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ANTECEDENT AND CONSEQUENTS OF ECO-INNOVATION FOR SUSTAINABILITY: GENERATIONS' PERCEPTIONS IN BRAZIL AND PORTUGAL

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ABSTRACT

Purpose – This study aims to analyze the perception of generations (Baby boomers, X and Y) about the influence of Holistic Helixes of Innovation on Eco-innovation, as well as Eco-innovation on Environmental Practices, Cleaner Production, Social Actions, Regional Development, Smart Cities and Sustainable Development.

Theoretical framework – Holistic Helixes of Innovation, Eco-innovation, Environmental Practices, Cleaner Production, Social Actions, Regional Development, Smart Cities and Sustainable Development.

Design/methodology/approach – The method used was a descriptive, quantitative research, applied to 1032 individuals residing in Brazil and Portugal, analyzed using Structural Equation Modeling.

Findings – Holistic Helixes of Innovation strongly influence Eco-innovation. This finding can contribute to the promotion of public policies to encourage integration among stakeholders of holistic innovation helices, such as universities, government, industries, technology parks, spin-offs, incubators, startup, consulting teams, non-governmental organizations, shareholders, suppliers, and customers. The study also shows the positive influence of eco-innovation on environmental practices, cleaner production, social actions, smart cities, sustainable development, with emphasis on regional development.

Research, Practical & Social implications – The Eco-innovation precepts are key to trigger positive influences on socio-environmental aspects, smart cities and regional and sustainable development. In this sense, organizations and governments can contribute to society, with greater efficiency, allocating resources in projects that develop socio-environmental innovations.

Originality/value – It is relevant for science to know the variables that can help governments and other organizations to develop policies and actions to promote the improvement of people's quality of life from a long-term triple bottom line perspective.

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ANTECEDENTE E CONSEQUENTES DA ECO-INOVAÇÃO PARA A SUSTENTABILIDADE: PERCEPÇÕES DAS GERAÇÕES NO BRASIL E EM PORTUGAL

Objetivo: Este estudo tem como objetivo analisar a percepção das gerações (*Baby boomers*, *X* e *Y*) sobre a influência das Hélices Holísticas de Inovação na Ecoinovação, bem como da Ecoinovação nas Práticas Ambientais, Produção Mais Limpa, Ações Sociais, Desenvolvimento Regional, Cidades Inteligentes e Desenvolvimento Sustentável.

Método: O método utilizado foi uma pesquisa descritiva, quantitativa, aplicada a 1.032 indivíduos residentes no Brasil e em Portugal, analisada por meio da Modelagem de Equações Estruturais.

Originalidade/Relevância: Holistic Helixes of Innovation, Eco-innovation, Environmental Practices, Cleaner Production, Social Actions, Regional Development, Smart Cities and Sustainable Development.

Resultados: As Hélices holísticas de inovação influenciam fortemente a ecoinovação. Essa constatação pode contribuir para a promoção de políticas públicas de incentivo à integração entre os *stakeholders* das hélices holísticas de inovação, como universidades, governo, indústrias, parques tecnológicos, *spin-offs*, incubadoras, *startup*, equipes de consultoria, organizações não governamentais, acionistas, fornecedores e clientes. O estudo também mostra a influência positiva da ecoinovação nas práticas ambientais, produção mais limpa, ações sociais, cidades inteligentes, desenvolvimento sustentável, com ênfase no desenvolvimento regional.

Contribuições teóricas/metodológicas: Os preceitos da ecoinovação são fundamentais para desencadear influências positivas nos aspectos socioambientais, nas cidades inteligentes e no desenvolvimento regional e sustentável. Nesse sentido, organizações e governos podem contribuir com a sociedade, com maior eficiência, alocando recursos em projetos que desenvolvam inovações socioambientais.

Contribuições sociais/para a gestão: Pode-se observar o efeito moderador dos países (Brasil e Portugal), destacando que a relação entre Ecoinovação e *Smart Cities* é elevada em ambos os países, mas há diferenças intensas na intensidade das relações.

Palavras-chave: Hélices holísticas de inovação. Ecoinovação. Desenvolvimento sustentável. Brasil. Portugal.

ANTECEDENTES Y CONSECUENCIAS DE LA ECOINNOVACIÓN PARA LA SOSTENIBILIDAD: PERCEPCIONES DE GENERACIONES EN BRASIL Y PORTUGAL

Objetivo: Este estudio tiene como objetivo analizar la percepción de generaciones (Baby boomers, X e Y) sobre la influencia de los Propulsores de la Innovación Holística en la Ecoinnovación, así como la Ecoinnovación en Prácticas Ambientales, Producción más Limpia, Acciones Sociales, Desarrollo Regional, Ciudades Inteligentes y Desarrollo Sostenible. **Método:** El método utilizado fue una investigación descriptiva, cuantitativa, aplicada a 1.032 personas residentes en Brasil y Portugal, analizada mediante Modelado de Ecuaciones Estructurales.

Originalidad/Relevancia: Hélice holística de innovación, ecoinnovación, prácticas ambientales, producción más limpia, acciones sociales, desarrollo regional, ciudades inteligentes y desarrollo sostenible.

Resultados: Las hélices de innovación holística influyen fuertemente en la ecoinnovación. Este hallazgo puede contribuir a la promoción de políticas públicas para fomentar la integración entre los actores de las hélices de la innovación holística, como universidades, gobierno, industrias, parques tecnológicos, spin-offs, incubadoras, startups, equipos de consultoría, organizaciones no gubernamentales, accionistas, proveedores. y clientes. El estudio también muestra la influencia positiva de la ecoinnovación en las prácticas ambientales, producción más limpia, acciones sociales, ciudades inteligentes, desarrollo sostenible, con énfasis en el desarrollo regional.

Contribuciones teóricas/metodológicas: Los preceptos de la ecoinnovación son fundamentales para desencadenar influencias positivas en los aspectos sociales y ambientales, en las ciudades inteligentes y en el desarrollo regional y sostenible. En este sentido, las organizaciones y los gobiernos pueden contribuir a la sociedad, con mayor eficiencia, destinando recursos a proyectos que desarrollen innovaciones sociales y ambientales.

Contribuciones sociales/gerenciales: Se puede observar el efecto moderador de países (Brasil y Portugal), notando que la relación entre Ecoinnovación y Smart Cities es alta en ambos países, pero existen intensas diferencias en la intensidad de la relaciones.

Palabras clave: Hélices de innovación holística. Ecoinnovación. Desenvolvimiento sustentable. Brasil. Portugal.

1. Introduction

Organizations of different sizes and segments, as well as society, have been negatively impacting the environment, which compromises the availability of natural resources for future generations. Environmental problems require new innovative solutions (Brem and Radziwon, 2017). However, in the development of innovation, it is necessary to incorporate environmental sustainability, to become an eco-innovation, that is, an innovation that aims at environmental sustainability.

Innovation is a source of competitive advantage for organizations, which is triggered by new products, processes, and services, and can be tied to environmental sustainability to minimize the impact on the environment. The global environmental crisis, including the lack of resources, environmental degradation, and pollution, has pushed countries all over the world to pay greater attention to sustainable development (Cai and Li, 2018).

In this context, the multiple helixes of innovation emerge, which encompass the scope of government, companies, universities, suppliers, and clients, who suffer from normative, coercive and social pressures that are important for environmental preservation and natural resources. However, literature on the collaboration of the multiple helixes of innovation related to eco-innovation still leaves a research gap, as according to Yang et al. (2012), placing environmental issues on innovation helixes will expand the number of actors involved, and according to Guerrero and Urbano (2017), point out that in emerging economies, the benefits of the helixes of innovation are still unpredictable, which requires studies to better understand the influence of these agents on innovations.

According to Vieira and Radonjič (2020), there is a general lack of direct reference to the term eco-innovation, since the sustainability reports of European companies (Dow Jones Sustainability Index) show that companies have released information on different types of eco-innovation, although they did not explicitly refer to them as eco-innovations. However, according to Barbieri and Santos (2020), eco-innovative businesses are prominent elements in the development of sustainable production and consumption systems in organizations of all sizes, especially for small and medium-sized companies, where one of the main challenges is to direct eco-innovation strategies for the purposes of your business model. Therefore, eco-innovation is classified as a methodology used in the industrial process, which aims to optimize materials and natural resources, aiming at the efficiency of the production process, the reduction of industrial waste, consequently the improvement of organizational performance and the decrease environmental impact (Severo et al., 2018; García-Granero et al., 2018).

Coherently, environmental practices and cleaner production methodology can be used to segregate waste generated correctly and reduce the consumption of natural resources. For Ikram et al. (2019), the adoption of an environmental management system can be an effective tool for organizations to address economic, social and environmental issues, in addition to being a viable means of developing business objectives and improving social responsibility activities (Ikram et al., 2019), as well as investments in reducing emissions and renewable energy consumption, simultaneously improve environmental sustainability practices (Ikram et al., 2020a). In this scenario, according to Ikram et al. (2020b), the environmental certification also contributes effectively to economic development in developed and developing countries. Therefore, organizations that make use of environmental practices will be contributing to the preservation of the environment and the quality of life of society.

Although researchers and practitioners focus their attention on the economic and environmental dimension of sustainability, less attention is paid to the social dimension of sustainability, particularly in developing countries (Kumar and Anbanandam, 2019). Social actions with a focus on innovation drive organizational change, stimulate holistic strategic management, approach to sustainability challenges (Roome, 2011).

According to Machado Jr. et al. (2018) and Guimarães et al. (2020), cities with a set of superior economic, social and environmental indicators have the potential to present better living conditions for their inhabitants. However, the knowledge and framework for data use for smart cities remain relatively unknown (Lim et al., 2018). Another important aspect is the view of consumers on the environmental practices of companies (Severo et al., 2018), as well as the perspective of environmental awareness of individuals, on the importance of preserving these resources and using sustainable environmental practices (Fraj and Martinez, 2007; Severo et al., 2019).

To research the perspectives of individuals in society, it was divided into three distinct groups, considering the respondents' year of birth as a criterion, for both groups were formed based on the studies of Strauss and Howe (1991) and Severo et al. (2018): i) Baby Boomers Generation those born before 1965; ii) Generation X those born between the years 1965 to 1981; and, iii) generation Y those born after 1981. The generations (Baby Boomers, Generation X, Generation Y) have different behaviors and characteristics (Akhras, 2015; Severo et al., 2018). It is noteworthy that in the studies by Strauss and Howe (1991), Zopiaris et al. (2012), Zahari and Esa (2016), Lissitsa and Kol (2016) and Severo et al. (2018; 2019) indicate that the Baby Boomers generation has more conservative and optimistic behaviors, while Generation X seeks professional stability, and at the other extreme Generation Y has a preference for challenges, has great ability to take risks, and is highly creative, innovative and individualistic.

In the light of the above, this study aims to analyze the perception of generations (Baby boomers, X and Y) about the influence of the Holistic Helixes of Innovation (HHI) on Eco-innovation (EI), as well as Eco-innovation about Environmental Practices (EP), Cleaner Production (CP), Social Actions (SA), Regional Development (RD), Smart Cities (SC) and Sustainable Development (SD). The analysis occurred through the perception of 587 Brazilians and 445 Portuguese, measured through multivariate data analysis with the application of Structural Equation Modeling (SEM).

2. Theoretical Background

2.1 Holistic helixes of innovation and eco-innovation

In what concerns innovative helixes, Etzkowitz and Leydesdorff (1995) highlight the triple helix, in which innovation occurs at the intersection of three institutional spaces, companies, government and educational institutions (Yoda and Kuwashima, 2020). If innovation is the engine of economies, the partnerships in the triple helix model of innovation are the fuel that makes this engine work (Mascarenhas et al., 2020). For Yu et al. (2020), innovation is an important engine for the progress of science and technology.

For Sato (2017), an in-depth investigation is needed of how successful cases of innovation were achieved only after an attractive environment was created, primarily through combined efforts of interaction between industry (business), university, and government. According to Yu et al. (2020), it is imperative to promote the sustainable development of science and technology service intermediaries, as well as external institutions that support innovation activities.

According to this triad, each strand relates to the other two, developing an overlap of communications, networks, and organizations (Dudin et al., 2015). However, for

Carayannis and Campbell (2009) there is a fourth helix, which combines from the perspective of an audience based on media and culture, resulting in an ecosystem of knowledge and emerging innovation, well configured for the knowledge economy and society. According to Carayannis et al. (2017), the fifth helix supports the formation of a win-win situation between ecology, knowledge, and innovation, creating synergies between economy, society, and democracy, which is the good basis for the sustainable development of the territories.

In this scenario, these interactions between the multiple helixes of innovation, in turn, are the key to fostering innovation and the economic development of countries and organizations (Etzkowitz and Leydesdorff, 2000; Razak and White, 2015; Li et al., 2018).

However, innovating with environmental sustainability into account may be the new frontier of organizational competitiveness (Severo et al., 2018). According to this, eco-innovation can improve a company's environmental performance and, through environmental performance, have a positive impact on its economic performance (Cai and Li, 2018; You et al., 2019; Geng et al., 2020). Bringing environmental concerns into focus of innovation processes will in several cases also expand the numbers of actors involved (Yang et al., 2012). The multiple helixes of innovation can foster eco-innovation (Carayannis and Campbell, 2010; Gouvea et al., 2013).

2.2 Eco-innovation, environmental practices and cleaner production

In recent years, the search for innovative pathways towards sustainability has been brought to the forefront of international agenda settings (Severo and Guimarães, 2015; Colombo et al., 2019). According to Kanda et al. (2018), García-Granero et al. (2018) and Lin et al. (2020), eco-innovation is an approach to environmental sustainability. For Chen et al. (2017), an eco-innovation has become a core engine for long-term stable economic development, as well as a fundamental way to ease the tension between economic growth and environmental resources management.

Eco-innovation is a complex process that involves product, process, organizational and marketing dimensions, each with its own determinants, characteristics and contributions to environmental business performance (García-Granero et al. 2020).

In this context, in recent years, the theme of environmental practices, through eco-innovation, has received increasing attention in academic research (Chen et al., 2017; Cai and Li, 2018; Hojnik et al., 2018; Hojnik and Ruzzier, 2016; Lin et al. 2020; Wang et al., 2020). According to Chen et al. (2017), in this new era of ecological civilization, eco-innovation has a high and distinctive value for contemporary organizations. Hojnik et al. (2018) emphasize that eco-innovation adoption is on the rise, both by businesses and by consumers. At the industrial level, the development of eco-innovation is a mechanism to achieve sustainability (López and Montalvo, 2015), reduction of carbon emissions (Wang et al., 2020), and for the consumer, eco-innovation is a way of expressing conscious consumption (Severo et al., 2018).

At the global level, eco-innovation aims to use environmental practices, as well as designing a new system integrating the dimensions of sustainable development, adding the environment, social issues, technology and stakeholders (Pialot and Millet, 2018). However, Dieste et al. (2020) highlight that the impact of environmental practices on the environment is not yet effectively clarified. However, small and large companies use different resource allocation patterns to benefit from the implementation of environmental management practices and environmental management systems (Wong et al., 2020), as well as ISO 14001 certification (Ikram et al., 2020b).

Environmental practices are therefore aimed at reducing the use of natural resources such as materials, energy, water and land, as well as reducing the release of harmful substances through the introduction of a new or improved product/service, process, (Cheng and Shiu, 2012), or market programs (Chen et al., 2017), as well as the use of cleaner production methodology in the industrial process (Zhang et al., 2014; Pinto et al. et al., 2018; Severo et al., 2018; De Guimarães et al., 2019; Dong et al., 2019).

The cleaner production is an environmental methodology, which was created by the United Nations Industrial Development Organization, which is a specialized agency of the United Nations, which promotes industrial development for poverty reduction through an inclusive globalization and environmental sustainability (De Guimarães et al., 2019).

The 2017 International Workshop on Advances in Cleaner Production held in São Paulo, Brazil, in 2017, promoted an assisted discussion workshop directed by Donald Huisingh. The workshop focused on the role of the Advances in Cleaner Production Network to meet the United Nations Sustainable Development Goals (Giannetti et al., 2018). Cleaner production is a lively concept in which new procedures and technologies constantly emerge introducing methods and practices to prevent damages to the environment (Giannetti et al., 2020).

For, according to Cong and Shi (2019), cleaner production is a key concept of industrial sustainable development as well as research hotspot; as well as the continuous application of an integrated environmental preventive strategy that stresses the importance of environment and human beings (Dong et al., 2019).

2.3 Eco-innovation and social actions

The eco-innovation associated with social actions is still a recent topic in the scientific literature. In general, social responsibility is related to social actions towards employees and society, as well as philanthropy, reputation and organizational image (Jamali et al., 2015, Voegtlin and Greenwood, 2016, Gold et al., 2018, López-González et al., 2019). According to Yuan et al. (2018), still, there is disquiet on how these companies go about undertaking community development initiatives spawning various forms of criticisms regarding negative side-effects of corporate social action.

In this context, eco-innovation implementation is positioned as a target for organizations to be more sustainable in order to reduce negative externalities and reach governments 'green requirements and consumers' demands (García-Granero et al., 2018). For Hojnik and Ruzzier (2016) regulations and market, attraction factors are the most critical drivers of Eco-innovation in companies.

According to Halkos and Skouloudis (2018), recent and drastic socioeconomic and political changes, inefficiencies in the public sector, limited resources due to macroeconomic instability (economic recession 2008/2009), makes companies more actively involved in the mitigation of environmental and social pressures, problems beyond the mere management of externalities, leading to a creation of value for the common benefit. For Kumar and Anbanandam (2019), a sustainable business organization needs to consider the importance of economic, environmental, and social sustainability.

Tamvada (2020) highlights that a vast literature focuses on the nature, role, and dynamics of corporate social responsibility, however recently, an emerging part of literature is examining the need to regulate corporate social responsibility. As new customers become more informed and responsible about the environment, companies need to act responsibly to attract responsible customers (Akbari et al. 2019).

According to Del Baldo (2019), the improvement of a socially responsible commitment, with corporate social responsibility practices and the creation of a public benefit, as well as improvements in accountability, transparency, and stakeholder engagement, optimize social actions. Social actions can act as a catalyst to deal with pressing social problems that, if properly managed, can be transformed into large-scale social opportunities (Rake and Grayson, 2009; Low and Siegel, 2019).

2.4 Eco-innovation, regional development and smart cities

Eco-innovation is an effective way to bring together new technologies, communication, and environmental sustainability. In this sense, Xavier et al. (2017) indicate that various business models have been proposed to help companies achieve a greater understanding of the dynamics of eco-innovation in order to facilitate the integration of sustainable processes by optimizing dynamic capabilities and capabilities. Therefore, for Bossle et al. (2016) it is important to include all actors in the process of transition to an economy that integrates ecological concepts into innovation and competitiveness strategies, which is the main function of the eco-innovation strategy.

Tamayo-Orbegozo et al. (2017) point out that eco-innovation attracts interest among companies, governments, and researchers as a means of achieving a higher degree of sustainable development. Therefore, eco-innovation contributes significantly to the development of the region in a sustainable way, since innovation can be directed towards sustainable development in order to preserve natural resources for future generations (Severo et al., 2018).

According to Beretta (2018), it is necessary to know whether projects with environmental objectives also produce socially beneficial results, with special reference to the issue of social inclusion. Also, according to the author, The European Union is institutionalizing eco-innovation and smart cities, aiming at improving the quality of life of citizens. In this sense, cities worldwide are attempting to transform themselves into smart cities (Lim et al., 2018).

In recent years, smart city has attracted increasing attention from both academia and industry due to a mix of urbanization, informatization, and globalization (Zheng et al., 2020). In this scenario, smart cities are projects in which a certain urban space uses information-aware communication and information technologies, urban management and social action driven by data, and Internet of Things (IoT) (Caragliu et al., 2011; Fei et al., 2016; Sharma et al., 2020), reference to the issue of social inclusion (Beretta, 2018). In this sense, smart cities present themselves as a viable solution to aggregate public resources, human capital, social capital and information, and communication technologies, to promote sustainable development (De Guimarães et al., 2020).

According to Beretta (2018), urban populations are increasing, as are the consumption of energy, transport and water, and the construction of buildings and public spaces. In this sense, smart cities represent the context in which eco-innovation is highly needed. For this, it is fundamental to find intelligent solutions, that is, highly efficient and sustainable, generating economic prosperity and social welfare.

In this scenario, the evaluation of balanced regional development should consider not only the economic and ecological benefits but also regional differences (Shu and Xiong, 2018). Para Chen et al. (2019), the degree of openness, urbanization, industrial structure, and technological innovation play an active role in promoting regional green sustainable development. It should be stressed that the sharing of common resources, with the objective of establishing urban and regional innovation ecosystems, requires sustainable partnerships and cooperation strategies among the different stakeholders, which aim at sustainable development. Such a development is able to meet the needs of today's generations without compromising the supply capacity of future generations.

2.5 Eco-innovation and sustainable development

Eco-innovation is based on a definition established by the European Commission (2018) and the assimilation, production, and exploitation of new services and processes whose main objective is to prevent or reduce the negative impacts of the use of different resources, and is based on this, that eco-innovation emerges as an alternative that integrates an existing gap between the market and research, since it is through the development of new products, processes, services and also new forms of management and business methods that are articulated that aim to protect the environment and meet environmental objectives, and drive economic growth.

To contribute to the discussion, Carrillo-Hermosilla et al. (2009) emphasize that the concept of eco-innovation considers the impacts of the industry on the environment, based on a need for more sustainable development, of which there is an interdependence between the environment and the economy. In this context, Aldieri et al. (2019) analyzed the impact of eco-innovation in contexts with differentiated economic structures and public policy mediations (USA, Japan, and Europe), and concluded that there is a relationship between the institutional framework, public policies and the effects of eco-innovation in fostering sustainable development. In this sense, the intermediaries (universities, incubators, organizations and public service) that supports the production of eco-innovations assumes roles guided by learning, aggregation, awareness, and interaction among themselves (Kanda et al., 2018).

According to Cancino et al. (2018) there is a need to manage technological innovations for sustainable growth from a systematic perspective. Tamayo-Orbegozo et al. (2017) points out that eco-innovation is an emerging issue among companies, universities and governments, as this is an efficient way to achieve a higher degree of sustainable development. Sustainable innovations can influence sustainable development by creating a new generation of sustainable products, services and technologies capable of stimulating the world economy and regional development (Gouvea et al., 2013; De Guimarães et al., 2018).

Thus, eco-innovation is a tool that demonstrates the evolution of the environmental behavior of organizations, aiming at reducing environmental impacts, improving environmental performance and providing sustainable development and becoming a competitive advantage alternative (Peiró-Signes and Segarra-Oña, 2018; Kiefer et al., 2018; Salim, 2019).

The United Nations 2030 Agenda for Sustainable Development is comprehensive, and its contributions aim at participation, partnerships, education, sustainable living and global citizenship (Shulla et al., 2020). Coherently, the United Nations (UN) presented 17 Sustainable Development Goals (SDGs), which can be used by different nations and companies. The research by Martins et al. (2020) points out that Brazil has been carrying out some relevant actions, both sporadic and planned, with significant opportunities for improvement, where the most cited contributions are those related to increased productivity and technological modernization, which contributes to the insertion of young people in the market improving resource efficiency and minimizing environmental degradation.

For Zhao et al. (2020), the efforts of curbing air pollution and improving air quality are especially valuable for sustainable development. In this scenario, sustainable development aims to meet the needs of current generations, without compromising the availability of natural resources for future generations, as well as the availability of energy and food (Severo et al., 2018).

In this context, Table 1 presents a summary of the concept used in the researched constructs, which also supported the research hypotheses, by comparing the researched studies, the gaps and contributions of this research.

Table 1
Constructs and definitions, gaps and contributions of this research

Construct	Definitions
Holistic Helixes of Innovation (HHI)	The Holistic Helixes of Innovation (HHI) is characterized by interactions between government, industry, business, public and civil society, the natural environment, the access to knowledge/technology, sources of funding and government subsidies, which can impact the performance of companies different sizes, knowledge management, the development of innovative projects, climate change and the scientific-educational community. Those theoretical assumptions are based on Etzkowitz and Leydesdorff (1995), Etzkowitz and Leydesdorff (2000), Carayannis and Campbell (2009), Razak and White (2015), Dudin et al. (2015), Sato (2017), Carayannis et al. (2017), Guerrero and Urbano (2017), Brem and Radziwon (2017) and Li et al. (2018), Mascarenhas et al. (2020), Yu et al. (2020), and Yoda and Kuwashima (2020).
Eco-innovation (EI)	The Eco-innovation (EI) is an innovation aimed at environmental sustainability, it is important for the development of production systems, sustainable consumption in organizations of all sizes, drives and environmental resources management, organizational performance, issues social, technology and stakeholders, as well as integrating ecological concepts in innovation and competitiveness strategies. Those theoretical assumptions are based on López and Montalvo (2015), Bossle et al. (2016), Chen et al. (2017), Severo et al. (2018), Pialot and Millet (2018), Kanda et al. (2018), García-Granero et al. (2018), Cai and Li (2018), Vieira and Radonjič (2020), Barbieri and Santos (2020), Wang et al. (2020), and García-Granero et al. (2020).
Environmental Practices (EP)	The Environmental Practices (EP) aim at the correct segregation and disposal of waste, reducing the use of natural resources and polluting emissions, such as materials, energy, water and land, the use of renewable energies, is an effective tool for organisations to address economic, social and environmental issues. Those theoretical assumptions are based on Cheng and Shiu (2012), Severo and Guimarães (2015), Ikram et al. (2019), Ikram et al. (2020a), Ikram et al. (2020b), and Wong et al. (2020).
Cleaner Production (CP)	CP is a methodology used in industrial processes, which seeks to optimize the use of materials and natural resources and to reduce industrial waste, prevents pollution, is a key concept of industrial sustainable development as well as research hotspot, an integrated environmental preventive strategy that stresses the importance of environment and human beings. Those theoretical assumptions are based on Zhang et al. (2014), Pinto et al. et al. (2018), Severo et al. (2018), Giannetti et al. (2018), De Guimarães et al. (2019), Dong et al. (2019), and Giannetti et al. (2020).
Social Actions (SA)	SA is related to social actions towards employees and society, promoted by a collaborative system by private and public companies, for profit, non-profit and civil organizations, institutions, BCs and among others, as well as philanthropy, reputation and organizational image. Those theoretical assumptions are based on Jamali et al. (2015), Voegtlin and Greenwood (2016), Gold et al. (2018), López-González et al. (2019), Del Baldo (2019), Low and Siegel (2019), and Tamvada (2020).
Regional Development (RD)	The degree of openness, urbanization, industrial structure and technological innovation play an active role in promoting regional sustainable development. Those theoretical assumptions are based on Liu and Huang (2018), Bossle et al. (2016), Shu and Xiong (2018), and Chen et al. (2019),
Smart Cities (SC)	Uses informational communication and information technologies, Internet of Things (IoT), urban management and social action guided by data, aiming to improve the quality of life of citizens. Those theoretical assumptions are based

	on Caragliu et al. (2011), Fei et al. (2016), Beretta (2018), Sharma et al. (2020), Zheng et al. (2020), and De Guimarães et al. (2020).
Sustainable Development (SD)	SD is the development that is concerned with natural resources, so that future generations have their needs met. They aim at participation, partnerships, education, insertion of young people in the labor market, sustainable living, clean air, resource efficiency, minimizing environmental degradation and promoting global citizenship. Those theoretical assumptions are based on Severo et al. (2018), Beretta (2018), Zhao et al. (2020), Martins et al. (2020), and Shulla et al. (2020).

3. Method

3.1 Research hypotheses

Based on the studies presented in the Theoretical background section, important concepts and dependency relationships between the constructs were identified: Holistic Helixes of Innovation, Eco-innovation, Environmental Practices, Cleaner Production, Social Actions, Regional Development, Smart Cities and Sustainable Development. Based on the literature consulted the Theoretical Model (Fig. 1) was developed, consisting of seven hypotheses, which expresses the Theoretical Framework of analysis of the data of the research, considering the relations of influences between the constructs. The research hypotheses are presented below:

H1: The Holistic Helixes of Innovation are positively related to Eco-innovation.
H2: Eco-innovation is positively related to Environmental Practices.
H3: Eco-innovation is positively related to Cleaner Production.
H4: Eco-innovation is positively related to Social Actions.
H5: Eco-innovation is positively related to Regional Development.
H6: Eco-innovation is positively related to Smart Cities.
H 7: Eco-innovation is positively related to Sustainable Development.

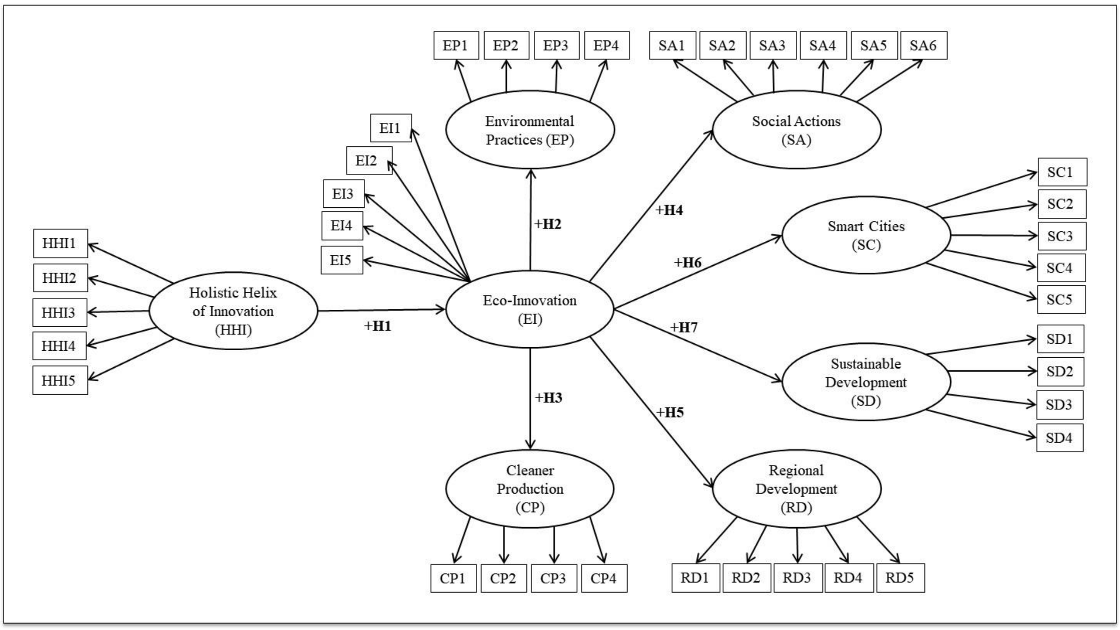

Fig. 1. Theoretical Model – Research Hypothesis Framework

As an addition to the research, the moderating effect of the Generations (Baby Boomers, Generation X, Generation Y) was evaluated on the constructs, assuming that there must be different perceptions of the respondents, depending on the Generation of each group, which should interfere in the means responses in each construct.

Another variable tested was the moderating effect of the country in which the respondent resides (Brazil or Portugal), considering that the two countries are in different stages of economic, environmental and social development, although these countries share the same language and that Brazil has been primarily colonized by Portugal.

3.1 Data collect and data analysis

The quantitative and descriptive research was carried out on individuals residing in Brazil and Portugal, through an applied survey collected with Snowball technique, in which initially the researchers sent the electronic questionnaire (Google Forms) to the contacts of social networks, as they replicated the research to other people, thus obtaining 1085 answers. Data collection was carried out from November 2019 to March 2020.

In order to characterize the respondents' profile, the following questions were asked: i) Respondent's age: respondents were classified based on the studies of Strauss and Howe (1991) about the different generations, dividing those born before 1965 as Baby boomers, a generation X born between 1965 and 1981, and generation Y born after 1981; ii) Gender: female, male or other; iii) Degree of Schooling; iv) Work and position in the company.

The questionnaire (Table 2) was developed based on the studies:

a) Holistic Helixes of Innovation (HHI): adapted from the studies of Etzkowitz and Leydesdorff (1995), Etzkowitz and Leydesdorff (2000), Gouvea et al. (2013), Grundel and Dahlström (2016), Guerrero and Urbano (2017), and Chen et al. (2018);
b) Eco-innovation (EI): based on the study by Severo et al. (2018);
c) Environmental Practices (EP): adapted from studies by Severo et al. (2018), García-Granero et al. (2018) and Pinto et al. (2018);
d) Social Actions (SA): adapted from the studies of Voegtlin and Greenwood (2016), Tamayo-Orbegozo et al. (2017), Loosemore et al. (2018), Halkos and Skouloudis (2018);
e) Regional Development (RD): adapted from the studies of Liu and Huang (2018) and Bossle et al. (2016);
f) Smart Cities (SC): adapted from Caragliu et al. (2011) and Fei et al. (2016), Beretta (2018), and Nilssen (2019);
g) Sustainable Development (SD): adapted from studies by Severo et al. (2018) and Beretta (2018).

The questionnaire consists of affirmations (Table 2) in which the respondent chose in a 5-Point Likert scale (from totally disagree to totally agree) the answer that best expresses the opinion on the subject questioned.

Table 2
Observable variables and constructs

Observable Variables
Holistic Helixes of Innovation (HHI)
HHI1) I believe that interactions between government, universities, technology parks, business incubators, spin-offs, startup companies, clients and suppliers characterize the Holistic Helixes of Innovation and promote Eco-innovation.
HHI2) I observe in the regional context the positive impacts caused by the Holistic Helixes of Innovation.
HHI3) I consider the Holistic Helixes of Innovation to be the key to the development of new environmentally correct products, processes, and services.
HHI4) I consider that the relationship of the Holistic Helixes of Innovation is a decisive factor for economic, social and environmental development.
HHI5) Government policies are fundamental for the interaction between the agents of the Holistic Helixes of Innovation.
Eco-Innovation (EI)

EI1) Eco-innovation fosters a new perspective on the relationship between innovation and the environment.
EI2) Eco-innovation provides value to the business/product/service.
EI3) Eco-innovation encourages the use of Environmental Practices in companies.
EI4) Eco-innovation leads to reduced environmental impact.
EI5) Eco-innovation contributes to achieving long-term sustainability results.
Environmental Practices (EP)
EP1) Environmental Practices reduce the use of natural resources, materials, energy, water, land and the release of harmful substances.
EP2) The implementation of Environmental Practices associated with Eco-innovation makes organizations more sustainable.
EP3) In my residence I carry out the separation of recyclable and electronic waste.
EP4) The use of Environmental Practices influences my environmental awareness.
Cleaner Production (CP)
CP1) I prefer to buy products or services from companies that seek to reduce the consumption of raw material, water and energy in their processes.
CP2) Whenever possible, I try to acquire products and services from companies that work on improvements in the production process that reduce the generation of waste.
CP3) I think it is very important for companies to use new practices that target CP.
CP4) I believe that the use of CP methodologies positively broadens the company's image vis-à-vis the stakeholders.
Social Actions (SA)
SA1) The Social Actions developed by companies help people who are in social vulnerability.
SA2) The Social Actions developed by companies influence the reduction of poverty and social inequality.
SA3) The Social Actions developed by companies stimulate the commitment to the future of children.
SA4) The Social Actions of companies stimulate care with health, safety and working conditions.
SA5) The Social Actions of companies go beyond employees and society, aim at philanthropy, reputation, and organizational image.
SA6) Regional/global social problems influence my actions of social responsibility.
Regional Development (RD)
RD1) The new business models (Cooperatives, Business Networks, Associations, Individual Micro-Entrepreneur, others) of companies promote Regional Development.
RD2) The economy that integrates ecological concepts into strategies of innovation and competitiveness promotes Regional Development.
RD3) The Regional Development caused new sources of income in the region.
RD4) Regional Development contributes to increased employment in the region.
RD5) I noted that Eco-innovation promotes Regional Development.
Smart Cities (SC)
SC1) The environmental actions of smart cities minimize environmental impacts.
SC2) I consider that smart cities use projects with data-driven communication and information technologies, with reference to the issue of social inclusion.
SC3) The social and environmental actions of smart cities improve people's quality of life.
SC4) I believe that smart cities using Eco-innovation contribute to sustainability, generating economic prosperity and social well-being.
SC5) Eco-innovation in smart cities develops skills for cities to be innovative, improving urban quality of life.
Sustainable Development (SD)
SD1) My consumption of food/products/services is conscious of Sustainable Development.
SD2) I use collective vehicles (bus, train, subway, bicycles, others) aiming at Sustainable Development.
SD3) I buy green products thinking about Sustainable Development.
SD4) I use the natural resources (water, earth, sun, winds, others) aiming at Sustainable Development.
Likert Scale: 1 Totally Disagree; 2 Partially Disagree; 3 don't agree, don't disagree; 4 Partly Agree; 5 Totally Agree

Data collection occurred by applying the questionnaire to residents in Brazil and Portugal, obtaining a non-probabilistic sample, collected for convenience, using the Snowball method, from the contacts of the researchers in the social networks (Facebook and LinkedIn). The collection of data through snowball sampling was based on the precepts of Snijders (1992), in which the researchers identified members of a specific population (participants from their social networks), who were asked to identify other members of the population, those so identified are asked to identify others, and so on. It is noteworthy that the researchers asked the respondents to share the online questionnaire (Google Forms) with their contacts on social networks, thus the data collection expanded rapidly among respondents from Brazil and Portugal.

Initially, a pre-test was done with 50 respondents, to evaluate the comprehension of the questions. Subsequently, the pretest responses were incorporated into the research sample. Data collection resulted in a total of 1085 forms answered. After data cleaning, there were 1032 valid cases, which is higher than recommended by Kline (2011) and Hair Jr. et al. (2014) that suggest for the use of SEM between 200 and 400 respondents and at least 10 responses for each variable, in which the final sample resulted in 27.2 respondents per observed variable.

The final sample consists of 1032 valid cases, distributed in: i) place of the respondent: 587 from Brazil; 445 from Portugal; ii) Generation: 13.4% Baby Boomers (Born before 1965); 28.5% Generation X (Born in the period from 1966 to 1994); 58.1% Generation Y (Born 1995); iii) Gender: 56.4% female; 43.6% male; iii) Education: 58.8% are studying or have a degree; 19.3% are studying or have a specialization (Post-graduation); 12.1% are studying or have a master's degree, doctorate or postdoctoral degree; iv) 87.8% of the respondents are working in: 29.8% auxiliary / technical / analyst, 13.8 managers, 19.0% teachers and 37.5% other professional activities.

In Fig. 2 the methodological procedures of the research are described, considering Data collect, Data Analysis and Hypothesis Testing. For the data analysis, the normality and reliability of the data were verified and later the Exploratory Factor Analysis (EFA) with Varimax Rotation, through the use of SPSS® (v.21) software.

The application of the Structural Equation Modeling (SEM) method used the precepts of Hair Jr. et al. (2014), was made with the assistance of AMOS® (v.21) software. To calculate the relationships between constructs, the SEM method based on covariance (CB-SEM) was used, since this method allows us to evaluate the effects of mediation and moderation, considering several groups and multi-group analysis.

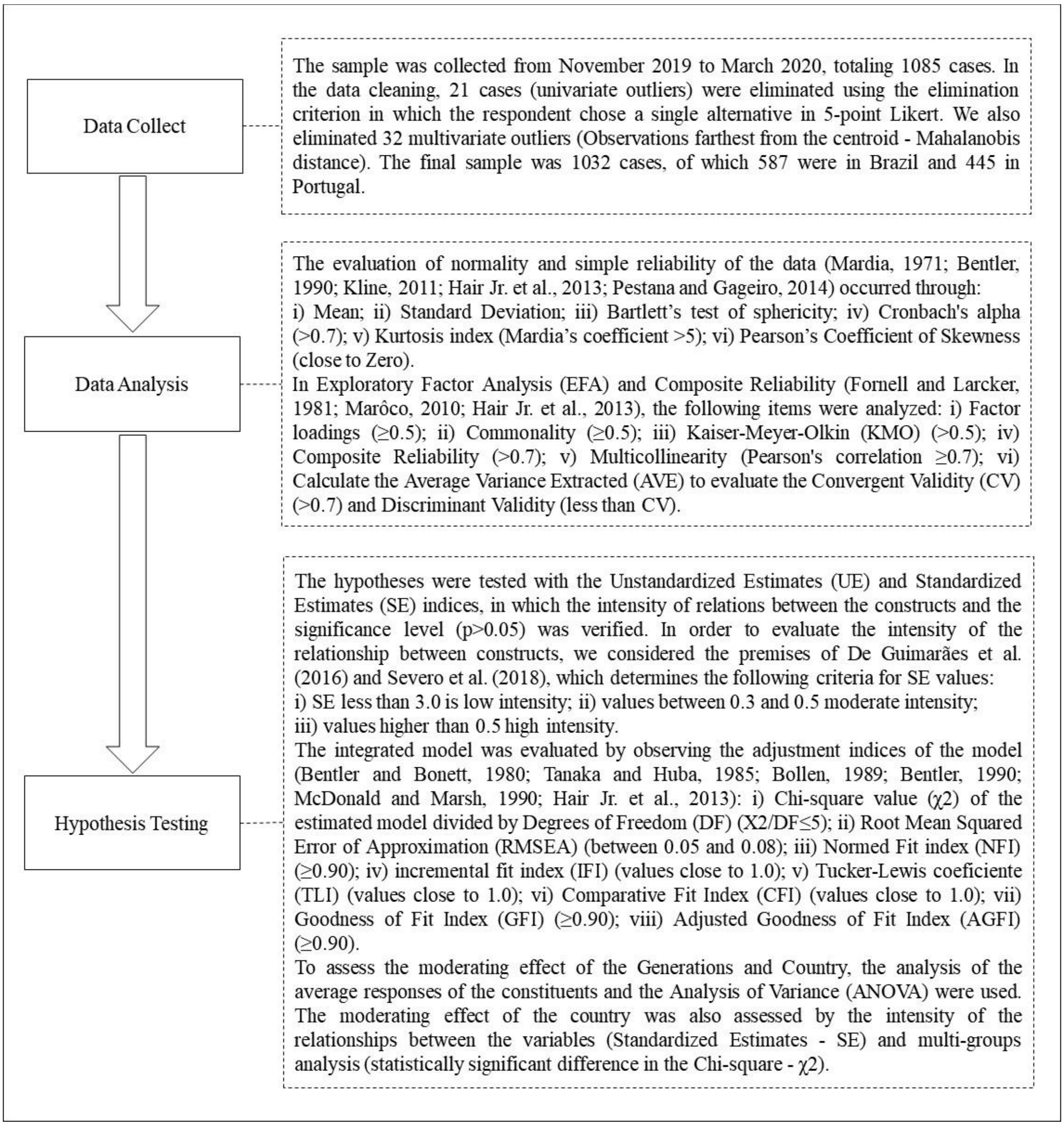

Fig. 2. Search method

4. Results and Discussion

After cleaning the data, Data Analysis and Hypothesis Testing procedures were performed (Fig. 1), which used multivariate data techniques, especially the evaluation of the measurement model (relationship between observable variables and construct formation) and the structural model (relationships between constructs).

The data collected through social networks influenced the high index of respondents of Generation Y (58.1%). Most of the respondents are enrolled in higher education (Undergraduate 58.8%) and 31.4% are studying or have postgraduate studies (master's, doctoral or postdoctoral). This profile of the respondents allows more assertive answers since the training contributes to the understanding of the affirmative (questionnaire) presented in the survey.

In the process of evaluating normality, the reliability of the data was measured by Bartlett's test of sphericity (Pestana and Gageiro, 2014), which presented significant values ($p<0.001$) in the constructs and in the set of all variables (Table 3) proving that the hypothesis of the data is not normal cannot be accepted, therefore, the data can have a normal distribution. This result was confirmed by the test of Kurtosis index (Mardia's coefficient <5) (Mardia, 1971; Bentler, 1990) and Pearson's Coefficient of Skewness (Kline, 2011; Hair Jr. et al., 2014).

Table 4 shows the Cronbach's alpha values, which were above the recommendations (>0.7) by Hair Jr. et al. (2014). The Mean and Standard Deviation values of the observable variables (Table 4) show that the respondents agree with the affirmative since the mean responses were higher than 3.2 and the mean standard deviation of the responses were close to 1. The greater discrepancy between the respondents to be observed in variable EP3, with a Standard Deviation of 1.4495 and average of 3.785, even though Standard Deviation can still be considered low.

The validation of scale, observable variables and constructs occurred with the application of Exploratory Factor Analysis (EFA) and Composite Reliability, following the precepts of Fornell and Larcker (1981), Marôco (2010) and Hair Jr. et al. (2014). In the calculation of the EFA (Table 4), the principal components analysis was used, using the Varimax Rotation, which grouped the variables observable in the 8 constructs (Holistic Helixes of Innovation - HHI, Eco-innovation - EI, Environmental Practices - EP, Cleaner Production - CP, Social Actions - SA, Regional Development - RD, Smart Cities - SC, Sustainable Development - SD) with cumulative 73.1% Variance of data from all observable variables. It is observed in Table 3 that the Variance Explained of each construct was superior to 62%, which is higher than recommended (> 60%) by Hair Jr. et al. (2014).

The values of Kaiser-Meyer-Olkin (KMO) (Table 3) are higher (>0.5), indicating the adequacy of the factorial analysis model, through the test of the general consistency of the data. Therefore, the research data present adequacy and feasibility for the application of EFA. Factorial loads and Commonality (Table 4) resulted in values higher than that recommended (≥0.5). These results indicate that the observable variables contribute to the formation of the construct and are highly correlated with each other.

Table 3
Tests of KMO, Bartlett's Sphericity and Variance Explained

	HHI	EI	EP	CP	SA	RD	SC	SD
KMO	0.729	0.811	0.714	0.798	0.821	0.822	0.875	0.682
Bartlett's Test of Sphericity	3640,2*	2175.1*	7870.9*	1934.5*	5909.6*	3048.5*	3503.9*	1548.9*
Variance Explained	67.9%	62.7%	85.0%	70.9%	74.2%	68.9%	74.5%	62.5%

* Level of significance (p<0.001)

The Composite Reliability of the set of all variables resulted in 0.991, as well as the Composite Reliability of the contours (Table 4) were higher than the recommended values (>0.7) by Hair Jr. et al. (2014). Composite Reliability evaluates the degree of consistency between multiple measures of a variable, so the observable variables and the constructs have measurement consistency, which makes possible the application of EFA and Structural Equation Modeling (SEM).

Pearson's correlation analysis identified high correlations (greater than 0.8) between SA1←→SA6 (0.841), SA2←→SA6 (0.815), SA3←→SA6 (0.850) and SA4←→SA6 (0.844) indicating Multilevel variable SA6, in this sense, Hair Jr. et al. (2014) claim that the Multicollinearity occurs when any single independent variable is highly correlated with a set of other independent variables. In this research, it was decided to maintain the SA6 variable because it presents different concepts of the other variables and contributes to the theoretical explanation of the SA construct.

The tests of normality, reliability (simple and composite), tests of variance and EFA validated the scale and the constructs. Therefore, the questionnaire was statistically validated through the framework developed by Etzkowitz and Leydesdorff (1995; 2000), Caragliu et al. (2011), Gouvea et al. (2013), Bossle et al. (2016), Grundel and Dahlström (2016), Fei et al. (2016), Voegtlin and Greenwood (2016), Guerrero and Urbano (2017), Tamayo-Orbegozo et al. (2017), Beretta (2018), Chen et al. (2018), García-Granero et al. (2018), Halkos and Skouloudis (2018), Liu and Huang (2018), Loosemore et al. (2018), Nilssen (2019), Pinto et al. (2018), and Severo et al. (2018). The results of the research, referring to the measurement model (observable variables), allow to affirm that the scale developed in this research presents feasibility to measure the composition of the constructs, in this sense, the questionnaire can be applied in other contexts.

Table 4
Exploratory factor analysis (Varimax Rotation) and data reliability

	Factorial Loads	Communality	Mean	Standard Deviation	Cronbach's Alpha	Composite Reliability
Holistic Helixes of Innovation (HHI)						
HHI1	0.718	0.652	3.901	0.9069		
HHI2	0.710	0.661	3.343	0.9429		
HHI3	0.759	0.738	4.023	0.7776	0.871	0.930
HHI4	0.682	0.704	3.965	0.8279		
HHI5	0.888	0.928	3.953	0.7460		
Eco-Innovation (EI)						
EI1	0.673	0.627	4.244	0.9082		
EI2	0.638	0.592	4.128	0.8603		
EI3	0.592	0.565	4.134	0.8762	0.848	0.907
EI4	0.750	0.721	4.250	0.7714		
EI5	0.681	0.670	4.244	0.7845		
Environmental Practices (EP)						
EP1	0.967	0.982	4.157	0.9792		
EP2	0.965	0.977	4.145	0.9751	0.923	0.974
EP3	0.926	0.864	3.785	1.4495		
EP4	0.690	0.655	4.209	0.9169		
Cleaner Production (CP)						
CP1	0.774	0.711	3.963	0.8701		
CP2	0.776	0.696	4.084	0.8131	0.861	0.918
CP3	0.812	0.739	4.281	0.7657		
CP4	0.763	0.719	4.216	0.7216		
Social Actions (SA)						
SA1	0.783	0.774	3.634	1.0118		
SA2	0.824	0.755	3.250	1.1009		
SA3	0.799	0.771	3.634	1.0678	0.926	0.961
SA4	0.846	0.782	3.715	1.0150		
SA5	0.656	0.512	3.767	1.0311		
SA6	0.921	0.955	3.581	0.9276		
Regional Development (RD)						
RD1	0.592	0.627	4.064	0.8156		
RD2	0.636	0.664	3.977	0.8354		
RD3	0.708	0.785	3.971	0.8592	0.887	0.931
RD4	0.663	0.730	4.151	0.8899		
RD5	0.572	0.704	3.831	0.8361		
Smart Cities (SC)						
SC1	0.780	0.761	4.081	0.9054		
SC2	0.680	0.730	3.767	0.9176	0.913	0.951
SC3	0.742	0.809	3.977	0.8828		

SC4	0.770	0.790	4.047	0.8482		
SC5	0.741	0.724	4.041	0.8242		
Sustainable Development (SD)						
SD1	0.577	0.595	3.651	0.9050	0.785	0.875
SD2	0.871	0.838	3.598	0.7730		
SD3	0.778	0.691	3.494	0.9619		
SD4	0.722	0.597	3.710	0.8909		

The high values of the Factorial Loads, Communality and AVE indicate that the constructs are consistent in their measurements and that there is an intense internal correlation between the observable variables in the construct formation. This expresses the importance of the elements that make up each construct, for example, to evaluate EI is fundamental you approach the issues that involve the guidelines for sustainable business, among which are: relation between innovation and environment; to add value to the business/product/service; encouraging the use of environmental practices; reduction of environmental impact; and, achieving long-term sustainability results.

The Average Variance Extracted (AVE) was used to evaluate the Discriminant Validity (DV) based on Corrected Correlations of the Confirmatory Factor Analysis model, obtained by calculation in the AMOS® software, which uses the Covariance-Based SEM (CB-SEM). For Forell and Larcker (1981) and Severo et al. (2018), the AVE is used to evaluate the explanatory power of the observable variables (indicator) on the construct, measuring how much of the total variance of each indicator is being used to compose the construct evaluation.

To evaluate the AVE, the Fornell-Larcker criterion (Fornell and Larcker, 1981; Henseler et al., 2014) was used, which expects that the values of the Convergent Validity (CV) should be higher than the quadratic correlation with any other latent variable (construct), represented by the DV values. It is observed in the calculation of AVE (Table 5) that all the constructs present higher CV than DV.

Table 5
Average Variance Extracted (AVE)

Constructs	**HHI**	**EI**	**EP**	**CP**	**SA**	**RD**	**SC**	**SD**
Holistic Helixes of Innovation (HHI)	0.732^{a}							
Eco-innovation (EI)	0.514^{b}	0.663^{a}						
Environmental Practices (EP)	0.107^{b}	0.310^{b}	0.903^{a}					
Cleaner Production (CP)	0.299^{b}	0.614^{b}	0.264^{b}	0.737^{a}				
Social Actions (SA)	0.180^{b}	0.412^{b}	0.213^{b}	0.231^{b}	0.808^{a}			
Regional Development (RD)	0.420^{b}	0.604^{b}	0.350^{b}	0.445^{b}	0.575^{b}	0.732^{a}		
Smart Cities (SC)	0.395^{b}	0.641^{b}	0.133^{b}	0.468^{b}	0.469^{b}	0.724^{b}	0.795^{a}	
Sustainable Development (SD)	0.072^{b}	0.293^{b}	0.159^{b}	0.455^{b}	0.267^{b}	0.329^{b}	0.325^{b}	0.651^{a}

^{a} Average Variance Extracted (AVE) – Convergent Validity (CV)
^{b} Discriminant Validity (DV)

In the measurement of the AVE (Table 5), it was identified that there is a high correlation (CV=0.724) among the SC←→RD, indicating that the greater the use of the SC precepts, the greater the RD perception. This finding of the research corroborates with the studies of Beretta (2018), Caragliu et al. (2011), and Fei et al. (2016), which show that the SC's objective is to improve citizens' quality of life and socio-environmental development.

Fig. 3 presents the measurement model and the structural model, with SEM results. From the application of the SEM, to evaluate the influence relationships between the constructs, the hypothesis tests were carried out, which resulted in the values of Unstandardized Estimates (UE) and Standardized Estimates (SE) expressed in Table 6. The results of UE and SE were statistically significant (p<0.001). Based on the assumptions of De Guimarães et al. (2016) and Severo et al. (2018), the SE values of the relationships between EI→EP (H2) and EI→SD (H7) are of moderate intensity. The relationships between HHI→EI (H1), EI→CP (H3), EI→SA (H4), EI→RD (H5) and EI→SC (H6) are considered high intensity. The survey results indicate that the hypotheses were supported.

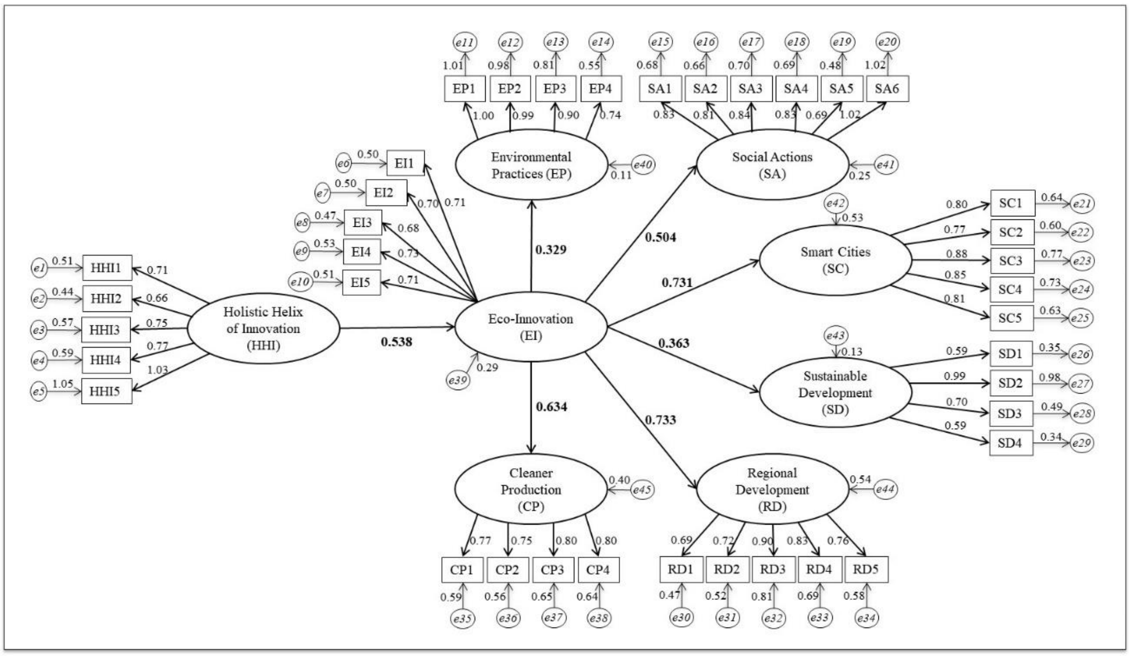

Fig. 2. Integrated Model – Standardized Regression Weights

Table 6
Hypothesis Testing

	Constructs			Standardized Estimate (SE)	Unstandardized Estimate (UE)	p
H1	Holistic Helixes of Innovation (HHI)	→	Eco-innovation (EI)	0.538	0.453	***
H2	Eco-innovation (EI)	→	Environmental Practices (EP)	0.329	0.503	***
H3	Eco-innovation (EI)	→	Cleaner Production (CP)	0.634	0.571	***
H4	Eco-innovation (EI)	→	Social Actions (SA)	0.504	0.655	***
H5	Eco-innovation (EI)	→	Regional Development (RD)	0.733	0.727	***
H6	Eco-innovation (EI)	→	Smart Cities (SC)	0.731	0.824	***
H7	Eco-innovation (EI)	→	Sustainable Development (SD)	0.363	0.222	***

*** Significance level p<0.001

The hypothesis tests found important and significant relationships between the constructs studied. The research has shown that the Holistic Helixes of Innovation are important antecedents and directly influence Eco-innovation (H1: HHI→EI), with a high intensity (SE = 0.538), which corroborates with the studies of Lee and Kim (2016), which states that active interactions in the research and development (R&D) networks of the institutional players of innovation helixes, such as university-industry-government, can improve the innovative capacities of countries. This finding also supports Liu and Huang (2018), argument that universities have a key role to play in the relations of innovation helixes, as they form citizens who will manage organizations.

The theoretical model (Fig. 2) presents as a mediator of the Eco-innovation (EI) relations, proposing that this construct directly influences the constructs Environmental Practices (EP), Cleaner Production (CP), Social Actions (SA), Regional Development RD), Smart Cities (SC) and Sustainable Development (SD), represented by the hypotheses H2 (EI→EP), H3 (EI→CP), H4 (EI→SA), H5 (EI→RD), H6 (EI→SC) and H7 (EI→SD). All hypotheses were supported, with moderate and high intensities of the relationships (Table 5). Among the results, we highlight the high intensity of the EI→RD (SE=0.733) ratio, which, based on citizens' perception, indicates that sustainable innovation can positively influence the development of the region, since according to studies by Xavier et al. (2017) and Bossle et al. (2016) sustainable innovation stimulates a new business environment that integrates economic and environmental gains, through new processes and competitive business strategies.

Another important aspect of the research results is evidence that EI fundamentals can positively influence the use of Smart Cities precepts. The research confirms that the respondents recognize the EI→SC relation with a high intensity (SE=0.731), which contributes with the studies of Caragliu et al. (2011), Fei et al. (2016) and Beretta (2018) on the need to use technological innovations, as well as new communication and information systems, to develop strategies to attend to the increase of urban populations, which causes increased consumption of energy, transport, water, new buildings and public spaces.

In order to evaluate the quality of the integrated model, the adjustment indices of the model (Table 7) were evaluated based on Bentler and Bonett (1980), Bollen (1989), Bentler (1990), McDonald and Marsh (1990), and Hair Jr. et al. (2014). The results of the calculation of all observable variables, in which the values of AVE, Composite Reliability, and KMO are considered satisfactory, however the specific indexes of adjustment of the structural model (□2/DF, RMSEA, NFI, IFI, TLI, CFI, GFI, AGFI) expressed in Table 7, have low values. These results do not invalidate the hypothesis of the research, it only indicates that the model can be improved, with the inclusion or exclusion of observable variables, as well as with the possibility of inserting in the structural model the possible correlations between the observable variables and between the constructs.

Table 7
Model adjustment indexes

AVE*	Composite Reliability*	KMO*	□2/DF	RMSEA	NFI	IFI	TLI	CFI	GFI	AGFI
0.756	0.991	0.870	10.1	0.067	0.751	0.770	0.754	0.769	0.687	0.648

* Significance level p<0.001

To assess the moderating effect of the Generations (Baby Boomers, Generation X, Generation Y), we used the analysis of the mean responses in the construct and analysis of variance (ANOVA). Table 8 shows the results of the averages of the respondents for each construct, showing that there is no difference between the Generations in the construct Holistic Helixes of Innovation (HHI), therefore the Generations perceive positive results from government actions and private organizations, however the general mean (3.837) can be considered important, as it is located in the middle third of the 5-point Likert.

The results expressed in Table 8 (ANOVA) demonstrate that there are differences between the average responses of the Generations, in the constructs EI, EP, CP, SA, RD, SC and SD ($p<0.05$), therefore these results partially confirm the moderating effect of Generations on the constructs, since the HHI construct did not present significant differences ($p<0.919$).

It is noteworthy that the results indicate that the Baby Boomers generation has higher averages in the constructs EP (4.522) and SD (3.714); It was identified that Generation Y has the highest means in the constructs EI (4.258), CP (4.238), AS (3.783), RD (4.092) and SC (4.104).

Table 8
Moderating effect of the generation – Mean and ANOVA

Constructs	Generation	Respondents N	Mean	ANOVA Sig.*
Mean Holistic Helixes of Innovation (HHI)	Baby Boomers	138	3.852	0.919
	Mean Generation X	294	3.845	
	Mean Generation Y	600	3.830	
	General Mean	1032	3.837	
Eco-innovation (EI)	Baby Boomers	138	4.148	0.003
	Mean Generation X	294	4.106	
	Mean Generation Y	600	4.258	
	General Mean	1032	4.200	
Environmental Practices (EP)	Baby Boomers	138	4.522	0.000
	Mean Generation X	294	4.255	
	Mean Generation Y	600	3.883	
	General Mean	1032	4.074	
Cleaner Production (CP)	Baby Boomers	138	4.103	0.00
	Mean Generation X	294	3.943	
	Mean Generation Y	600	4.238	
	General Mean	1032	4.136	
Social Actions (SA)	Baby Boomers	138	3.580	0.000
	Mean Generation X	294	3.224	
	Mean Generation Y	600	3.783	
	General Mean	1032	3.597	
Regional Development (RD)	Baby Boomers	138	3.930	0.000
	Mean Generation X	294	3.841	
	Mean Generation Y	600	4.092	
	General Mean	1032	3.999	
Smart Cities (SC)	Baby Boomers	138	3.730	0.00
	Mean Generation X	294	3.853	
	Mean Generation Y	600	4.104	
	General Mean	1032	3.983	
Sustainable Development (SD)	Baby Boomers	138	3.714	0.028
	Mean Generation X	294	3.534	
	Mean Generation Y	600	3.629	
	General Mean	1032	3.613	

* Significance level $p<0.05$.

As an addition to the research, it was verified the possibility of a difference between the averages of the respondents in Brazil and in Portugal (Table 9). With the application of analysis of variance (ANOVA), we identified a significant difference in the constructs EI, EP, CP, SA, RD, SC and SD ($p<0.05$), but in the HHI construct there were no significant differences ($p<0.488$) between countries.

Table 9
Moderating effect of the country – Mean and ANOVA

Constructs	Generation	Respondents N	Mean	ANOVA Sig.*
Mean Holistic Helixes of Innovation (HHI)	Brazil	587	3.850	0.488
	Portugal	445	3.820	
	General Mean	1032	3.837	
Eco-innovation (EI)	Brazil	587	4.235	0.049
	Portugal	445	4.153	
	General Mean	1032	4.200	
Environmental Practices (EP)	Brazil	587	3.879	0.000
	Portugal	445	4.331	
	General Mean	1032	4.074	
Cleaner Production (CP)	Brazil	587	3.748	0.000
	Portugal	445	3.398	
	General Mean	1032	3.597	
Social Actions (SA)	Brazil	587	4.062	0.000
	Portugal	445	3.915	
	General Mean	1032	3.999	
Regional Development (RD)	Brazil	587	4.142	0.001
	Portugal	445	3.773	
	General Mean	1032	3.983	
Smart Cities (SC)	Brazil	587	3.667	0.00
	Portugal	445	3.543	
	General Mean	1032	3.613	
Sustainable Development (SD)	Brazil	587	4.221	0.004
	Portugal	445	4.024	
	General Mean	1032	4.136	

* Significance level $p<0.05$.

In order to evaluate the possible moderating effect of the country (Brazil, Portugal) on the intensity of relations between the variables, the multi-groups analysis was performed (Byrne, 2010), measuring the SE index of the two groups and verifying if a statistically significant difference in the Chi-square (□2). In Table 10 it can be observed that there is a significant difference in the relationships between the constructs standing out in the relation between EI→EP Portugal (SE=0.237) presents a low intensity, in the same way the respondents of Brazil (SE=0.279) present a low intensity in the EI→SD relationship, however, the results of these relations are important and the hypotheses in the two countries were confirmed.

Table 10
Moderating effect of the country – multi-groups analysis

	Constructs			Brazil SE[a]	Portugal SE[a]	Chi-square (□2) difference p
H1	Holistic Helixes of Innovation (HHI)	→	Eco-innovation (EI)	0.500	0.612	***
H2	Eco-innovation (EI)	→	Environmental Practices (EP)	0.445	0.237	***
H3	Eco-innovation (EI)	→	Cleaner Production (CP)	0.493	0.707	***
H4	Eco-innovation (EI)	→	Social Actions (SA)	0.598	0.386	***
H5	Eco-innovation (EI)	→	Regional Development (RD)	0.852	0.560	***
H6	Eco-innovation (EI)	→	Smart Cities (SC)	0.766	0.714	***

H7	Eco-innovation (EI)	→	Sustainable Development (SD)	0.279	0.354	***

[a] Standardized Estimate (SE)
*** Significance level p<0.001

5. Conclusion

The main contribution of the research is to evidence that Holistic Helixes of Innovation (HHI) are predictors of the process of sustainable innovation, which is expressed in this research in the Eco-innovation (EI) construct. In this study, the important influence of HHI on IE in Brazil and Portugal was identified, demonstrating that this is not a phenomenon of local perception, but something that is perceived in different contexts. This finding can contribute to the promotion of public policies to encourage integration among HHI stakeholders: Universities, Government, Transformation Industries, Technology Parks, Spin-offs, Incubators, Startup, Consulting Teams, Non-Governmental Organizations, Company Shareholders, Suppliers, and Customers.

5.1 Theoretical implications

The integration between the different HHI agents can generate EI that consequently positively influences the promotion of Environmental Practices (EP), Cleaner Production (CP), Social Actions (SA), Regional Development (RD), Smart Cities (SC) and Sustainable Development (SD). In this context, the research contributes to the advancement of science by proving that, in individuals' perceptions, EI is a strategic drive to significantly increase people's quality of life elements, such as RD, SC, SA, and SD, as well as EI is a potentiator of environmental sustainability, which was measured using EP and CP constructs.

The survey results indicate that Generation Y perceives greater importance of EI, CP, AS, RD, and SC, which can be evidenced in the analysis of the mean responses in the constructs. These results demonstrate Generation Y's greater sensitivity to situations involving socio-environmental responsibility and Sustainable Development, which increases confidence in new generations so that they can act and create conditions for a sustainable future.

The moderating effect of the country (Brazil, Portugal) on the intensity of the relationships between the variables, can be seen in Table 10, in which it is identified, that for residents in Brazil, EI exerts a strong influence on AS, RD and SC. Therefore, this study contributes to science by concluding that the EI precepts are vectors for increasing socio-environmental practices, transforming cities into Smart Cities, and contribute to sustainable regional development.

Another important academic contribution of the research is the provision of an Analysis Framework with the measurement model and the structural model, which has been validated statistically (observable variables and constructs). The integrated model (Framework) proposed in the research can be replicated in different regional contexts.

5.2 Practical Implications

Regarding the managerial contributions of the research, we highlight the identification of the predictors of PE and CP, which are the constructs of HHI and EI. In this sense, organizations should focus on the dissemination of environmental actions promoted by companies to increase the potential value of the company's brand, which has already been proven in the studies of Severo et al. (2018).

The identification of the positive influence of IE precepts on the concepts of Smart Cities, in the aspects of sustainability and quality of life in urban centers, indicate the need for city managers to use technological innovations in the management of the demands of transport, energy, water and others public resources. Therefore, the research results contribute to the understanding that innovation must be designed to improve people's quality of life through the integration of technologies and environmental sustainability.

Another managerial contribution is linked to the interpretation that the EI precepts are key to trigger positive influences on socio-environmental aspects, smart cities and regional and sustainable development. In this sense, organizations and governments can contribute to society, with greater efficiency, allocating resources in projects that develop socio-environmental innovations.

5.3 Search limitations and future studies

The research presents important findings, however, there are limitations related to data collection, from the exclusive perception of individuals. This perception of individuals with the use of a Likert Scale can allow response biases, such as the misleading generalization (Halo effect) and Common-Method Variance (CMV) described by Bagozzi and Yi (1991), Podsakoff et al. (2003) and Richardson et al. (2009). In this sense, the data were statistically validated with the use of tests of normality, simple reliability, composite reliability, tests of variance and the application of the Confirmatory Factor Analysis Marker proposed by Williams et al. (2003a; 2003b) to identify the possible CMV occurrence.

Another limitation of the research refers to the countries chosen for the study, as Brazil and Portugal are at different levels of economic and social development, since Brazil is still considered in a country in the "development" phase, while Portugal is a nation that is part of the European Union, already with a higher level of development. This may have interfered with the variation in results when comparing the two countries. However, this limitation does not compromise the results and reinforces the moderating effect of the respondents' residence.

Based on the findings of the research, we suggest new studies that identify other mediating factors and moderators, in order to understand the elements that can effectively promote regional development and sustainable development. For it is relevant for science to know the variables that can help governments and other organizations to develop policies and actions to promote the improvement of people's quality of life from a long-term triple bottom line perspective.

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Contribution of authors

Every author should account for at least one component of the work. Paper approved for publication need to specify the contribution of every single author.

Contribution	[Author 1]	[Author 2]		
1. Definition of research problem	√			
2. Development of hypotheses or research questions (empirical studies)	√			
3. Development of theoretical propositions (theoretical work)	√	√		
4. Theoretical foundation / Literature review	√	√		
5. Definition of methodological procedures	√	√		
6. Data collection	√	√		
7. Statistical analysis	√	√		
8. Analysis and interpretation of data	√	√		
9. Critical revision of the manuscript	√	√		
10. Manuscript writing	√	√		
11. Other (please specify)				