technology," "Customers," "Growth," "People" and "World" found in Figure 22 are a few of the most common in companies' statements for companies leading ESG practices, showing the values behind their motivation.

Figure 22 – Word Cloud generated from Statements on Sustainability of the Top 10 ESG Companies

Source: authored by the author (2023)

When analyzing the support material available used as a reference to guide and report sustainable practices, such as standards, certifications, and indexes (see item 2.2.2), SASB, GRI and TCFD were incorporated by nearly all companies with higher maturity levels (**Table 6** and **7**). Pizzi et al. (2022) highlighted that SASB's adoption is driven by factors related to financial dynamics, while GRI's adoption is influenced by the existence of corporate governance mechanisms inspired by sustainable and ethical principles, and the combination of the two standards might represent well-established sustainability governance within the company. The Energy Management company (maturity level 5) reported a multitude of standards adhered to its services in addition to SASB, GRI and TCFD, including: European Sustainability Reporting Standards (ESRS); International Organization for Standardization (ISO); Sustainable Development Goals (SDGs); Science-Based Target initiative (SBTi); Organization for Economic Co-operation and Development (OECD); International Labour Organization (ILO); Dow Jones Sustainability Index (DJSI).

Table 6 – Frequency of the reference material used out of five companies interviewed

Companies Interviewed	
Referece	**Frequency**
TCFD	3
ISO	3
SASB	3
GRI	2
SDGs	2

Source: authored by the author (2023)

Table 7 – Frequency of the reference material out of 10 companies analyzed

Top 10 ESG companies	
Reference	**Frequency**
GRI	10
SASB	10
TCFD	9
CDP	3
ISO	3
SDGS	3
UNGC	2
IIRF	1
WEF IBC	1
SCM	1

Source: authored by the author (2023)

Environmental initiatives can be divided into four main concerns, based on data gathered: I) Greenhouse Gasses (GHG) emissions; II) Renewable Energy; III) Resources; and IV) Waste:

I) GHG emissions are measured with CO2 equivalent (CO2eq), a metric present in most cases. All companies measure their gases emissions related to Scope 1 and 2 - associated with direct emissions from owned resources and related to energy consumption generation, respectively (Greenhouse Gas Protocol, 2017). However, no company has sufficient data to measure Scope 3 emissions, which are indirect emissions related to the product/service lifecycle (Greenhouse Gas Protocol, 2017). According to the Consulting firm (Company 5), almost half of its clients lack the knowledge, tools and/or maturity to measure even Scope 1 and 2 emissions.

II) Renewable Energy is also present in all companies' initiatives and is measured by the percentage of energy consumed from renewable resources. This measurement

was current in all 10 top ESG companies and 3 out of 4 companies interviewed, being the ones with lower maturity that have not adopted it.

III) Resources targets are present in 8 out of 10 top ESG companies and 2 out of 4 interviewed, mainly the ones whose product/service is resource dependent. They are committed to reducing the use of raw materials and water, increasing efficiency. They also count on measures to restore ecosystems and biodiversity.

IV) Waste was a concern for 7 out of 10 top ESG companies and 2 out of 4 companies interviewed. When analyzing the top 10 companies out of 7, three companies have net-zero waste goals, three have goals for waste reduction, and one is already in conformity with the regulation regarding proper disposal. Intertwined with Resources, those companies also bring recycling as an initiative for waste management.

The governance behind sustainability analysis follows a similar pattern shown in Figure 23. For companies with higher maturity, the decisions start with the Board of Directors, setting the strategy to be reviewed and approved by the Executive Committee alongside the Shareholder Committee. This first part of the process is managerial-focused. When approved, the Sustainability Office coordinates and monitors the strategy implementation and related projects while reporting performance to stakeholders. Finally, policies are implemented and monitored by local leadership and disseminated to all employees. Most companies also count on an external Audit company to monitor its conformities. It is important to note that although the terms may differ, the process was similar. In terms of companies with lower maturity (level 2 or 3) according to the Consulting firm (Company 5), they have project management responsible for implementing sustainable practices into the company, encompassing all aspects of strategy, management, and execution, centered in one place. Companies at Level 1 or 0 have sustainable practices only to meet regulations requirements - or take no actions - without planning and monitoring.

Figure 23 - Sustainability Governance Pattern Framework

Source: authored by the author (2023)

5.2 WASTE MANAGEMENT

Economic development drives industrialization, which increases the rate of natural resource extraction and the quantity and harmfulness of waste generated (Sarkodie, 2018). When considering the presence of a waste management plan incorporated into environmental initiatives (**Table 8**), half of the companies interviewed stated that they have a Local Solid Waste Management Plan (LSWMP) -highlighting the relevance of waste in the companies' budget (**Table 9**) - however, further information on how it is structure was not found. Nevertheless, four out of five interviewed companies, including the Consulting firm (Company 5), considered quantifying waste generation important (**Table 10**). For the top 10 ESG companies, based on their reports, 9 out of 10 had waste reduction goals, implying that it is important to quantify it (**Table 11**). Out of these 9 companies, 5 have net zero waste goals - cutting emissions to as close to zero as possible, with any remaining emissions re-absorbed by the environment (UN, 2022) - while the others have plans to add efforts to reduce waste, having no specific targets.

Table 8 – Presence of Local Solid Waste Management Plan (LSWMP)

Company	LSWMP
1	-
2	-
3	Yes
4	Yes

Source: authored by the author (2023)

Table 9 – Relevance of Waste in the budget, being 0 = irrelevant and 5 = extremely relevant

Company	Relevance of Waste in Budget
1	0
2	0
3	5
4	4

Source: authored by the author (2023)

Table 10 – Importance of quantifying waste generation for companies interviewed

Company	Is it important to quantify Waste?
1	Yes
2	-
3	Yes
4	Yes
5	Yes

Source: authored by the author (2023)

Table 11 – Presence of Local Solid Waste Management Plan (LSWMP) for Top 10 ESG companies

Company	LSWMP
Linde (LIN)	Yes
Accenture (ACN)	Yes
Microsoft (MSFT)	Yes
Salesforce (CRM)	Yes
Nvidia (NVDA)	Yes
Adobe (ADBE)	Yes
J.B. Hunt (JBHT)	-
Best Buy (BBY)	Yes
Xylem (XYL)	Yes
Texas Instruments (TXN)	Yes

Source: authored by the author (2023)

Finally, the questionnaire aimed to map the knowledge about LCA and its implementation. According to the four internal interviews, the Energy Management and Sugar-Energy companies were familiar with this tool (**Table 12**). Considering implementation, only the Energy Management company has LCA implemented in its process. The Sugar-Energy company uses it indirectly through certifications with LCA methodologies (**Table 13**). For these questions, the Consulting firm was not considered as its responses are based on its clients.

The Consulting firm reported that companies may be aware of LCA. However, they do not have it implemented; and if they do, it does not cover the entire supply chain. Regarding the top 10 ESG, the term "Life Cycle Assessment" was mentioned in their reports, and half of them presented the usage of LCA to understand their product/service emission through the supply chain (**Table 14**).

Table 12 - Knowledge about LCA inside the company

Company	Knowledge about LCA
1	-
2	-
3	Yes
4	Yes

Source: authored by the author (2023)

Table 13 - Implementation of LCA in companies interviewed

Company	Is LCA implemented?
1	-
2	-
3	Yes
4	Indirect

Source: authored by the author (2023)

Table 14 - Implementation of LCA in the Top 10 ESG Companies

Company	LCA
Linde (LIN)	Yes
Accenture (ACN)	Yes
Microsoft (MSFT)	Yes
Salesforce (CRM)	-
Nvidia (NVDA)	Yes
Adobe (ADBE)	-
J.B. Hunt (JBHT)	-
Best Buy (BBY)	-
Xylem (XYL)	Yes
Texas Instruments (TXN)	-

Source: authored by the author (2023)

Table 15 – Summary of Companies Interviewed

Company	Company's Description	Focus	Maturity	Relevance of Waste in Budget	Knowledge about LCA	Is LCA implemented?
1	Automotive Manufacturer	Internal	2	0	-	-
2	Bank	Internal	2	0	-	-
3	Energy Management	Internal	5	5	Yes	Yes
4	Sugar-energy	Internal	4	4	Yes	Indirect
5	Sustainability Consulting	External	3	-	Yes	Partialy

Source: authored by the author (2023)

Table 16 – Summary of Top 10 ESG Companies

Company	LSWMP	LCA
Linde (LIN)	Yes	Yes
Accenture (ACN)	Yes	Yes
Microsoft (MSFT)	Yes	Yes
Salesforce (CRM)	Yes	-
Nvidia (NVDA)	Yes	Yes
Adobe (ADBE)	Yes	-
J.B. Hunt (JBHT)	-	-
Best Buy (BBY)	Yes	-
Xylem (XYL)	Yes	Yes
Texas Instruments (TXN)	Yes	-

Source: authored by the author (2023)

The importance of waste is shown to be related with higher maturity and to company's activities - companies who have a direct and evident impact on the environment find it relevant (**Table 15**). This, however, does not imply the presence of a LSWMP nor an implementation of waste management tools, such as LCA (**Table 16**). The standardization processes, widely implemented, also lack precision; for

instance, ISO 14000 covers LCA in its ISO 14040, and certified companies still do not have it implemented in their operations.

6 CONCLUSIONS

Although policymakers have discussed sustainability since 1972, it is tough to find accurate, confluent, profound knowledge on it. A better understanding of the correlation between natural resources, economic development, and emissions is essential for policymakers and government officials to mitigate impacts (Danish, 2019). This study aimed to map the presence and maturity of ESG within companies and showed that despite most companies being aware of ESG, there is a great gap between what is required from the private sector and the understanding of environmental impacts and the actions taken, especially concerning waste. The interviews conducted with five companies showed that guidance on ESG implementation, such as the NBR PR 2030, is unusual and not widely adopted. By analyzing the Top 10 ESG companies, it was concluded that the standardization process also lacks precision; for instance, ISO 14000 covers LCA in its ISO 14040, and certified companies still do not have it implemented in their operations. Without knowing its impacts, it becomes a challenging task to know a company's actual impact and take actions towards a less pollutant and more efficient production.

One of the five companies interviewed, the Consulting firm, affirmed that companies with direct and evident impact on the environment are the main ones looking for consulting in sustainability, showing alarming concerns since most companies do not know their materiality and do not have reliable parameters to measure their impact on the environment. The companies that are leading ESG implementation, focus on emissions Scope 1 and 2, using CO2eq metrics in all cases, leaving Scope 3, especially waste treatment and disposal emissions, on the fringe, even though waste was underlined as relevant by high ESG maturity (see **Table 15** and **16)**. Thus, it was concluded that there is an urge for a group of indicators to assist the private sector in monitoring the activities' impacts based on the environmental aspects related to sustainability, as also stated by Rashed et al. (2021), especially for waste generation, management, and disposal. These metrics should use LCA for more accurate and reliable data on companies' processes throughout the entire chain.

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APPENDIX I – QUESTIONNAIRE APPLIED IN INTERVIEWS

1) Does the company have ESG initiatives within its strategy?

2) What is the motivation (influencing factors) for the company to adopt ESG practices? Please provide an example.

3) What is the importance for the company of adopting ESG practices?

4) Considering that Materiality refers to which issues are the most important to address and those where the company has the most impact (environmental, social, economic), what would be the Materiality of your Company?

5) Based on the figure below, how would you define the company's maturity about ESG practices?

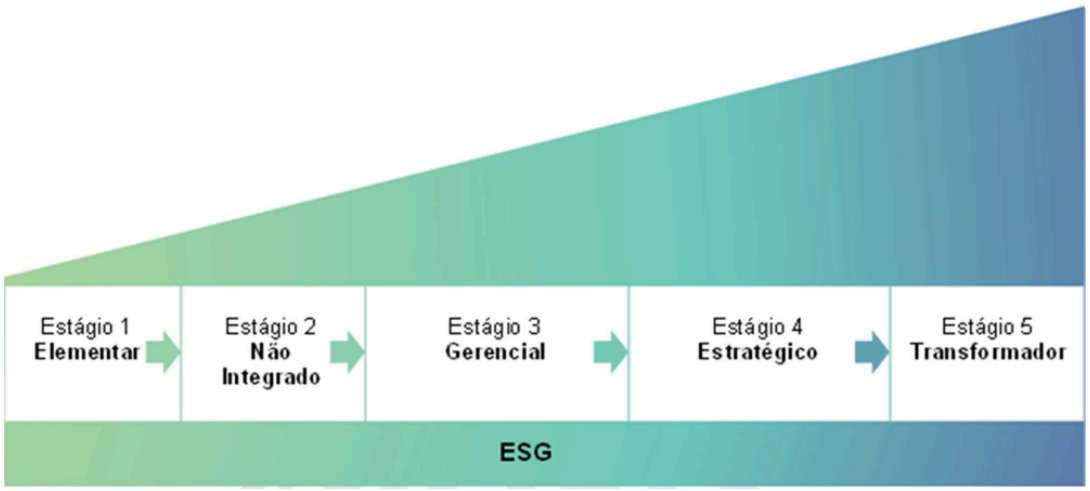

Figure: Company's maturity in ESG

Source: ABNT NBR PR 2030/2022

6) What ESG indicators, metrics, and certifications are used during the company's strategic decision-making process? How and why are they used?

7) What internal and external environmental initiatives/actions exist in the company?

8) Does the company have an internal Solid Waste Management Plan (SWMP)? If yes, how is it structured?

9) In which sectors/departments is knowledge about Life Cycle Thinking (LCA) disseminated?

10) On a scale from 0 to 5, with 0 being irrelevant and 5 being extremely relevant, how relevant is the cost of implementing Solid Waste Management actions?

11) Would quantifying Solid Waste generation be a key factor for decision-making in waste management?

12) Who are the key sectors/departments and individuals involved in approving ESG initiatives?

13) What are the internal procedures for approving these initiatives?

14) Does the company have available materials that could complement this research?