



INFLUENCE OF TECHNOLOGICAL INNOVATION IN THE DEVELOPMENT OF ESG PRACTICES: DESCRIPTIVE ANALYSIS

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ABSTRACT: *Studies on sustainability over time have grown in importance both in academia and in the business world. Aspects related to technological innovation need to be present in business so that different strategies are evaluated in order for the company to remain competitive in the market. In this context, ESG (environmental, social and governance) practices can increase the likelihood of business success through sustainable management and in accordance with society's wishes, directly reflecting on organizational reputation. However, sustainable activities and technological innovations are normally studied and discussed independently. This article aims to outline a profile of the insertion of technological innovation in scientific productions focused on ESG practices. To achieve the objective, a descriptive analysis was carried out, with samples of documents belonging to the Scopus database, from 2013 to 2023. After the analyses, it was possible to identify the consistent evolution of publications, diversity of journals interested in the subject, most cited articles, countries with relevant searches and keyword network. Finally, as a result, three areas directly related to technological innovation in ESG activities were identified – green innovation, finance and governance approach.*

KEYWORDS: ESG; TECHNOLOGICAL INNOVATION; BIBLIOMETRIC ANALYSIS.

1. INTRODUCTION

Organizations are increasingly seeking to apply scientific and technical knowledge to develop and implement innovative solutions that meet specific demands. Through technological innovation, it is possible that new technologies, methods, processes, or products are introduced that bring significant improvements in relation to existing ones (GARCIA; CALANTONE, 2002). Technological innovation can be driven by a variety of factors, such as scientific advances, changes in consumer needs and expectations, government regulations, market demands and competition (CAMISÓN; VILLAR-LÓPEZ, 2014). In addition, it can occur in several sectors and areas, ranging from advances in electronics and telecommunications to new technologies in medicine, energy, agriculture, and transport (KIHOMBO et al., 2021) .

Technological innovation plays a fundamental role in the search for sustainable solutions, in the development of new business models and in the response to social challenges (SINHA; SENGUPTA; ALVARADO, 2020). In this context, the relationship between ESG (Environmental, Social, and Governance) and technological innovation is increasingly relevant and essential nowadays (CHEN et al., 2023). ESG is an acronym that represents the three main criteria considered to evaluate the performance of companies in environmental, social and governance aspects. ESG criteria are used to assess sustainability and corporate responsibility, as well as a company's impact in the environmental, social and governance spheres (KAISER, 2020; POLLMAN, 2021).

ESG criteria are often considered by investors, analysts and investment managers when evaluating companies and making investment decisions. Investors are increasingly considering ESG performance as an integral part of their investment strategies, recognizing that sustainable and socially responsible companies are more likely to face future risks and have strong long-term financial performance (ALAREENI; HAMDAN, 2020). Furthermore, the adoption of ESG practices is becoming a growing trend among companies, who recognize the importance of integrating environmental, social and governance considerations into their strategies and operations to meet stakeholder demands and promote a positive impact on society (GILLAN; KOCH; STARKS, 2021).

The adoption of ESG principles can create technological innovation opportunities that drive companies' growth and competitiveness (CHEN et al., 2023). The demand for sustainable products and services is on the rise, and companies that develop innovative

solutions to meet these demands have a competitive advantage (HUGHES; URBAN; WÓJCIK, 2021). Technological innovation allows companies to create new products, services and business models aligned with ESG criteria, capturing new market segments, and attracting investments (LI; LI, 2022).

As a consequence, there is a meaningful gap in the literature related to the influence of technological innovation in the development of ESG practices, and both academia and companies can benefit from this debate. To address such research gap, identifying the effects of technological innovation in ESG practices, we reviewed and analyzed the insertion of technological innovation in scientific work related to ESG.

This paper is structured in four further sections. In the following section, a theoretical framework is presented, with essential definitions and an outline of the current debate on the topic. Section 3 characterizes the methods to search, collect, analyze and synthesize data. Section 4 presents the descriptive analysis results and discusses the main findings. Last, section 5 presents conclusions, implications, limitations, and suggestions for future research.

2. THEORETICAL FRAMEWORK

2.1 Environmental, Social and Governance (ESG)

In the constant search for competitive advantages, organizations have identified over the years that through continuous improvement of existing business processes and products, it is possible to achieve sustainable corporate solutions (PORTER; LINDE, 1995). In a consumer society, organizations must focus on reducing environmental impacts through innovations that reduce the total cost of a product and improve its value (HART; MILSTEIN, 1999).

As a result of an evolution in this area, since the beginning of the 21st century, environmental, social and governance aspects, named in the literature as Environmental, Social and Governance (ESG), have become relevant in the business strategies of organizations (HUSTED; FILHO, 2017; NERI, 2021). The three pillars of sustainability are considered, determining actions that preserve the environment, focus on social issues and, through corporate governance, ensure the application of compliance activities of organizations (ALSAYEGH; RAHMAN; HOMAYOUN, 2020; PEDERSEN; FITZGIBBONS; POMORSKI, 2021).

The acronym ESG was instituted in the publication *Who Cares Wins*, developed by the Global Compact of United Nations Organizations (UN) in 2004. At the time, the initiative questioned financial institutions on how to insert social, environmental and corporate governance issues in the capital market (ONU, 2004). Since then, driven by the issue of sustainability, the term has maintained its notoriety and has expanded to other sectors, as it remains on the agenda of discussions in various international forums (NERI, 2021) .

Despite being a challenging task for organizations, the adoption of ESG principles brings favorable consequences, such as increased reputation, market growth and greater attraction of investments (DE LUCIA; PAZIENZA; BARTLETT, 2020; KARWOWSKI; GRZYBEK, 2021). The importance of each of the pillars (environmental, social and governance) changes according to the different characteristics of each sector in which it operates and the strategic objectives of each organization (KAISER, 2020).

2.2 Technological Innovation

Innovation is related to the creation of new knowledge and ideas to facilitate new business outcomes, aiming at improving internal business processes and structures, and creating market driving products and services (PLESSIS, 2007). In the innovation process, organizations transform ideas into new and better products, services, or processes in order to successfully advance, compete and differentiate themselves in their market (BAREGHEH; ROWLEY; SAMBROOK, 2009).

An organization's ability to innovate is a precondition for the successful use of creative resources and new technologies. On the other hand, the introduction of new technologies often presents complex opportunities and challenges for organizations, leading to changes in management practices and the emergence of new organizational forms (CAMISÓN; VILLAR-LÓPEZ, 2014; MORONI; ARRUDA; ARAUJO, 2015) . In both services and manufacturing, the most important objective of companies' innovation strategies is to improve service/product quality, increase market shares and reduce production costs (SIRILLI; EVANGELISTA, 1998).

Technological innovation is the improvement in processes and products through investment in technology, with the purpose of optimizing results and adding value to the business (CHEN et al., 2023; KOGAN et al., 2017). Generally, technological innovation is also associated with new organizational forms. In order to carry out successive innovations, it

is necessary to have an organizational structure with a high capacity to adapt to technological innovations (MULVEY; GONCALVES, 2022; SIRILLI; EVANGELISTA, 1998).

3. METHODS

Bibliometrics is a technique that aims to better understand the literature on a given topic (EIRAS et al., 2017). It starts with bibliographic portfolio planning; then it is carried in major databases; and finally, bibliometric analysis is performed (TRANFIELD; DENYER; SMART, 2003). In the portfolio planning phase, the *Scopus* database was selected, for it comprehensive digital collections and wide spectrum of journals. Articles in *Environmental Science, Business, Management and Accounting, Social Sciences, Energy, Economics, Econometrics and Finance, Engineering, Computer Science, Mathematics, Decision Sciences, and Earth and Planetary Sciences* categories, from January 2013 to June 2023, were picked out.

The general structure for searching articles had two main identifiers: *ESG* and *Technological Innovation*. To extract the most appropriate publications, both union and intersection operators were used: “ESG” OR “Environmental, Social and Governance” AND “innovation” OR “technological innovation”.

Table 1. Bibliographic portfolio inclusion criteria

Planning	Bibliographic portfolio
Database	Scopus
Document type	Articles
Period	January 2013 to June 2023
Category	Environmental Science, Business, Management and Accounting, Social Sciences, Energy, Economics, Econometrics and Finance, Engineering, Computer Science, Mathematics, Decision Sciences, and Earth and Planetary Sciences
Search string	“ESG” OR “Environmental, Social and Governance” AND “innovation” OR “technological innovation”
Processing of data	Descriptive and content analyzes

Initially, the Scopus database presented 195 articles. Then, titles and abstracts of all articles were analyzed. Those not addressing the relation between technological innovation and ESG were eliminated. An example of such excluded articles is a study of filtering based extended stochastic gradient (ESG) algorithm. After this filter, 168 articles comprise the final sample, as shown in Figure 1.

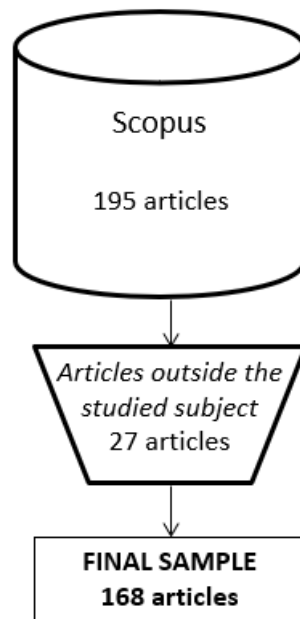


Figure 1 - Filtering process

A descriptive analysis was developed to identify aspects such as relevant journals, publication per year, most cited articles, relevant countries and keywords network. Thenceforth, its possible to identify main definitions, new areas and to understand how technological innovation is applied in the context of ESG.

4. FINDINGS

4.1 Descriptive analysis

A descriptive analysis was conducted with the 168 articles in the dataset, to identify relevant journals, publications per year, most cited articles, countries that most published, articles developed by Brazilian researchers and keywords network.

Regarding the most cited journals, it was possible to identify that *Sustainability* is the main reference on the subject with 39 articles, thus representing 23.21% of the sample. It should also be noted that it is a widespread theme among different types of publications – there are 168 articles published in 89 different sources. Table 2 highlights the journals that published at least five articles and their respective Scientific Journal Ranks (SJR), serving as a reference for research and good publication opportunities.

Table 2. Journal information

Journal	Quantity	SJR (2022)
Sustainability	39	0.664
Journal of Cleaner Production	9	1.981
Journal of Business Research	6	2.895
Frontiers in Environmental Science	5	1.005

The number of documents published between January 2013 and June 2023 is illustrated in Figure 2. From 2013 to 2019, the academic production that relates the influence of technological innovation to ESG practices is considered very low, that is, the first 7 years analyzed represent only 8.33% of the sample. In 2020 and 2021, the most critical years of the COVID-19 pandemic, the number of published articles increased considerably, representing 19.64% of the sample, making the topic recognized by the academic community.

Finally, in the last 2 years, scientific production has increased considerably, representing 72.02% of the sample. This boost was generated by the need for the scientific community and companies to seek sustainable solutions after the COVID-19 pandemic. In this way, it is possible to verify that the study of the relationship between technological innovation and ESG is part of a theme that occupies a prominent place in the main research institutions around the world.

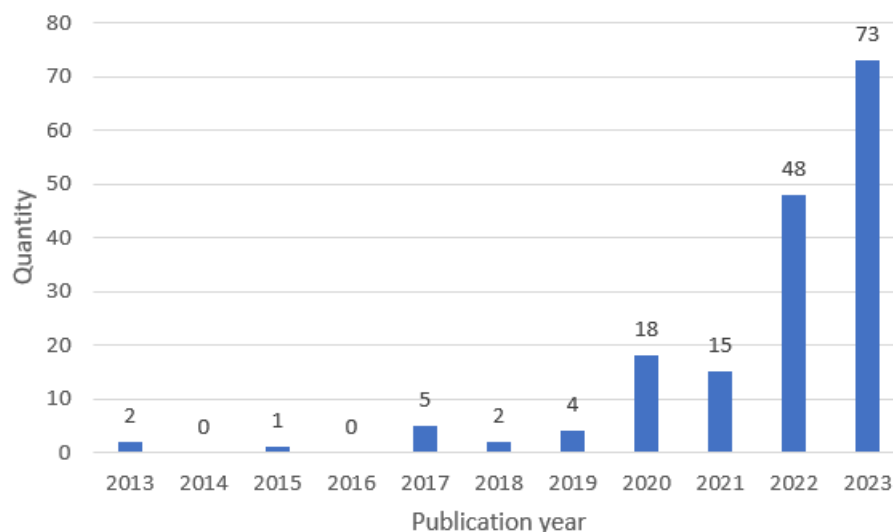


Figure 2. Distribution of documents published between 2013 and 2023

Table 3 displays the five most cited documents, identifying the most influential documents in the period.

Table 3. Most cited documents

Authors	Title	Journal	Year	Citation	Average
Engle, R.F., Giglio, S., Kelly, B., Lee, H., Stroebel, J.	Hedging climate change news	Review of Financial Studies	2020	158	52,6
Broadstock, D.C., Matousek, R., Meyer, M., Tzeremes, N.G.	Does corporate social responsibility impact firms' innovation capacity? The indirect link between environmental & social governance implementation and innovation performance	Journal of Business Research	2020	107	35,6
Rajesh, R.	Exploring the sustainability performances of firms using environmental, social, and governance scores	Journal of Cleaner Production	2020	92	30,7
Zhang, F., Qin, X., Liu, L.	The interaction effect between ESG and green innovation and its impact on firm value from the perspective of information disclosure	Sustainability	2020	38	12,6
De Lucia, C., Pazienza, P., Bartlett, M.	Does good ESG lead to better financial performances by firms? Machine learning and logistic regression models of public enterprises in Europe	Sustainability	2020	33	11

The most influential articles were published in 2020. Although the topic of sustainability has been relevant since the mid-20th century and articles on technological innovation and ESG were treated independently at the beginning of the 21st century, the study of these two topics together is very recent, presenting a field yet to be explored by researchers.

Table 4 presents the five countries that most published about the theme in question, demonstrating that ESG practices and technological innovation have been discussed in various academic communities around the world. China's leading role in research related to the topic stands out, with 39.28% of published articles. It should be noted that from the sample selected, Brazil presented four publications (2.38% of the sample), being included in the global context.

Table 4. Countries that published the most

Country	Articles	Percentage
China	66	39,28%
United States	24	14,28%
United Kingdom	16	9,52%
Italy	12	7,14%
South Korea	12	7,14%

The studies developed in Brazil are highlighted in Table 5, demonstrating thus, the participation of Brazilian researchers in the international scenario and the existence of field for further research in the country.

Table 5 - Articles developed by Brazilian researchers

Authors	Title	Journal	Year
Zeidan, R., Spitzcek, H.	The Sustainability Delta: Considering Sustainability Opportunities in Firm Valuation	Sustainable Development	2015
Beck, D., Ferasso, M.	How can Stakeholder Capitalism contribute to achieving the Sustainable Development Goals? A Cross-network Literature Analysis	Ecological Economics	2023
Pinheiro, A.B., Panza, G.B., Berhorst, N.L., Toaldo, A.M.M., Segatto, A.P.	Exploring the relationship among ESG, innovation, and economic and financial performance: evidence from the energy sector	International Journal of Energy Sector Management	2023
Simões-Coelho, M., Figueira, A.R., Russo, E.	Motivations for a sustainable ethos: evidence from the globally present Brazilian multinational Natura &Co	Environment Systems and Decisions	2023

Finishing the descriptive analysis, the VOSviewer® software was used to analyze the keyword network from the sample articles (Figure 3). As expected, the highest occurrences are directly related to the words *ESG* and *innovation*. However, in addition to related themes, it was possible to identify 3 areas that are linked to the influence of technological innovation on ESG practices, namely: *green innovation*, *finance* and *governance approach*. In addition, information in the keyword network helps to guide new research and even financial contributions by organizations.

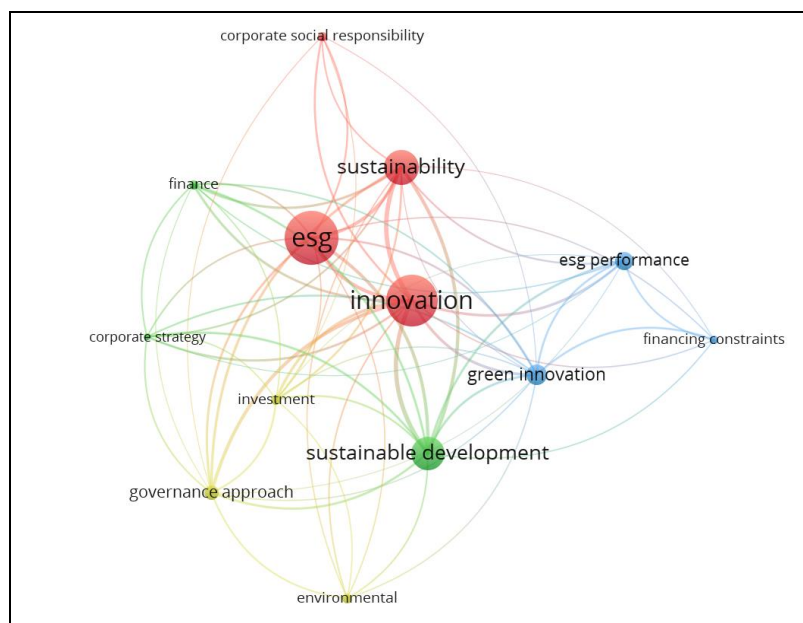


Figure 3. Keyword network

5. CONCLUSION

To address a literature gap in the relation of innovation and the development of sustainable aspects, the present paper reviewed and analyzed the insertion of technological innovation in the scientific research focused on ESG practices. A bibliometric analysis composed of descriptive analysis was used. Articles were extracted from Scopus database. The final sample for the descriptive analysis was composed of 168 articles.

In the first part of this research, a descriptive analysis was carried out for an overview of the relation between technological innovation and ESG. The subject is spread among 89 academic journals, showing there is ample space for research and publications. However, it is worth highlighting the importance of the Sustainability journal, such as the publication of 23,21% of the sample. Research interest in the association of ESG practices to innovation has grown considerably in the last 2 years, probably driven by academia and companies seeking sustainable and strategic solutions after the period of the COVID-19 pandemic.

Another relevant aspect was the relation with other areas of knowledge, highlighted by the topics in the most cited documents and by the keyword network. In the final part of the research, the analysis highlighted studies of topics related to technological innovation and their application in ESG practices. As a result, were identified – green innovation, finance and governance approach.

From the findings and conclusions, it can be argued the field would benefit from further research on topics concerning green innovation and sustainable development. In addition, more research on the relation between investment and ESG performance is needed. Moreover, it would be interesting to analyze how finance constraints are dealing with corporate strategy. Despite those findings, this article has some limitations regarding its method and nature. For instance, this is an exploratory study, in which descriptive article analyzes are to some extent subjective. Given that limitation, a further quantitative research on technological innovation in sustainable business, identifying costs and benefits is suggested.

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