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SUSTAINABLE TECHNOLOGICAL DEVELOPMENT: A CHALLENGE IN BUSINESS INCUBATORS IN BRAZIL

DESENVOLVIMENTO TECNOLÓGICO SUSTENTÁVEL: UM DESAFIO NAS INCUBADORAS DE EMPRESAS NO BRASIL

DESARROLLO TECNOLÓGICO SOSTENIBLE: UN DESAFÍO EN LAS INCUBADORAS DE EMPRESAS EN BRASIL

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ABSTRACT

This article aims to analyze and understand technological development supported by sustainability in business incubators through a systematic literature review (SLR). The Sustainable Development Goals (SDGs) were developed by the United Nations (UN) as an important guiding tool for society. Business incubators play an important role in a local ecosystem to foster new ideas and promote the important mission of development with the lowest possible environmental impact. However, it is clear that technological development impacts on relevant gaps regarding the construction of sustainable and healthy environments applied to society. This work seeks to answer the question in a multidisciplinary way: what are the challenges encountered in sustainable technological development in Brazilian business incubators? The results point to the great potential of incubators to promote technological development with less environmental impact, however several limitations still prevent this process from occurring in an ideal way.

Keywords: Business Incubators. Technological Development. Sustainable Development.

RESUMO

O presente artigo tem como objetivo analisar e compreender o desenvolvimento tecnológico amparado na sustentabilidade em incubadoras de empresas por meio de uma revisão sistemática da literatura (RSL). Os objetivos a serem alcançados para o desenvolvimento sustentável (ODS) foram desenvolvidos pela Organização das Nações Unidas (ONU) como uma importante ferramenta norteadora da sociedade. As incubadoras de empresas têm papel relevante em um ecossistema local para fomentar novas ideias e provocar a importante missão do desenvolvimento com o menor impacto ambiental possível. Contudo, percebe-se que o desenvolvimento tecnológico impacta em lacunas relevantes referente a construção de ambientes sustentáveis e saudáveis aplicados à sociedade. O presente trabalho busca responder à pergunta de forma multidisciplinar: quais os desafios encontrados no desenvolvimento tecnológico sustentável nas incubadoras de empresas brasileiras? Os

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resultados encontrados apontam para um grande potencial das incubadoras em promover desenvolvimento tecnológico com menor impacto ambiental, porém diversas limitações ainda impedem que esse processo ocorra da forma ideal.

Palavras-chave: Incubadoras de Empresas. Desenvolvimento Tecnológico. Desenvolvimento Sustentável.

RESUMEN

Este artículo busca analizar y comprender el desarrollo tecnológico basado en la sostenibilidad en incubadoras de empresas mediante una revisión sistemática de la literatura (SLR). Los Objetivos de Desarrollo Sostenible (ODS) fueron desarrollados por las Naciones Unidas (ONU) como una importante herramienta de orientación para la sociedad. Las incubadoras de empresas desempeñan un papel fundamental en los ecosistemas locales, impulsando nuevas ideas y cumpliendo la importante misión de desarrollo con el menor impacto ambiental posible. Sin embargo, es evidente que el desarrollo tecnológico genera importantes brechas en la construcción de entornos sostenibles y saludables para la sociedad. Este trabajo busca responder a la pregunta de forma multidisciplinaria: ¿cuáles son los desafíos del desarrollo tecnológico sostenible en las incubadoras de empresas brasileñas? Los resultados indican un gran potencial para que las incubadoras promuevan el desarrollo tecnológico con un menor impacto ambiental, pero varias limitaciones aún impiden que este proceso se lleve a cabo de forma óptima.

Palabras clave: Incubadoras de Empresas. Desarrollo Tecnológico. Desarrollo Sostenible.

1 INTRODUCTION

In the Houaiss minidictionary of the Portuguese language (2010, p. 431), "incubation" means, among other definitions, "period of elaboration, preparation of an event, a work." In this way, companies that have just started their business, the so-called "startups", can benefit from technological incubators so that they have better elaborated their market processes, and also a preparation of such processes in order to maintain themselves and achieve their purposes successfully. According to Anprotec – National Association of Entities Promoting Advanced Technology Enterprises (2005), "the business incubator is a mechanism for accelerating the development of enterprises, [...] through a business regime, services and shared technical support, as well as practical and professional guidance". Also, according to this association, for business incubators to be formed and fulfill their role, they need to be maintained by government entities, universities, community groups, among others.

Furthermore, Sábato and Botana (1975) maintain that cooperation between universities and companies is fundamental for technological innovation in the economic and social development of Latin America. In addition, as the increase in production, innovation and consumption at a global level has happened over the last decades, society's attention to social, economic and environmental problems has also been awakened (ROCHA *et al.*, 2021, p. 116). By way of conceptualization, the term "technology", for Pinto (2005, p. 219), has four main meanings, interconnected with each other: 1) etymologically, the term is related to theory, science, study, discussion of technique, and, therefore, to the ways of doing something; 2) the term is equivalent only to technique, having as a synonym the American variant "*know how*"; 3) the term encompasses the set of all the techniques available to a society at any time in its history, and this meaning is the one that allows us to measure the degree of productive progress of that society; and 4) the term technology allows us to ideologize technique, that is, the word "technology" mentions the ideology of technique.

It is important to highlight that technology is currently understood differently from how it was until recently. Iacono, Almeida and Nagano (2011, p. 1487) explain that the success of innovations brings a new way of innovating, through what is known as the "interactive model of innovation". Before, in what is called the traditional linear model, only basic research takes place, and the technology has an exogenous character, that is, free access, and can be acquired by companies. Now, the technology:

> It is considered endogenous, a complex, multidimensional phenomenon, which takes into account the participation of various types of actors, and takes the relationship between science and technological and economic development from an interactive view. The perspective of the interactive innovation model starts to consider interactions and joint actions, key elements for multidisciplinary learning and for the development of new products and new technologies (IACONO; ALMEIDA; NAGANO, 2011, p. 1487).

In this sense, this article seeks to answer the question: what are the challenges encountered in sustainable technological development in Brazilian business incubators? The main objective is to analyze and understand the technological development supported by sustainability in business incubators through a systematic literature review (RSL). In addition, it is intended to briefly address historical aspects that involve the emergence of incubators and thinking about sustainable technological development.

The importance of this study is justified by the fact that it is essential that there is synchronized planning in relation to the tripod of sustainability – social, economic, and environmental (ECOTRONICS AMBIENTAL, 2022) – with business incubators, since these are places "where a common goal of systematizing the transition from invention to commercialization of new technologies emerges" (RIBEIRO; ANDRADE, 2007, p. 4), and, therefore, agents that modify life in society. According to Hayne (2003 *apud* RIBEIRO; ANDRADE, 2007, p. 2):

> As technological progress influences economic progress and this, through the dynamics of the capitalist mode of production, has been responsible for a violent aggression to the environment, a new form of management of human and material resources emerges that must take into account the interests of sustainable development.

In this context, technology business incubators partially meet the requirements of the sustainability goals to promote development with the lowest possible environmental impact. The present research used a methodological approach of qualitative research to find the results in the academic literature and that will be described in the next section.

2 METHODS

In order to achieve the proposed objective, the present research used a different research modality from the convenience review, in which, according to Galvão and Ricarte

(2020, p. 58), the researcher discusses scientific material that he deems relevant to address a certain theme, but without presenting well-defined criteria on the search.

The systematic review of the literature "follows specific protocols, and [...] seeks to understand and give some logic to a large documentary corpus, especially by verifying what works and what does not work in a given context" (GALVÃO; RICARTE, 2020, p. 58). Regarding the typology, this is a systematic review of the literature with meta-synthesis. According to Siddaway, Wood and Hedges (2019 *apud* GALVÃO; RICARTE, 2020, p. 60), "the objective of a meta-synthesis is to synthesize qualitative studies on a topic in order to locate key themes, concepts, or theories that provide new or more powerful explanations for the phenomenon under analysis".

That said, it should be noted that a tool developed to assist in the verification of minimum criteria to be adopted for a systematic literature review was used: Prisma 2020 – *Preferred Reporting Items for Systematic Reviews and Meta-Analyses*. "The adoption of robust protocols for the development of RSL can contribute to this research model presenting greater transparency and reproducibility", is what Marcondes and Silva (2022, p. 3) highlight.

2.1 SELECTION OF DATABASES

After delimiting the issue that would be addressed in this review, it was necessary to define which databases would be consulted for the search for materials that would be part of the scope of this research. Thus, due to the ease of access and richness of materials consistent with the intentions of this work, the following were defined: 1) CAPES Journal Portal (Coordination for the Improvement of Higher Education Personnel); and 2) SCIELO (*Scientific Electronic Library Online*).

2.2 INCLUSION AND EXCLUSION CRITERIA

The following criteria for inclusion and exclusion of materials were used:

1) Type of material: scientific articles published in journals;
2) Time gap: 24 years (articles were searched between the years 2000 and 2023);
3) Definition of search strings (keywords and combinations of terms): "technological development", "business incubators" and "healthy and sustainable environments";
4) Boolean operator adopted: "and";
5) Filtering method of the articles that would be included in the review: reading of the title and abstract in Portuguese;

6) Other criteria for the selection of scientific articles:

Number of citations: unused;

Cross-reference: unused.

2.3 OTHER METHODOLOGICAL PROCEDURES

After selecting the databases and applying the inclusion and exclusion criteria, a total of 09 (nine) scientific articles selected for this systematic review were reached (see table below):

Table 1

Final sampling of the articles obtained from the application of the inclusion and exclusion criteria mentioned in section 2

Article number, assigned in alphabetical order of author	**Articles referenced through ABNT**
Article no. 1	CARDOSO, André Coimbra; FELIX et al. Sustainable development-oriented incubators: Is it possible? The case of the Technology Business Incubation Center (CIETEC). Journal of Social and Environmental Management, São Paulo, v. 2, n. 2, p. 69-87, May/Aug. 2008.
Article No. 2	CASADO, Frank Leonardo; SILUK, Julio Cezar Mairese; ZAMPIERI, Nilza Luiza Venturini. Entrepreneurial university and sustainable regional development: proposal of a model. Revista de Administração da Universidade Federal de Santa Maria, Santa Maria, v. 5, Special Edition, p. 633-650, dez. 2012.
Article no. 3	FONSECA, Sergio Azevedo; SOUZA, Silvia Batista de; JABBOUR, Charbel José. Challenges and opportunities of business incubators for the incorporation of environmental strategies. OES Magazine, Salvador, v. 17, n. 53, p. 331-344, Apr./June 2010.
Article no. 4	IACONO, Antonio; ALMEIDA, Carlos Augusto Silva de; NAGANO, Marcelo Seido. Interaction and cooperation of technology-based incubated companies: an analysis of the new innovation paradigm. Revista de Administração Pública, Rio de Janeiro, p. 1485-1516, set./out. 2011.
Article No. 5	LOPES, Walter Saraiva; SASSI, Renato José. Development of technology-based firms of the Vale do Paraíba Paulista region: survey with incubators managers and incubated companies. Management and Production, São Carlos, v. 26, n. 4, e1302, 2019.
Article No. 6	RIBEIRO, Ana Cristina Silva; ANDRADE, Emmanuel Paiva de. Sustainability: a challenge to the management of incubators and incubated companies: the experience of IEBTUFF. In: XXVII ENCONTRO NACIONAL DE ENGENHARIA DE PRODUÇÃO, Anais, Foz do Iguaçu, p. 1-10, out. 2007.
Article no. 7	ROCHA, Idenilse Deniz da et al. Sustainability practices and indicators in technological incubators in Southwest Paraná and Western Santa Catarina. Revista Competitividade e Sustentabilidade, [S. l.], v. 8, n. 1, p. 115–132, 2021.
Article No. 8	SILVA, Carlos Eduardo Lopes da et al. The role of the business incubator for sustainable development: the proposition of action of the UFF incubator in the Campos basin. In: XX NATIONAL SEMINAR ON TECHNOLOGY PARKS

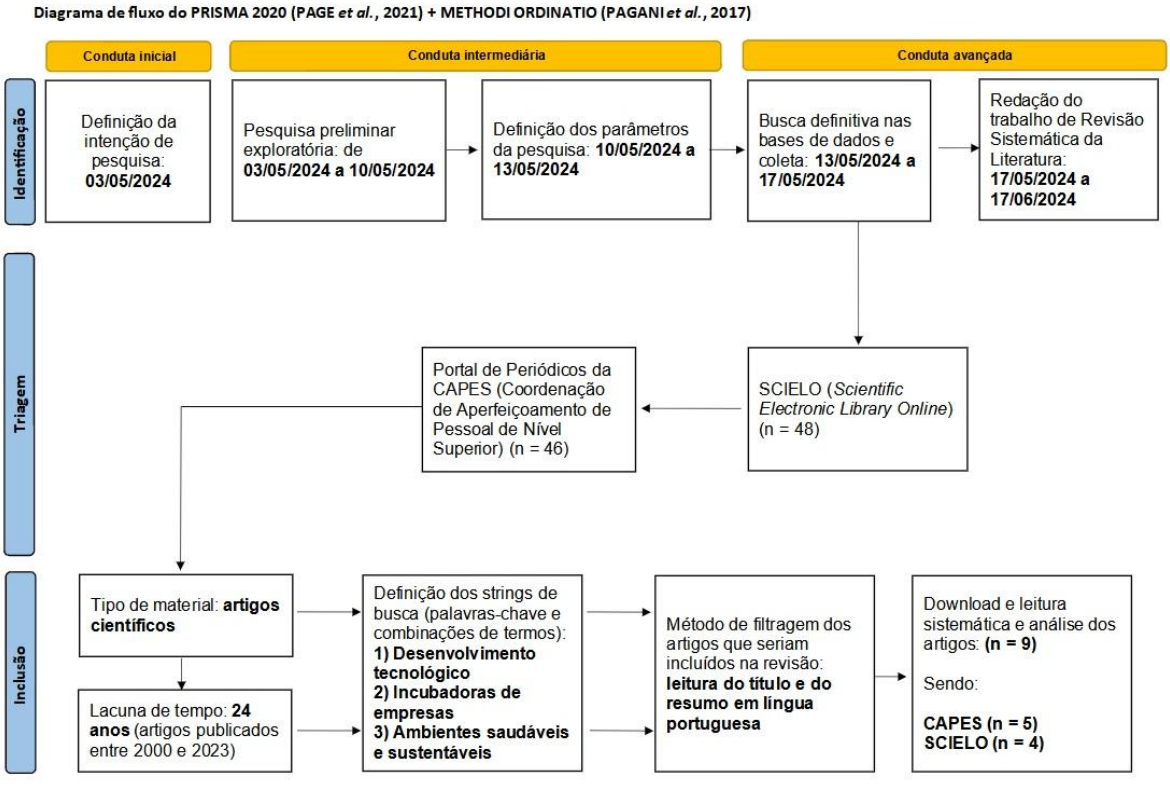
	AND BUSINESS INCUBATORS AND XVIII ANPROTEC WORKSHOP, Anais, Campo Grande, 2010.
Article No. 9	SORANZO, Jean Paulo. Sustainable Development and the National Environmental Policy Law. Legal Sciences, v. 19, n. 1, p. 18-22, 2018.

Source: Prepared by the authors (2014).

In addition to the above, the researchers chose to use a platform for sharing the data they obtained in the databases: shared folders and subfolders in *Google Drive* for better organization. We also chose to develop a research flowchart, a tool that helps researchers organize the steps to be carried out for the development of the systematic review, and a cloud of keywords that were most visible in the reviewed articles, both shown below (Figures 1 and 2, respectively).

Figure 1

PRISMA 2020 flow diagram



Source: prepared by the authors (2024), based on Page et al. (2021, p. 5 apud MARCONDES; SILVA, 2022, p. 14) and Pagani et al. (2017).

Figure 2

Cloud of keywords identified in the reviewed articles

Source: prepared by the authors with the help of the digital tool "Wordcloud.online" (2024).

3 THEORETICAL FRAMEWORK

3.1 HISTORY OF BUSINESS INCUBATORS

The first reports that deal with the theme of business incubation date back to the end of the 50s. These models, which precede the current one, emerged after the closure of the activities of one of the branches of the company Massey Ferguson, in the state of New York, in the United States, when the entrepreneur Joseph Mancuso bought the facilities with the intention of dividing the company into small spaces and leasing them to business projects or companies that were in the initial phase of work. In the 70s, also in the USA, the activities of recent graduates were fostered, mainly in the area of technology and sustainable development, aiming to place new entrepreneurs in the market.

After several companies approved and developed with the methods of incubation activities, they arrived in Brazil in the 80s, when Professor Lynaldo Cavalcanti, then president of CNPq (National Council for Scientific and Technological Development), instituted the first business incubator, after the creation of technological foundations in Brazil. According to ANPROTEC (National Association of Enterprise Promotion Entities), created in 1987, the

objective of incubators is to provide support during the initial stage of a company or an enterprise.

The incubator has the role of facilitating and providing a healthy environment for business structuring and development. In addition to all the technical support and advisory services, sharing the same space with other developing companies makes business development solid, thus preparing new companies for a market that is increasingly competitive (LAJES; TONHOLO, 2006). In addition to business management services, information, training and complementary support, it is the role of the incubator to provide assistance in the commercialization of products and services of new enterprises. According to data from the Ministry of Science and Technology (2010 to 2020), about 70% of entrepreneurs who develop their companies in an incubated environment have a greater expectation of growth and permanence in the market.

Considering that, for Cardoso (2008, p. 70), "the issue of sustainable development involves a change in both organizational and individual behavior", micro and small business incubators, especially those that incorporate innovation and technology ventures, can become a great catalyst for sustainable development, because, in addition to contributing to the establishment of micro and small companies and becoming self-sustainable, Regarding the economic pillar, they can also encourage these businesses to operate based on what is recommended by the guidelines for correct processes from a social and environmental point of view.

Thus, the importance of business incubators, especially those linked to the technological sector, in the role of promoting sustainable technological development, is perceived, a topic discussed below.

3.2 SUSTAINABLE TECHNOLOGICAL DEVELOPMENT

Sustainable technology development is any and all types of technological development used with the vision of conserving natural resources, promoting social and economic development for all generations. It is a sum of techniques, skills, methods and processes used to produce a product or the provision of a service with the least possible environmental impact, and yet promote social and economic development (RONCAGLIO; JANKE, 2009).

Since the Stockholm Conference, which took place in June 1972 and brought together heads of state from 113 countries, as well as several international governmental and non-

governmental organizations, the world has started to look at issues such as air pollution and excessive consumption of natural resources from a new perspective.

At the United Nations General Assembly, in 2015, the 2030 Agenda for Sustainable Development (UN) was established, with the purpose of achieving sustainable development in its three dimensions (economic, social and environmental) in a balanced and integrated way, generating development in the three pillars of sustainability, as shown in Figure 3.

Figure 3

Elements to generate a sustainability model

Source: Ecotronics Ambiental (2022).

The tripod of sustainable development is arranged as follows: **1) environmental development** – ecological maintenance and conservation of natural resources are fundamental. Lovins et al. (1999) highlight the importance of energy efficiency and the reduction of carbon emissions as pillars for environmentally sustainable technological development; **2) Economic development** – economic growth must be sustainable, promoting technologies that generate green jobs and inclusive growth. Porter and Van der Linde (1995) argue that ecological innovation can lead to economic competitiveness, contradicting the view that sustainability entails additional costs; and **3) social development** – social inclusion and improving the quality of life are crucial. Sachs (2015) emphasizes that

sustainable development must reduce inequalities and promote social well-being through inclusive public policies and technologies.

In this same action, the 17 Sustainable Development Goals (SDGs) and 169 targets were established, as illustrated in Figure 4, and each country would have its responsibility according to its possibilities of actions to reduce social inequality, sustainable economic growth and preservation of natural resources. Sustainable technological development is an interdisciplinary field that seeks to reconcile technological innovation with the need to preserve the environment and promote social and economic well-being.

This modality of sustainable technological development is based on the idea that technological progress should occur in a way that does not compromise the ability of future generations to meet their needs. According to the Brundtland Commission (1987), sustainable development is that which "satisfies the needs of the present without compromising the ability of future generations to satisfy their own needs".

Figure 4

Sustainable Development Goals (SDGs)

Source: United Nations Brazil (2024).

This concept has been expanded to include technological innovation, where sustainability is integrated from the early stage of development through implementation and use. Figure 4 shows the UN Sustainable Development Goals, the colors and the icons disseminated worldwide.

Some areas of development of some of the main technological axes under development in Brazil that address sustainability as an essential factor are the following: **1) renewable energy** – solar and wind energy have stood out for their ability to reduce carbon emissions. Jacobson and Delucchi (2011) show that it is technically and economically feasible to supply a large part of the energy consumed worldwide with 100% renewable energy by 2050; **2) Sustainable transport** – Electric and hybrid vehicles, as well as improvements in public transport infrastructure, are essential. Sperling and Gordon (2009) discuss how the transformation of the transport sector can be a catalyst for a sustainable future; **3) Sustainable construction** – Green buildings, using sustainable building materials and energy efficiency, are key. Kibert (2008) explores how sustainable building practices can reduce environmental impact and promote human health; and **4) sustainable agriculture** – sustainable agricultural technologies promote efficiency in water use and crop rotation. Pretty (2008) highlights the importance of sustainable agriculture for food security and environmental conservation.

4 RESULTS AND DISCUSSIONS

From the reading of the nine articles that were selected for this RSL, it is observed that they deal, in general, with five main themes: 1) Potential of business incubators to contribute to micro and small companies having a concern with sustainable development; 2) Universities as potential agents of sustainable development and social responsibility practices; 3) The historical and structural difficulties of small companies to make investments in dimensions other than the economic one; 4) The perception of managers of incubators and technology-based companies (TBEs) about the factors that contribute to the development of TBBs; and 5) Policy and sustainable development. These topics will be discussed below.

4.1 POTENTIAL OF BUSINESS INCUBATORS TO CONTRIBUTE TO MICRO AND SMALL ENTERPRISES HAVING A CONCERN FOR SUSTAINABLE DEVELOPMENT

The case study by Cardoso *et al*. (2008, p. 84), after evaluating the potential of one of the most important incubators in Brazil, the Center for the Incubation of Technology Companies (CIETEC), concluded that the possibility of incubators fostering sustainable development in incubated companies is very high, as long as there is the necessary structuring for this. In other words, there is potential, but the theme is little explored. The incubator in question, despite being sensitive to the issue of sustainable development, "does

not translate its concerns into consistent projects currently", and the institution "places its hopes in academic research that should help the center to develop policies oriented towards sustainable development" (CARDOSO *et al*., 2008, p. 84).

The research by Fonseca, Souza and Jabbour (2010, p. 342) corroborates the study by Cardoso *et al.* (2008) in the perspective on the potential and possibilities of business incubators being treated as public policy instruments for the promotion of environmental practices in companies. The authors concluded that "the results revealed the great distance of Brazilian incubators in relation to the role they should play as agents of public policies to promote sustainable local development" (FONSECA; SOUZA; JABBOUR, 2010, p. 331). The study also highlights that there is a lack of approaches to the environmental issue within the scope of incubators, noting that "incubator programs and projects with an environmental focus are still rare" (FONSECA; SOUZA; JABBOUR, 2010, p. 338).

Ribeiro and Andrade (2007) brought the contribution of the Technology-Based Business Incubator of UFF (Fluminense Federal University) and its incubated companies to local and regional sustainable development. The authors found that "there are numerous difficulties for the socially responsible development of micro and small enterprises" (RIBEIRO; ANDRADE, 2007, p. 8), but that the configuration of the incubators enables them to contribute to the promotion of sustainable development in Brazil "through business solutions that promote environmental conservation and social inclusion, through the development of new products and services under the focus of sustainability" (RIBEIRO; ANDRADE, 2007, p. 1). The study also identifies some solutions already adopted by the incubated companies, such as the adoption of eco-efficiency principles, recycling, reduction of toxic products and responsibility actions with suppliers, customers and professionals. However, Ribeiro and Andrade (2007, p. 8) state "that it is important that companies are concerned first and foremost with their growth", since 70% of micro and small companies close within five years in Brazil. In this context, "sustainability issues are fundamental, but they must boost business, without compromising the environment and the team" (RIBEIRO; ANDRADE, 2007, p. 9).

Silva *et al.* (2010) proposed to present a set of actions that can guide the Incubators for the development of sustainable innovation systems. The study is based on the performance of the Business Incubator of UFF (Fluminense Federal University), in the Productive Arrangement of Oil and Gas of the Campos Basin. "The process is characterized by transdisciplinary action in broad areas such as risk management, environmental

management, process management, quality management, industrial reliability, among other areas" (SILVA *et al.*, 2010, p. 3). The authors present 8 actions to promote knowledge and infrastructure for the transformation of the current industrial arrangement of the Campos Basin into a sustainable region and thus meet environmental demands, as well as promote the economic and social development of the region in the medium and long term. The researchers' proposal was made because "a systemic effort by the Business Incubators towards projects aimed at the environment and sustainable development is not identified, despite the fact that several isolated actions are noted" (SILVA *et al.*, 2010, p. 1).

4.2 UNIVERSITIES AS POTENTIAL AGENTS OF SUSTAINABLE DEVELOPMENT AND SOCIAL RESPONSIBILITY PRACTICES

The article by Casado, Siluk and Zampieri (2012), in turn, deals with sustainable and innovative entrepreneurship from universities. As creators and disseminators of knowledge, these institutions also have the potential to contribute to sustainable development. The authors systematized the necessary bases for the consolidation of an entrepreneurial university, where "a model of entrepreneurship program suitable to be implemented both in educational and technological research institutions is presented, which brings together specific structured actions" with a view to contributing "to the formation and development of the entrepreneurial culture in these institutions" (CASADO; SILUK; ZAMPIERI, 2012, p. 697). The work concludes that, by aiming to promote entrepreneurial attitudes and regional sustainable development, the university will contribute decisively to the ordering of an entrepreneurial culture.

The article by Silva *et al.* (2010) highlights the *Triple Helix model* of interaction between government, university and business, a model that, according to Etzkowitz (2008 *apud* SILVA *et al.*, 2010, p. 2), "emerges as a mechanism to overcome the challenges involved in a better and greater transfer of knowledge and technology from universities to society and business". Thus, "the business incubator presents itself as a potential inducer for sustainable actions, since it is inserted in a context of integration between universities, companies and governments" (SILVA *et al.*, 2010, p. 1), a context defined by the aforementioned model.

4.3 THE HISTORICAL AND STRUCTURAL DIFFICULTIES OF SMALL COMPANIES TO MAKE INVESTMENTS IN DIMENSIONS OTHER THAN THE ECONOMIC

For Fonseca, Souza and Jabbour (2010, p. 342), the absence of data on the effective and potential contributions of incubators to the incorporation of the environmental and social dimensions in the business strategies of micro and small companies "ends up limiting the mobilization of incubators as instruments of public policies for the promotion of sustainable development". Environmental practices internalized by medium and large companies are distant from micro and small ones. And these are the largest generators of pollution, in addition to having less efficiency in the use of inputs. The article concludes that micro and small companies "do not have internal factors that contribute to the adoption of environmental practices" (FONSECA, SOUZA AND JABBOUR, 2010, p. 336).

First, the environmental concept is not familiar to this organizational universe and, when it is known, its commercial advantages have not been disclosed or appreciated. Second, "small businesses are very skeptical about the real benefits that can potentially come from implementing environmental management systems." Finally, "low environmental awareness and the absence of pressure from customers are inhibiting factors in the resolution of environmental constraints" (FONSECA, SOUZA AND JABBOUR, 2010, p. 336).

Using the variables "absolute frequency, relative frequency, minimum, maximum, mean, standard deviation, entropy and weight of information", Rocha *et al.* (2021, p. 115, 121) analyzed sustainability practices in 56 companies incubated in the Southwest region of Paraná and West of Santa Catarina. The social, environmental and economic practices of each company were addressed. As a result, it was noted that "the Triple Bottom Line approach to sustainability is not in balance as expected. Sustainable economic development is ahead of environmental and social development" (ROCHA *et al.*, 2021, p. 128). The research instrument was composed of 11 closed questions, which addressed characteristics of the respondents and the company. Regarding the social, environmental and economic dimensions, 3 blocks of questions were applied, totaling 20 indicators, in which the 5-point *Lickert scale was used* . "The results demonstrate the predominance of the adoption of the economic dimension (average 3.73), compared to the social dimension (3.13) and the environmental dimension (2.57)" (ROCHA *et al.*, 2021, p. 127). For the authors, the three dimensions must be in harmony, so that there is integration of sustainable development in order to contribute to the integrity of the planet, nature and society over generations.

4.4 THE PERCEPTION OF MANAGERS OF INCUBATORS AND TECHNOLOGY-BASED ENTERPRISES (TBS) ABOUT THE FACTORS THAT CONTRIBUTE TO THE DEVELOPMENT OF TBS

Iacono, Almeida and Nagano (2011, p. 1486) consider that technology is no longer only what occurs inside the company, but also outside, "as a systemic and interactive phenomenon", and consider that incubators can leverage technology-based companies (TBEs) in Brazil towards more prosperous technological development. The authors sought to evaluate the degree of importance perceived by TBBs for interactions and cooperative relationships, in their current stage of incubation, and the trend of this behavior for the post-incubation period. The results, according to Iacono, Almeida and Nagano (2011, p. 1513) showed that EBTs have a positive tendency to the development of joint actions and greater interaction in the incubation stage, but these are characterized as low intensity. "Although companies indicate a strong tendency to cooperate in the post-incubation period, the data show that existing cooperative relationships are very weak with some agents, which suggests the presence of barriers." Regarding the incubators, the study concludes that "there is evidence of their little involvement in activities and/or events related to innovation themes. It is important to highlight that the incubators have practices that are still very focused on entrepreneurship" (IACONO; ALMEIDA; NAGANO, 2011, p. 1513). In the study, there is no mention of sustainable development, nor of sustainability, but it is understood that its focus was placed on interactions towards innovation.

The study by Lopes and Sassi (2019, p. 1) sought to analyze the degree of importance of the factors that contribute to the development of EBTs from the perspective of managers of technology-based incubators (IBTs) and companies in the Paraíba Paulista Valley in 2011. The factors considered were: "entrepreneurial characteristics, resources offered by the IBTs, resources offered in partnerships with other development agents and requirements for the selection of EBTs by the IBTs". The managers answered a questionnaire where they evaluated the degree of importance of several subfactors within the factors mentioned above on a scale of 1 to 5. The highest concentration of answers was 4 and 5, demonstrating that the factors listed are of paramount importance for the development of TBS. It is important to highlight the factor that includes the issue of sustainability: "technical support services, demand for products or services with innovative characteristics, sustainability of the project, economic viability of the product or service were considered very important by managers"

(LOPES; SASSI, 2019, p. 10). The study shows that: "incubator managers evaluated sustainability as a very important factor for an EBT" (LOPES; SASSI, 2019, p. 11).

4.5 POLITICS AND SUSTAINABLE DEVELOPMENT

Soranzo (2018, p. 18) spoke about sustainable development in the light of the National Environmental Policy Law. This law "characterized the way in which the environment should be understood, including the general and specific objectives that the legislator sought to defend". The rule instrumentalized the Environmental Public Administration, "in which through three mechanisms it would be able to apply the regulation, namely: environmental intervention, environmental control and repressive control, with the imposition of sanctioning measures". According to the author, "Law No. 6,938/81 was reinforced through articles 170 and 225, due to the public interest in aiming at sustainable and innovative development, based on the social, environmental and economic tripod". According to Soranzo (2018, p. 21), "the interest in acting is notorious, however, only the legal and legal foundations fail the ability to propagate and disseminate among the masses the due precaution to be taken by society". The study concluded that with each passing day, one gets closer to a new discovery, "which will transform mass and consumerist culture into a conservative and less polluting culture" (SORANZO, 2018, p. 22). And sustainable economic development is the main tool for this, as long as one knows how to use the scarce natural resources that still exist.

In the context of this discussion, it is relevant to highlight that business incubators do have great potential to help incubated companies leverage the corporate processes that involve them towards a more sustainable development, taking into account the tripod of sustainability. However, they have limitations of various kinds, such as the lack of structure, the lack of a better exploration of the theme, the lack of references and approaches to the environmental and social issue within the scope of the incubators, the lack of consistent projects that concern sustainability, the peaceful wait for academic research to help in the creation of policies oriented towards sustainable development, the lack of familiarity with the environmental concept on the part of micro and small companies, the lack of knowledge of the commercial advantages that the environmental concept can generate and the skepticism of small companies regarding the benefits arising from the implementation of environmental management systems, among others (CARDOSO *et al*., 2008; FOSTER; SOUZA; JABBOUR, 2010; LEE; SASSI, 2019; BROOK; ANDRADE, 2007; SILVA *et al*., 2010).

As pointed out by Rocha *et al.* (2021) and Soranzo (2018), sustainable economic development is ahead of environmental and social development, which makes it difficult to advance towards environmentally and socially better conduct.

Iacono, Almeida and Nagano (2011), although at no time mention the words "sustainable" and "sustainability", see incubators as a tool capable of leveraging companies towards more prosperous technological development. Limited to "innovation" in a broader way, the research corroborates Rocha *et al.* (2021) and Soranzo (2018), when stating that incubators have practices that are still very focused on entrepreneurship, that is, leaving aside environmental and social aspects in favor of the economic.

Finally, Casado, Siluk and Zampieri (2012), in common dialogue with Silva *et al.* (2010), attribute to universities part of the responsibility for filling the gaps related to the limitations to sustainable development. No wonder, considering the strength and increasing scope of academia in Brazil.

5 CONSIDERATIONS

Having followed the paths that this work proposed to follow – on the one hand, to analyze and understand the technological development supported by sustainability in business incubators; on the other hand, to address historical aspects about incubators and sustainable technological development – it is considered that technology-based business incubators partially meet the requirements of the sustainability objectives to promote development with the lowest possible environmental impact. In other words, there is a great potential of Brazilian incubators to promote technological development with the lowest possible environmental impact, but several limitations still prevent this process from occurring in the ideal way.

Answering the problem question of this study, the challenges encountered in sustainable technological development in Brazilian business incubators are, for example: overcoming significant obstacles such as high initial costs in which many sustainable technologies are not yet accessible, hindering large-scale adoption; make entrepreneurs believe that, according to Stern (2007), initial investments in green technologies are essential to avoid the much higher costs of climate change in the future; overcoming the cultural and institutional resistance that may exist about technological change (this type of change may face resistance from established institutions and cultures, and North (1990) discusses how institutions can be obstacles or facilitators to sustainable technological change); review the

development of policies and regulations that guide the actions of government and/or private institutions that may limit sustainable development; promote policies that encourage the sustainable management of common resources, the need for which is emphasized by Ostrom (1990) – access to sustainable technologies must be equal in all regions and communities; distribute the benefits of technological progress fairly, promoting equity in sustainable development, which is very important, according to Sen (1999); among others.

Some examples of success in the Nordic countries that have adopted the use of renewable energy can already be seen. Denmark, Norway and Sweden are already leaders in renewable energy consumption. The political and economic strategies adopted by these countries are models of how sustainability can be integrated at the national level. Smart cities, such as Curitiba (Brazil) and Copenhagen (Denmark), are examples of cities that have implemented technological solutions to improve urban mobility and energy efficiency, demonstrating the potential of smart technologies for urban sustainability. Also noteworthy is the term "Green Technology Companies", such as Tesla and Beyond Meat, which are at the forefront of developing sustainable technologies in the transportation and food sectors, respectively. The innovations of these companies show how sustainability can be a driver of innovation and economic growth.

It is understood that sustainable technological development is crucial to address the environmental and social challenges of the twenty-first century. Integrating sustainability into technological practices is not only a necessity but also an opportunity to promote inclusive economic growth and a healthy environment. Cooperation between governments, businesses, universities, and civil society is essential to turn this vision into reality, ensuring a sustainable future for all.

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