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THE SYNERGY OF SUSTAINABLE DEVELOPMENT GOALS AND ECO-INNOVATION: A QUANTITATIVE STUDY FROM THE BRAZILIAN PERSPECTIVE

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ABSTRACT

Objective: This study explores the link between the 17 Sustainable Development Goals (SDGs) and eco-innovation, as perceived by 1,262 respondents in Brazil.

Method: Employing a quantitative approach, we utilized confirmatory factor analysis and multiple linear regression to analyze the data.

Main results: The findings demonstrate a significant influence of all SDGs on eco-innovation, with Sustainable Development Goal 17 (Partnerships to achieve the goal) showing the strongest correlation. Collaboration is pivotal in fostering sustainable practices.

Relevance/originality: This study's key contribution lies in the establishment of a statistically validated analysis framework, applicable in various regional, national, and international contexts, serving as a foundation for future research.

Theoretical/methodological contributions: We developed a comprehensive scale grounded in environmental, social, and economic principles to assess the 17 SDGs. The validated measurement tool enhances the understanding of their intersection with eco-innovation.

Social/management contributions: Our research has valuable implications for sustainable development managers and professionals, fostering awareness of the SDGs' importance and inspiring strategies for sustainability. It also informs socio-environmental policymaking at regional and national levels, aligning with the 2030 Agenda.

Keywords: Development goals; Sustainable development goals; Eco-innovation; Brazil.

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A RELAÇÃO ENTRE OS OBJETIVOS DE DESENVOLVIMENTO SUSTENTÁVEL E A ECO-INOVAÇÃO: PERCEPÇÕES DE BRASILEIROS EM UM ESTUDO QUANTITATIVO

RESUMO

Objetivo: Este estudo tem como objetivo explorar a relação entre os 17 Objetivos de Desenvolvimento Sustentável (ODS) e a eco-inovação, conforme percebida por uma amostra diversificada de 1.262 respondentes no Brasil.

Método: Utilizando uma abordagem quantitativa, conduzimos análises fatoriais confirmatórias e regressões lineares múltiplas para analisar os dados coletados.

Principais resultados: As descobertas demonstram uma influência significativa de todos os ODS na eco-inovação, com o Objetivo de Desenvolvimento Sustentável 17 (Parcerias para alcançar o objetivo) apresentando a correlação mais forte. A colaboração é fundamental para promover práticas sustentáveis.

Relevância/originalidade: A principal contribuição deste estudo reside na criação de um quadro de análise estatisticamente validado, aplicável em diferentes contextos regionais, nacionais e internacionais, servindo como base para pesquisas futuras.

Contribuições teóricas/metodológicas: Desenvolvemos uma escala abrangente fundamentada em princípios ambientais, sociais e econômicos para avaliar os 17 ODS. A ferramenta de medição validada aprimora a compreensão de como esses objetivos se cruzam com a eco-inovação.

Contribuições sociais/gerenciais: Nossa pesquisa possui implicações valiosas para gestores e profissionais envolvidos no desenvolvimento sustentável, promovendo a conscientização sobre a importância dos ODS e inspirando estratégias para a sustentabilidade. Além disso, informa a formulação de políticas socioambientais em níveis regional e nacional, alinhando-se à Agenda 2030.

Palavras-chave: Objetivos de desenvolvimento; Metas de desenvolvimento sustentável; Ecoinovação; Brasil.

1. Introduction

In the last decades, environmental problems have been impacting the environment, natural resources, and quality of life, as well as being discussed in several world forums. In 1987 the World Commission on Environment and Development drew up the Brundtland report, Our Common Future (BRUNDTLAND, 1987), which was a world landmark, in which it was stated that to be sustainable, the needs of present generations must be met, without compromise the ability of future generations to have their needs met.

For decades, the concept of sustainability has been recognized as the basis for survival and further development of humanity; as the result of joint efforts, the 2030 Agenda for Sustainable Development was adopted in 2015 by United Nations member states, as a plan and direction for future prosperity (MILICA; MILICA, 2020).

As of this report, environmental issues have become sources of strategic change, ecological factors have become part of innovation research and eco-innovation (EI) practices, such as cleaner production, life cycle analysis, eco-design, energy efficiency, with prominence in organizations (BENROMDHANE, 2015; KANDA et al., 2019; SEVERO; GUIMARÃES e DORION, 2022).

In this context, there was an increase in the discussion around sustainable development and the problems arising from this issue. To guide the discussions and actions, in 2015, the 17 Sustainable Development Goals (SDGs) were adopted, proposed in the 2030 Agenda, where governments and global companies use them as a new framework to guide the international work agenda. When putting sustainability at the center of these discussions (RIBEIRO; ESPUNY; HERMES, 2022), the necessary interconnection between environmental, social and economic aspects is emphasized (SCHLEICHER; SCHAASFSMA; VIRA 2018; MONTEIRO; DA SILVA; NETO 2019).

Observing the evolution of society towards greater environmental awareness, there is also a different behavior of organizations, seeking to adapt to this reality. In addition to producing products and services, companies are responsible for the environment in which they operate. This change in attitude is due to the need to minimize the effects of overexploiting resources and pollution. The technologies were being developed to make life easier for society, however over time, it has led to problems that threaten the very survival of the planet (ARORA, 2019).

In this scenario, the 17 SDGs proposed in the 2030 Agenda, still need studies to show their relevance, in the environmental, social, economical and for the quality of life of the planet. And due to the negative impacts that normally accompany innovations, Ratten (2018) and Colombo, Pansera and Owen (2019) emphasize that the definition of EI shows the reduction of problems, by emphasizing that the environmental and economic benefits will be perceived. Although EI has been practiced in companies for years, few studies have investigated EI decisions when there are relationships in the horizontal and vertical supply chain (LIN; WANG; YANG, 2020). Despite the growing interest in research in innovation, few studies explore the link between the development of new products and the sustainable performance of organizations (LIU et al., 2020).

In this context, to fill this gap, and to understand how society understands and analyzes the environmental context, the impacts of the actions of society and organizations, prevention actions, and the performance and efforts of governments, the question arises of research guiding this study: What is the relationship between Sustainable Development Goals (SDGs) and eco-innovation (EI)? To this end, the survey covered the perception of 1262 respondents in northeastern Brazil.

With regard to the northeastern region of Brazil, it is the region that has the longest coastline, covering 3338 km of beaches. The northeastern vegetation lists the Atlantic

Forest on the coast, the Mata dos Cocais in the Middle North, with ecosystems with emphasis on mangroves, caatinga, cerrado and resting. The economy is linked to several economic cycles, by agricultural and industrial activities and by tourism and trade, oil production, irrigated fruit culture, in addition to salt and shrimp.

In terms of innovations, the northeast of Brazil has seven technology parks, located in Alagoas (Parque Tecnológico de Alagoas); Bahia (Tecnovia); Ceará (Padetec); Paraíba (PaqTcPB); Pernambuco (Porto Digital and Parqtel) and Sergipe (SergipeTec), which have several companies incubated or installed, develop innovations and generate thousands of jobs and income for the northeastern regions. Of the regions, Recife is responsible for almost 95% of the plaster production for the whole country, as well as Porto Digital, being one of the main innovation environments in Brazil, having the mission of being one of the main pillars of the economy in the future of Pernambuco, as well as one of the anchors of sustainable development. In Porto Digital, the main strategic goal is to have, in 2020, 20000 people engaged in highly qualified professional activities, as well as greater added value in 400 innovative ventures (PORTO DIGITAL, 2020).

On the northern coast of Rio Grande do Norte (RN), the largest saline companies in the country are located, which produce 95% of the sea salt consumed and exported in the country, influencing local and regional economies, mainly through the generation of jobs and payment of taxes (ROCHA; CÂMARA, 1993; DNPM, 2015).

Given the above, the study aims to analyze the relationship between SDGs and IS, in the perception of 1262 respondents. In addition to this introduction, the article is structured in the following sections: i) literature review covering the themes of sustainable development (17 SDGs) and the possibility of these being related to eco-innovation; ii) research methods and techniques used; iii) results and discussions; and, iv) Conclusion.

2. Literature Review

2.1 Sustainable development

The term sustainable development came about after discussions about the responsible use of natural resources (BRUNDTLAND, 1987), which aims to meet the needs of generations, without compromising natural resources for future generations. In this context, recent policies and scientific research emphasize the importance of a holistic approach to the concept of sustainable development (SINAKOU et al., 2018).

In recent years, as a result of increasingly pronounced climate change, several studies are addressing the issue and emphasize the importance of sustainable development (MIKULČIĆ et al., 2019; BAI; OCHUODHO; YANG, 2019). In this scenario, sustainable development is impacted by industrial production (SHEN et al., 2019), human activities (MIKULČIĆ; DUIĆ; DEWIL, 2017), the degradation of natural resources, the productivity of soil resources, even in low-income countries. and high income, pollution has been increasing spending related to human health (LANDRIGAN et al., 2017; ARORA et al., 2018).

Coherently, due to climate change and the corresponding environmental and social changes, there is a great need for sustainable development for humanity (MIKULČIĆ et al., 2017). Environmental sustainability, then, is paramount for the balance of the environment, the quality of life of people, animals, that is, the entire terrestrial ecosystem (MAJAVA et al., 2016).

The sustainable development indicators published by Eurostat were divided into 10 thematic areas (SZOPIK-DEPCZYŃSKA et al., 2018), however, in March 2015, in addition to this division, the new indicator system was divided into 17 SDGs and 169 targets, according to the publication of the 2030 Agenda for sustainable development (HÁK; JANOUŠKOVÁ; MOLDAN, 2016; SZOPIK-DEPCZYŃSKA et al., 2018; MILICA; MILICA, 2020). According to Martín et al. (2020), in 2015 the United Nations (UN) established the 2030 Agenda for sustainable development with the aim of eradicating extreme poverty, reducing inequality, and protecting the planet. For Wang et al. (2020), most COP21 member countries have struggled to develop relevant policies to control carbon dioxide (CO_2) emissions since the Paris agreement in 2015.

In this context, it is recognized that developed and developing countries have several challenges in reaching the 17 SDGs in their three dimensions: social, economic, and environmental (UNITED NATIONS BRAZIL, 2015; SDG, 2019). These objectives and their respective goals and indicators seek to eliminate poverty and promote a dignified life. Eradicating poverty in all its forms and dimensions is an indispensable requirement for sustainable development (Fig. 1). According to Castor, Bacha and Nerini (2020), by definition, the 17 goals (SDGs) and their targets are "integrated and indivisible" and thus, action to implement the 2030 Agenda must consider their interlinked nature.

According to Schleicher, Schaasfsma and Vira (2018), the SDGs systematize a set of aspirations for the development of society, demonstrating what was universally accepted for countries. For the authors, each country will adapt to its needs and decide on the actions that will be necessary to reach these goals, but this freedom of adaptation can be considered challenging since it can make it difficult to reach goals that are more difficult to measure.

However, the 'non-sustainable' world reveals trade-offs between economy and biosphere SDGs, with a population growth of particular concern to a safe planetary operating space in the world's poorest regions; sustainable visions could reduce natural resource pressures and emissions and meet energy requirements at potentially limited economic cost (PHILIPPIDIS et al., 2020).

SDG 1	**Economic growth must be inclusive to provide sustainable jobs and promote equality**
SDG 2	The food and agriculture sector offers key solutions for development, and is central for hunger and poverty eradication.
SDG 3	Ensuring healthy lives and promoting the well-being for all at all ages is essential to sustainable development .
SDG 4	Obtaining a quality education is the foundation to improving people's lives and sustainable development.
SDG 5	Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world.
SDG 6	Clean, accessible water for all is an essential part of the world we want to live in.
SDG 7	Energy is central to nearly every major challenge and opportunity.
SDG 8	Sustainable economic growth will require societies to create the conditions that allow people to have quality Jobs.
SDG 9	Investments in infrastructure are crucial to achieving sustainable development.
SDG10	To reduce inequalities, policies should be universal in principle, paying attention to the needs of disadvantaged and marginalized populations
SDG 11	There needs to be a future in which cities provide opportunities for all, with access to basic services, energy, housing, transportation and more
SDG 12	Responsible Production and Consumption. Ensure standards of sustainable production and consumption.
SDG 13	Climate change is a global challenge that affects everyone, everywhere.
SDG 14	Careful management of this essential global resource is a key feature of a sustainable future.
SDG 15	Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss.
SDG 16	Access to justice for all, and building effective, accountable institutions at all levels.
SDG 17	Revitalize the global partnership for sustainable development.

Figure 1 - Sustainable Development Goals
Source: Adapted from Sustainable Development Goals (2019).

According to Monteiro et al. (2019), in the mining sector, there are several possibilities for reaching the 17 SDGs, such as promoting employment (SDG 8), contributing to the reduction of poverty (SDG 1) and hunger (SDG 2), among others. According to the authors, it was observed that the compliance with the SDGs related to the promotion of jobs, the improvement of the income of the community's residents, and the infrastructure of the environment is common to all mining activities or businesses that reach remote and poor areas. In the study by Sebestyén et al. (2019), the results show that SDGs are strongly interconnected, while SDG 5 (gender equality) is mainly linked to goal 17 (partnerships for the goals), as well as the importance of SDG 4 (education of quality).

2.2 Eco-innovation

Innovation aimed at sustainable development may seem like a simple act, but development and implementation are a complex, dynamic and uncertain process (SEYFANG; SMITH, 2007; SILVESTRE; ȚÎRCĂ, 2019; LIN; WANG; YANG, 2020). According to Cheng and Shiu (2012), Arranz et al. (2019) and Chen, Cheng and Dai

(2017), the innovation that aims at sustainability, is also known as eco-innovation (EI), in which several researches are happening, both in managerial and academic scope.

Eco-innovative business models are prominent elements of the development of sustainable production and consumption systems in organizations of all sizes, especially for small and medium enterprises, where a key challenge is to direct eco-innovation strategies toward the goals of their business model (BARBIERI; SANTOS, 2020). According to Alos-Simo, Verdu-Jover and Gomez-Gras (2020), the literature confirms that every industry is affected by sector-specific technology, which determines innovations in goods and services, although these technological differences remain ambiguous in the context of eco-innovation. Further, the relationship between eco-innovation (understood as management of clean production in the firm) and the different measures of performance is not completely clear.

According to Arranz et al. (2019), in the survey of 5461 Spanish companies, the complexity of the EI process negatively affects the decision to develop eco-innovations. For García-Granero, Piedra-Muñoz and Galdeano-Gómez (2020), EI is a complex process that involves product, process, organizational and marketing dimensions, each with its determinants, characteristics and contributions to the environmental performance of the business. Yang and Holgaard (2012) highlight that the peculiarities of EI indicate that politics and strategy formulation should take into account civil society groups, as they are useful not only to pressure the industry towards a green path, but also as business supporters green.

For He, Miao, Wong, and Lee (2018) the current literature on EI in the corporate environment is mainly focused on nine areas, including stakeholder influence, EI drivers, EI systems, eco-design, new product development, product-service systems, circular economy, environmental management systems, green supply chain management and performance and small-medium enterprises. According to Scarpellini et al. (2020), there is a positive relationship between the investment of resources and the financial performance of eco-innovative companies.

According to Kuo and Smith (2018), to achieve the goal of sustainability, EI has been proposed as an effective mechanism to help companies reduce negative impacts on the environment, however, with the advancement of technology, the scope of EI becomes bigger and more complex. Coherently, EI should be thoroughly analyzed for the context of each organization, as local policies, industrial activities, sectors of activity and geographic location directly impact the implementation and results of eco-innovation (HE et al., 2018; SEVERO; DE GUIMARÃES; DORION 2018; CAI; LI, 2018; MARÍN-VINUESA et al., 2020).

In this context, EI implementation is also positioned as a target for organizations to be more sustainable, to reduce negative externalities and reach ecological requirements and consumer demands (GARCÍA-GRANERO et al., 2018). Given the above, about the importance of the SDGs and EI for sustainable development, aiming to reduce poverty, transform lives and find ways to protect the planet, this study proposes to investigate the relationship between Sustainable Development Goals (SDGs) and Eco-innovation (EI).

3. Method

The methodology used was quantitative and descriptive research, through a Survey applied in Brazil, to analyze the importance of SDGs for EI. According to Hair Jr. et al., (2013), quantitative research is a structured model of data collection, submitted to a considerable number of respondents, with measurements that use numbers and represent the ownership of something. Descriptive research exposes characteristics of the investigated population, enabling correlations between variables, as well as serving as a basis for explaining phenomena. According to this, in quantitative research, the Survey method is the main method used in descriptive research, assuming hundreds or thousands of elements as a survey of the universe (HAIR Jr. et al., 2013).

In this context, regarding the investigated sample, it is characterized as non-probabilistic, for convenience (HAIR Jr. et al. 2013). The initial sample consisted of 1271 respondents. After cleaning the data, the final sample consisted of 1262 respondents, as 9 respondents were eliminated, which were considered univariate and multivariate outliers, since they had more than 10% of non-responses, or responses in a single alternative on the Likert scale of five points (HAIR Jr. et al., 2013). For this, data collection was carried out under the snowball aspect (LEE; SPRATLING, 2019), there is an effect of the Snowball sampling technique using social media, that is, through the researchers' contacts and social networks, where there was greater coverage in the northeastern Brazil states, from May to July 2019.

For data collection, a questionnaire with 60 questions was elaborated, where 5 questions were related to the profile questions of the respondents, such as: age, gender, education and family income, and 55 questions (Table 1) present statements through a 5-point Likert scale, ranging from totally disagree to totally agree, being: i) 1 = strongly disagree; ii) 2 = Partially disagree; iii) 3 = Neither disagree nor agree; iv) 4 = Partially agree; and, v) 5 = Strongly agree. It is worth mentioning that the final sample of 1262 respondents exceeded the minimum of 10 respondents per question, according to the premise of Hair Jr. et al. (2013), with an average of 22.9 respondents per observable variable.

The questions dealing with the profile of the respondents were developed by the researchers and adapted from the study by Severo et al. (2018), by characterizing the generations, the questions that address the 17 Sustainable Development Goals (SDGs) were adapted from the SDGs precepts advocated by the United Nations Brazil (2015), IPEA (2018) and SDGs (2019), and the questions that list the Eco-innovation (EI) adapted from the research by Chen et al. (2017), Severo et al. (2018), and Cai and Li (2018). It is noteworthy that before the application, the questionnaire was validated by two Researchers / Doctors who are experts in the thematic area studied. Accordingly, a pre-test was carried out with 25 respondents to understand the questions. Table 1 presents the constructs of SDGs and EI, the observable variables (questions), the factor load and the commonality.

Table 1 - Constructs and observable variables

Constructs (SDGs) and Observable Variables	Factorial load	Communality
No Poverty (SDG1)		
SDG1a- I realize that public policies (Municipal, State and Federal) will reduce the population's poverty by 50% by 2030.	0.899	0.808
SDG1b- I identify that there are national actions, social protection programs, and that by 2030 it will reach substantial coverage of the poor and vulnerable.	0.870	0.757
SDG1c- I believe that by 2030, there will be equal rights to access basic services, control over land and other forms of property, natural resources, financial services (microfinance).	0.848	0.719
Zero Hunger (SDG2)		
SDG2a- Based on government actions, I believe that by 2030, it will be possible to end hunger, as well as everyone's access to safe, nutritious and sufficient food throughout the year.	0.804	0,647
SDG2b- I believe that by 2030, there may be a doubling of agricultural productivity and income for small food producers, particularly women, indigenous peoples, family farmers, pastors and fishermen.	0.873	0.762
SDG2c- I understand that by 2030 there will be sustainable systems of food production and implementation of agricultural practices that increase productivity and preserve ecosystems.	0.800	0.639
Good Health and Well-being (SDG3)		
SDG3a- I believe that by 2030 we will have a reduction in the global maternal mortality rate.	0.855	0.730
SDG3b- I believe that by 2030, there will be a reduction in neonatal mortality and in children under 5 years of age.	0.909	0.827
SDG3c- I believe that by 2030, we will have universal access to sexual and reproductive health services, including family planning.	0.763	0.582
Quality Education (SDG4)		
SDG4a- I believe that by 2030, primary and secondary education will be equitable and of quality, leading to relevant and effective learning outcomes.	0.860	0.740
SDG4b- I believe that there will be improvements in physical education facilities, appropriate for children, sensitive to disabilities and gender, with safe and non-violent, inclusive and effective learning environments for all.	0.903	0.815
SDG4c- I believe that by 2030, there will be an increase in the number of qualified teachers, including through international cooperation for teacher training.	0.841	0.708
Gender Equality (SDG5)		
SDG5a- All forms of discrimination against women and girls will end.	0.919	0.845
SDG5b- I believe that all forms of violence against women and girls in the public and private spheres, including trafficking and sexual exploitation, will be eliminated.	0.900	0.810

SDG5c- There will be the full and effective participation of women, as well as equal opportunities for leadership at all levels of decision-making in political, economic and public life.	0816	0.667
Clean Water and Sanitation (SDG6)		
SDG6a- By 2030, universal and equitable access to safe and safe drinking water for all will be achieved.	0.905	0.819
SDG6b- Até 2030, teremos a melhoria da qualidade da água, redução da poluição, e aumento da reutilização da água.	0.810	0.656
SDG6c -By 2030, we will achieve access to adequate and equitable sanitation and hygiene for all, and ending open defecation.	0.899	0.808
Affordable and Clean Energy (SDG7)		
SDG7a- By 2030, we will have universal, reliable, modern and affordable energy services.	0.805	0.648
SDG7b- By 2030, we will have an increase and the share of renewable energies in the global energy matrix.	0.862	0.744
SDG7c- By 2030, we will have international reinforcement and cooperation to facilitate access to clean energy research and technologies, including renewable energy, energy efficiency.	0.892	0.796
Decent Work and Economic Growth (SDG8)		
SDG8a- By 2030, we will have the development and implementation of policies to promote sustainable tourism, which generates jobs and promotes local culture and products.	0.882	0.779
SDG8b- By 2030, we will achieve higher levels of productivity in economies through diversification, technological modernization and innovation.	0.862	0.742
SDG8c- By 2030, we will achieve decent work for all women and men, including young people and people with disabilities, as well as equal pay for work of equal value.	0.832	0.692
Industry, Innovation and Infrastructure (SDG9)		
SDG9a- Inclusive and sustainable industrialization will be promoted until 2030, increasing the participation of industry in the employment sector and in the Gross Domestic Product (GDP).	0.890	0.793
SDG9b- Until 2030, support for technological development, research and national innovation will take place, guaranteeing a favorable political environment for industrial diversification and adding value to commodities.	0.884	0.782
SDG9c- By 2030, there will be a strengthening of scientific research, improving the technological capacities of industrial sectors by 2030, encouraging innovation and increasing the number of workers in research and development (R&D).	0.884	0.782
Reduced Inequality (SDG10)		
SDG10a- By 2030, we will progressively reach the income growth of the 40% of the poorest population at a rate higher than the national average.	0.882	0.778
SDG10b- By 2030, there will be empowerment and promotion of social, economic and political inclusion, regardless of age, gender, disability, race, ethnicity, origin, religion, economic condition or other.	0.916	0.838
SDG10c- By 2030, we will have the implementation of safe migration policies for people.	0.897	0.804
Sustainable Cities and Communities (SDG11)		
SDG11a- By 2030, we will have everyone's access to safe, adequate and affordable housing, and to basic urbanization services in the slums.	0.898	0.807
SDG11b- By 2030, we will have access to safe, accessible, sustainable and affordable transportation systems for everyone, improving road safety through the expansion of public transport.	0.900	0.810
SDG11c- By 2030, we will reduce the negative environmental impact per capita of cities, including air quality and municipal waste management.	0.891	0.794
Responsible Consumption and Production (SDG12)		
SDG12a- By 2030, Brazil will achieve sustainable management and efficient use of natural resources.	0.886	0.785
SDG12b- By 2030, in Brazil we will reduce waste generation through prevention, reduction, recycling and reuse.	0.917	0,841
SDG12c- By 2030, in Brazil we will have relevant information and awareness for sustainable development and lifestyles in harmony with nature.	0.877	0.770
Climate Action (SDG13)		
SDG13a- World Meetings that address climate change issues, can bring solutions to the global environmental problem.	0.657	0.432
SDG13b- By 2030, we will have the integration of climate change measures into national policies, strategies and plans.	0.881	0.776

SDG13c- By 2030, we will have improvements in education, increasing human and institutional awareness and capacity on mitigation, impact reduction and climate change alert.	0.834	0.696
Life Below Water (SDG 14)		
SDG14a- By 2030, we will reduce marine pollution of all kinds, especially from land-based activities.	0.894	0.800
SDG14b- By 2030, small-scale artisanal fishermen will have access to marine resources and markets.	0.889	0.790
SDG14c- By 2030, we will have more coastal and marine areas preserved, in accordance with national and international legislation.	0.874	0.763
Life on Land (SDG15)		
SDG15a- By 2030, in Brazil, we will have positive results in combating desertification, land restoration and degraded soil, including land affected by desertification, droughts and floods.	0.899	0.809
SDG15b- We will reduce the degradation of natural habitats to stop biodiversity loss and, by 2030, protect and prevent the extinction of endangered species.	0.924	0.854
SDG15c- By 2030, we will have the conservation, recovery and sustainable use of terrestrial ecosystems, freshwater, forests, wetlands, mountains and arid lands.	0.877	0.769
Peace and Justice Strong Institutions (SDG16)		
SDG16a- I believe in Brazil there are actions by institutions (public and private) to reduce all forms of violence and mortality rates.	0.770	0.593
SDG16b- Until 2030, in Brazil we will have legal identity for everyone, including birth registration.	0.818	0.669
SDG16c- I believe that national institutions will be strengthened to prevent violence, combat terrorism and crime.	0.884	0.782
Partnerships to achieve the Goal (SDG17)		
SDG17a- I realize that by 2030, effective initiatives and measures for sustainable development will be implemented, which complement the gross national product (GNP).	0.884	0.782
SDG17b- I realize that there is a mobilization of domestic resources, including through international support to developing countries, to improve the national capacity to collect taxes and other revenues.	0.879	0.773
SDG17c- In Brazil, there is a tendency to increase policy coherence for sustainable development.	0.853	0.728
Eco-innovation (EI)		
EI1- In Brazil, public policies promote eco-innovation aimed at environmental sustainability.	0.812	0.659
EI2- Public and private institutions develop eco-innovation through environmental practices.	0.875	0.766
EI3- In Brazil, the Institutions work effectively to promote the development of eco-innovation, in order to reduce environmental impacts.	0.862	0.743
EI4- In Brazil, there is a concern with eco-innovation, as it contributes to achieving long-term sustainability results.	0.855	0.731

For data analysis, the descriptive statistics technique was first used (hair Jr. et al., 2013), which is used to transcribe data for a given sample using measures of central tendency and measures of dispersion.

Subsequently, multivariate data analysis was used, through confirmatory factor analysis (CFA) and multiple linear regression. Factor analysis aims to find factors in a group of explanatory variables for a given phenomenon, representing a class of processes used for summarizing data, originally contained in a group of variables, in a set of factors (HAIR Jr. et al., 2013). Multiple linear regression, on the other hand, uses measures that seek to explore the relationship between the variables studied (HAIR Jr. et al., 2013). Therefore, in the treatment of the research data, the SPSS® Version 21 software for Windows was used.

4. Results and Discussions

According to Severo et al. (2018), people's birth year, can classify their generation. Accordingly, the majority of respondents, 63.6% of the sample was composed of young people born from 1981, classified as generation Y, as well as 31.7% were born from 1965 to 1981, classified then as generation X, and 4.7% had been born before 1965, characterized as Baby Boomers.

As for education, most respondents (44.4%) have incomplete higher education, 18.2% have complete higher education, 13.5% have incomplete graduate education, 11.1% have secondary education, 9.5% have complete graduate education and 3.3% have education fundamental. Regarding family income, 32.6% of respondents have a family income of 2 to 4 minimum wages, 25.8% have a family income of up to 2 minimum wages, 24.6% of 4 to 10 minimum wages, while 11.6% have a family income of 10 to 20 minimum wages, and 5.4% a family income above 20 minimum wages.

4.1 Confirmatory factor analysis

Before the process of validating the observable variables, the Kaiser-Meyer-Olkin (KMO) tests were performed, of sample adequacy, the Bartlett's Sphericity Test, which indicate whether the variables are correlated, enabling the use of the technique factor analysis (HAIR Jr. et al., 2013). Table 2 highlights that the KMO has a value above 0.5 for all constructs, which indicates that factor analysis is an adequate technique for data analysis (HAIR Jr. et al., 2013). Coherently, Bartlett's Sphericity Test was significant ($p > 0.001$), indicating that there is a correlation between the variables, being adequate to the use of factor analysis.

In this scenario, a simple reliability analysis was also performed, by calculating Cronbach's Alpha, which presented values higher than the recommended (0.70), which statistically validates the observable variables (HAIR Jr. et al., 2013) however, only the SDG13 construct presented a value of 0.698, a value very close to the recommended one, however, the KMO and Bartlett's Sphericity tests were significant for the construct.

Table 2 - KMO tests, Bartlett's sphericity and Cronbach's alpha

SDGs	KMO	Bartlett's sphericity (Chi-square)	Cronbach's alpha
SDG1	0.715	299.741	0.843
SDG2	0.670	193.398	0.767
SDG3	0.638	257.948	0.796
SDG4	0.703	290.861	0.837
SDG5	0.698	350.677	0.853
SDG6	0.693	317.978	0.840
SDG7	0,689	257.941	0.814
SDG8	0.710	261.058	0.821
SDG9	0.738	333.499	0.863
SDG10	0.736	385.148	0.880
SDG11	0.743	368.109	0.879
SDG12	0.728	368.809	0.875
SDG13	0.596	165.540	0.698
SDG14	0.735	334.170	0.861
SDG15	0.729	398.605	0.883
SDG16	0.649	198.176	0.769
SDG17	0.724	292.187	0.843
EI	0.819	473.082	0.873

About the factorial loads (Table 1), all of them had values above the recommended, higher than 0.5 (HAIR Jr. et al., 2013), which attests to the observable variables elaborated for the constructs, as well as the Communality (Table 1) presented values greater than 0.5, showing a low correlation between the observable variables. Only the SDG13a variable showed a lower value than the recommended one (0.432), however, its factor load was satisfactory (0.657), and Hair Jr. et al. (2013) highlight that the exclusion of a variable must be at the discretion of the researcher, however, this variable has not been excluded, as it is important for understanding the construct of SDG13 (Action against global climate change).

It is noteworthy that the observable variable that presented the greatest factor load, that is, the one that most contributes to the construct, is that of SDG15 (Terrestrial Life) and is linked to SDG15b (0.924) “We will reduce the degradation of natural habitats, to stop the loss of biodiversity and, by 2030, protect and prevent the extinction of endangered species”. These results highlight that the respondents believe that there will be a reduction in the destruction of ecosystems, which contributes to the preservation of the environment and species, corroborating the study by Arora et al. (2018), which points out that the widespread interference of human activities has resulted in major problems, including environmental pollution, land degradation, global warming/climate change, scarcity of drinking water supplies and loss of biodiversity. These issues directly affected the quality and sustainability of ecosystems.

In this context, SDG5 (Gender equality) presented the second variable with the highest factor load (0.919), corresponding to SDG5a “All forms of discrimination against women and girls everywhere will be over”. Accordingly, it indicates that respondents are confident that discrimination against girls/women will not occur, a fact that is widely discussed in awareness campaigns and the media. These results confirm the research by Sebestyén et al. (2019), which presents the importance of gender equality in the business and social environment. However, in RN, aggression, and the proportion of women murdered has grown in recent years. According to data from the Institute of Applied Economic Research (IPEA, 2019), in Brazil in 2017, the average number of women murdered was 4.7, for each group of 100 thousand women. In the ranking of Brazilian states, the RN appears in 1st position (together with Acre), with a rate of 8.3, and the RN presented the greatest growth, in the number of women murdered, with a variation of 214.4% between 2007 and 2017.

The third observable variable that presented the highest factor load (0.917) is linked to SDG12 (Consumption and sustainable production), with SDG12b "By 2030, in Brazil, we will reduce the generation of waste through prevention, reduction, recycling and reuse". These results highlight that the respondents envisage a reduction in the generation of waste, as well as the use of recycling and reuse of packaging, which is in line with the statements by Mikulčić et al. (2017), because responsible and environmentally conscious management is a pillar of the concept of sustainable development.

Table 3 shows the total explained variance of the constructs, which were above 63%, with the construct SDG15 (Terrestrial life), which presented the highest value, representing 81.05% of the data variability. This result indicates that the observable variables (SDG15a, SDG15b, SDG15c) contribute significantly to the understanding of the construct. In this scenario, it can be said that the fight against desertification, the reduction of degradation of natural habitats, the recovery and sustainable use of terrestrial ecosystems contribute to a better quality of life, both animal, plant and human. Consistently, the sustainable use of natural resources, as well as the preservation of endangered species, are paramount for future generations.

Table 3 - Total variance explained

SDGs	Total variance explained
SDG1	76.15
SDG2	68.30
SDG3	71.30
SDG4	75.50
SDG5	77,39
SDG6	76.08
SDG7	72.95
SDG8	73.78
SDG9	78.56
SDG10	80.66
SDG11	80.35
SDG12	79.90
SDG13	63.44
SDG14	78.44
SDG15	81.05
SDG16	68.13
SDG17	76.07
EI	72.50

4.2 Multiple linear regression

To use multiple linear regression, initially, Pearson's Correlation matrix analysis was performed to verify Multicollinearity, which allows us to find out if some independent variables are highly correlated, which avoids Multicollinearity, and this occurs, when the correlations between the variables are above 0.8 (HAIR Jr. et al., 2013). Coherently, Pearson's Correlation showed low correlations between independent variables, with Multicollinearity not occurring between observable variables.

According to Hair Jr. et al. (2013), multiple linear regression is a statistical, descriptive, and inference analysis between a dependent variable (Y) as an effect of multiple independent variables (X) of cause. For the authors, the analysis indicates the cumulative effects of a group of independent variables (X1, X2, Xn) in a dependent variable (Y), in the same way, that it highlights the effects of independent or exploratory variables (Y = β1X1 + β2X2 + β3X3 + ... + β0). The research verified the relationship between the constructs SDG1, SDG2, ... SDG17 and the EI, resulting in 17 Models (Table 4). The Models had the averages of the EI Construct variables (EI1, EI2, EI3, and EI4) as a dependent variable (effect) and SDG1 ... SDG17 (SDG1a, SDG1b, and SDG1c ... SDG17a, SDG17b, and SDG17c) as variables independent (cause).

Table 4 - Multiple linear regression

	R	R square	R adjusted square	Standard error of estimate
Model 1	0.583[a]	0.340	0.331	0.76202
a. Predictors: (Constant), SDG1c, SDG1b, SDG1a				
b. Dependent variable: MedEI				
Model 2	0.621[a]	0.385	0.378	0.73521
a. Predictors: (Constant), SDG2c, SDG2a, SDG2b				
b. Dependent variable: MenEI				
Model 3	0.608[a]	0.369	0.361	0.74489
a. Predictors: (Constant), SDG3c, SDG3a, SDG3b				
b. Dependent variable: MedEI				
Model 4	0.674[a]	0.455	0.448	0.69256
a. Predictors: (Constant), SDG4c, SDG4a, SDG4b				
b. Dependent variable: MedEI				
Model 5	0.601[a]	0.361	0.353	0.74967
a. Predictors: (Constant), SDG5c, SDG5b, SDG5a				
b. Dependent variable: MedEI				
Model 6	0.672[a]	0.451	0.444	0.69477
a. Predictors: (Constant), SDG6c, SDG6b, SDG6a				
b. Dependent variable: MedEI				
Model 7	0.561[a]	0.315	0.306	0.77625
a. Predictors: (Constant), SDG7c, SDG7a, SDG7b				
b. Dependent variable: MedEI				
Model 8	0.627[a]	0.393	0.385	0.73062
a. Predictors: (Constant), SDG8c, SDG8b, SDG8a				
b. Dependent variable: MedEI				
Model 9	0.648[a]	0.420	0.413	0.71419
a. Predictors: (Constant), SDG9c, SDG9b, SDG9a				
b. Dependent variable: MedEI				
Model 10	0.655[a]	0.429	0.422	0.70852

a. Predictors: (Constant), SDG10c, SDG10a, SDG10b
b. Dependent variable: MedEI

Model 11	R	R square	R adjusted square	Standard error of estimate
	0.634[a]	0.402	0.394	0.72522

a. Predictors: (Constant), SDG11c, SDG11a, SDG11b
b. Dependent variable: MedEI

Model 12	R	R square	R adjusted square	Standard error of estimate
	0.735[a]	0.541	0.535	0.63561

a. Predictors: (Constant), SDG12c, SDG12a, SDG12b
b. Dependent variable: MedEI

Model 13	R	R square	R adjusted square	Standard error of estimate
	0.701[a]	0.491	0.485	0.66895

a. Predictors: (Constant), SDG13c, SDG13a, SDG13b
b. Dependent variable: MedEI

Model 14	R	R square	R adjusted square	Standard error of estimate
	0.760[a]	0.578	0.572	0.60936

a. Predictors: (Constant), SDG14c, SDG14b, SDG14a
b. Dependent variable: MedEI

Model 15	R	R square	R adjusted square	Standard error of estimate
	0.751[a]	0.565	0.559	0.61876

a. Predictors: (Constant), SDG15c, SDG15a, SDG15b
b. Dependent variable: MedEI

Model 16	R	R square	R adjusted square	Standard error of estimate
	0.670[a]	0.450	0.443	0.69579

a. Predictors: (Constant), SDG16c, SDG16a, SDG16b
b. Dependent variable: MedEI

Model 17	R	R square	R adjusted square	Standard error of estimate
	0.805[a]	0.649	0.644	0.55598

a. Predictors: (Constant), SDG17c, SDG17b, SDG17a
b. Dependent variable: MedEI

According to the parameters of Hair Jr. et al. (2013), regarding the degree of importance of R2: i) below 0.3 there is a low influence; ii) between 0.3 and 0.5 there is a moderate influence; iii) above 0.5 is considered a high influence. Coherently, the results of multiple linear regression have an explanation index higher than 31% (R^2) in all 17 Models analyzed (Fig. 2), that is, a moderate influence.

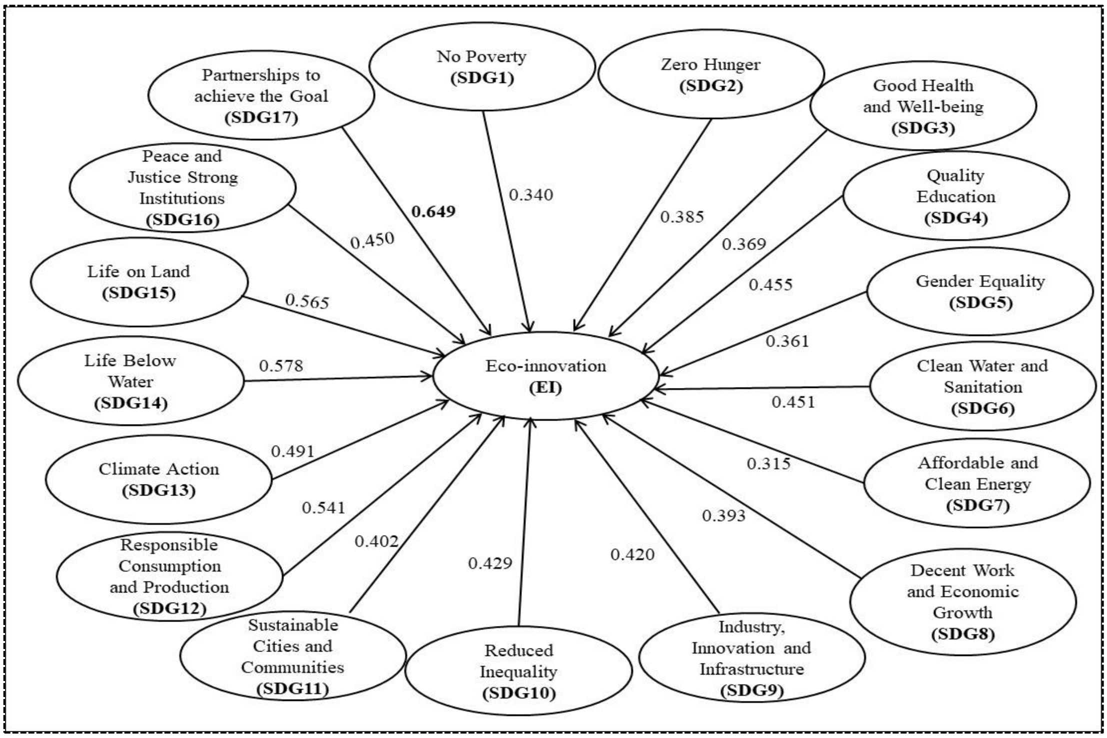

Figure 2 - Multiple linear regression results

In view of the above, the list of observable variables of the SDGs in the EI show significant intensities of influence, that is, the SDGs influence the EI. In this scenario, García-Granero et al. (2018) point out that understanding which indicators are best suited to measure the level of EI provides governments with the possibility of developing policies that encourage companies to be more sustainable, as well as implementing green practices more efficiently.

In this context, the highest relationship occurred between the SDG17 observable variables (Partnership and means of implementation) and the EI, with a high intensity in Model 17 (64.9%). In this sense, partnerships and adequate means of implementation are effective actions for sustainable development, as well as international support for developing countries. According to Colombo et al. (2019), while international organizations and institutions, such as the United Nations and the European Union, mobilized around the great challenge of sustainability, both on a local and global scale, EI as a key concept began to emerge and consolidated itself in policy documents and funding schemes.

Consequently, Model 14 has a high influence (57.8%), of SDG14 (Life in water) on the IS. These results indicate that respondents believe that there will be a reduction in marine pollution, as well as an increase in preserved coastal areas. Coherently, Model 15 also exhibits a good influence (56.5%), as the observable variables of SDG15 (Terrestrial life) significantly influence EI. Regarding terrestrial life, Arora et al. (2018) point out that human activities have caused the loss of habitats, resulting in the extinction of species, which in itself is of great concern. However, SDG7 (Clean and affordable energy) had the least influence (0.315), that is, Model 7 has a moderate influence on EI, where by 2030, we will have universal, reliable, modern and affordable access to energy services. energy, well strengthening and international cooperation to facilitate access to clean energy research and technologies, including renewable energies and energy efficiency.

5 Conclusions

The survey results highlight important relationships between the 17 Sustainable Development Goals (SDGs) and Eco-innovation (EI), in the perception of 1262 respondents. In view of the above, the list of observable variables of the 17 SDGs positively influence (significant intensities) EI. In this context, the relevant (highest) relationship occurred between the SDG17 observable variables (Partnership and means of implementation) and the EI, presenting a high intensity in Model 17 (R^2 = 64.9%). These findings corroborate the research by Colombo, Pansera and Owen (2019), since in recent years, the search for innovative paths towards sustainability has been brought to the forefront of scenarios on the international agenda.

According to Hák et al. (2016), the current format proposed for the SDGs, as well as their goals establish a global political framework. However, without a complete technical and scientific monitoring of its operation, the indicators can be ambiguous. In this sense, it is up to governments, companies, managers and civil society to act consciously, in order to implement the SDG17, as their goals are paramount for preserving the environment, improving the quality of the planet, since interconnected can bring synergies to environmental policies, plans and programs.

Another relevant fact is that most of the respondents, 63.6% of the sample is composed of young people of generation Y, being a generation that is strongly involved with information technologies and innovations, as well as having an education that already guided information on the issues of environmental problems, which have been growing since the industrial revolution. However, one must invest in educational policies of an environmental nature, as it will influence the environmental awareness of society, which will impact the quality of life of future generations.

With regard to the managerial and social contributions of the research, they allow managers and related professionals to become aware of the importance of SDGs, assisting them in strategies for sustainable development. In addition to information for socio-environmental actions of public policies of regional and national scope, to support cities and regions in the fulfillment of Agenda 2030.

Academic contributions are linked to the development of the scale to measure the 17 SDGs, based on environmental, social and economic precepts. Another important academic contribution of the research is the availability of an analysis Framework, which has been statistically validated (observable variables and constructs). Accordingly, the Framework proposed in the research can be replicated in different regional, national and international contexts.

Although the research data does not represent the totality of people in the northeast of Brazil, the study cannot be generalized. However, there are limitations related to data collection, based on the exclusive perception of individuals. Accordingly, the data were statistically validated using normality tests, simple reliability and tests of variance.

As suggestions for future studies, it is encouraged to analyze other regions of the country, being important longitudinal comparative analyzes with the inclusion of other environmental and social themes, such as smart cities, circular economy, eco-efficiency, cleaner production and renewable energies. In future research, it is also suggested to compare the regions, qualitatively and quantitatively, with the intention of identifying greater possibilities of aggregating actions that allow a better understanding of the SDGs.

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