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ARTICLES

Innovation with social and environmental impact: the TECNOVA-ES case

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ABSTRACT

Goal: This paper presents an assessment of the social and environmental innovation projects developed with the TECNOVA-ES grant from the government of the Brazilian state of Espirito Santo.

Methodological: The methodological approach contemplated three stages: 1) analysis of documentation related to the program from data made available by Espirito Santo's Research and Innovation Support Foundation (FAPES), coordinator of the TECNOVA-ES program; 2) data collection via surveys with participating companies; 3) data treatment and impact assessment.

Results: Our findings showed that over 60% of the projects had positive social impact and over 56% had a positive environmental impact.

Limitations of the investigation: One of the limitations refers to sample size. The TECNOVA-ES program contemplated 38 companies in Espirito Santo, out of which only 27 answered the survey.

Practical implications: In terms of public policy repercussions, this paper advises governments on the need to include the privilege of supporting innovation in its development programs, and that governments use their demand capacity to lead and direct entrepreneurs in the development of sustainable products and services.

Originality/Value: This research contributes to literature by approaching a topic that does not get enough attention in Brazil when it comes to public innovation grants. The dimensions of the assessment which were contemplated - social and environmental - are crucial to the country's contribution to reach the 17 Sustainable Development Goals.

Keywords: Innovation grants; Innovation project assessment; TECNOVA-ES; Sustainable development.

INTRODUCTION

Innovation that contemplates the social and environmental dimensions has become central to the debate on social and economical development in recent years. This happened due to the appeals of international organizations for the reduction of environmental degradation and social inequality, extinction of world hunger and improvement of housing conditions.

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The United Nations (UN) and the World Economic Forum have led these discussions since the last century, getting more attention from national governments in the first decades of the 21st century, which is illustrated by countries adhering to the 17 Sustainable Development Goals in the UN's 2030 Agenda (SDGs, 2021).

Governments on different levels have endeavored to encourage innovation, as it intersects with every SDG and holds strategic value for development (ARBIX, 2018). In the beginning of the century, the Brazilian government made an effort to strengthen its innovation system, as Frank et al. (2016), Koeller et al. (2019) and Leal et al. (2019) have pointed out. Simultaneous to investment in innovation, researchers from different institutions have assessed the innovation efforts of several Brazilian programs without taking into account attention to the assessment of social and environmental dimensions, Carrijo and Botelho, (2013); Rocha (2015); Torres and Botelho (2017); Avellar and Botelho (2018); Leal et al. (2021).

Bozeman and Youtie (2017) and Koeller et al. (2019) argued that assessing social and environmental impact is no trivial task. The indicators to be assessed in these dimensions are complex to establish. Besides, Salles Filho et al. (2011) showed that evaluations need to consider the program's goals, and the social and environmental matters are usually not contemplated in program goals, going unmentioned in calls for projects.

Even so, considering the relevance of social and environmental issues for sustainable development, this paper aims to present an assessment of the social and environmental impact of innovation projects developed in the Brazilian state of Espírito Santo supported by the TECNOVA-ES program.

Leal et al. (2021) showed that Espirito Santo, a state located in the southeast of Brazil, also took part in Brazilian innovation efforts, boosting support to innovation especially since 2003, through the creation of Espirito Santo's Secretariat of Science, Technology and Innovation (SECTI) and of the Research Support Foundation (FAPES). In 2013, the government of Espírito Santo partnered with Finep, the Brazilian innovation agency, to invest BRL 13.5 million across 38 innovation projects in the context of the Program of Research Support in Companies (called TECNOVA-ES), our object of study.

This paper is organized in four other sections, in addition to this introduction and the conclusion. The second section presents the theoretical references, the third one focuses on methodology, whereas the fourth discusses results and the fifth brings the conclusion.

THEORETICAL REFERENCES

Since the end of the 1990s and the early 2000s, a host of issues such as climate change, air and water pollution as well as the scarcity of natural resources have led to changes in the pattern of social behavior. In this context, society no longer wants to live with the depredation of the environment and extreme poverty in all its manifestations.

These questions are illustrated in the Paris Agreements and the UN's Sustainable Development Goals, which, among other things, established among countries that signed them a commitment to the reduction of greenhouse effect emissions - policies on the demand side of things (IEDI, 2021), at the same time that a host of supply related actions are expected from governments.

The scientific community has treated these matters as technological transitions, or TTs. TTs are defined as broad technological transformations in the way social functions such as transport, communication, housing, and food consumption are achieved (Gells, 2002; Perez, 2012; Pera et al. 2019).

At the end of the 20th century, the main official documents that started to guide public policy when it comes to the environment and the economy are related to the reports derived from the Conference of the Parties (COP), organized by the United Nations Climate Change Conference.

These reports summarize the findings of studies that aimed to harmonize the relationship between development, nature and society itself, since damage to natural resources grew due to the continuous increase in production (Rosa, Abdala and Cezarino, 2019). The definition of sustainable development present in all UN documents remains the one in the UN's Bruntland Report (1987), in which sustainable development is the one that aims to satisfy that it "meets the needs of the present without compromising the ability of future generations to meet their own needs" (UNITED NATIONS, 1987, p.27).

Figure 1 - Sustainable Development Goals.
Source: Available at: https://www.un.org/sustainabledevelopment/blog/2015/12/sustainable-development-goals-kick-off-with-start-of-new-year/

Upon signing the 17 goals from the 2030 Agenda for Sustainable Development, countries committed to "take the bold and transformative steps which are urgently needed to shift the world onto a sustainable and resilient path." (AGENDA 2030, 2021).

According to Perez (2012), sustainable development is contingent upon governments' ability to encourage green innovation. The action needed against climate change, paramount to preserve life on earth, must be led by governments, as they demand radical innovation that will not be carried out by the private sector due to the uncertainty inherent to the innovation process (Perez, 2012; Mazzucato, 2014).

When the world started discussing these matters, the state of Espírito Santo deepened its development process based on commodities, or more specifically, big projects like mining, steel mills, cellulose, ornamental rocks, petroleum and gas, activities that do not favor environmental conservation. Government institutions created with the goal of encouraging the state's development did not prioritize the social and environmental agendas (Leal and Villaschi, 2020).

Between the end of the 1990s and up to the first decade of the 2000s, more precisely until 2010, Espirito Santo acted by organizing Science, Technology and Innovation activities (ST&I) - such as the creation of Espirito Santo's Research Support Foundation (FAPES) and of the Science, Technology and Innovation Secretariat (SECTI-ES).

The innovation research (IBGE, 2020) showed that government subsidy and fiscal incentive to innovation were cited as the less frequent reasons for the development of sustainable innovation (11,2%). Besides, upon analyzing the impact of innovation programs in Brazil and Espírito Santo, social and environmental dimensions are usually not treated. Thus, taking into account the relevance of social and environmental issues for sustainable development, it is necessary to examine the theme and build approaches for the evaluation of this impact which, as shown by Bozeman and Youtie (2017), are challenging to the public program e evaluation programs.

METHOD

Figure 2 illustrates the research's methodological procedures.

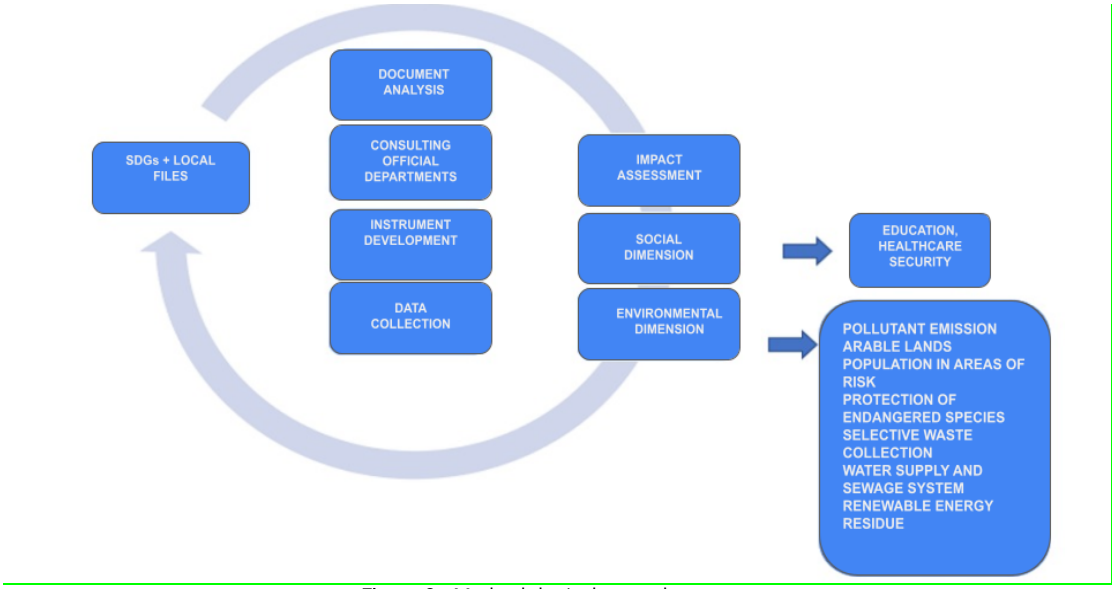

Figure 2 - Methodological procedure.

Documentation analysis

Following Roessner's classical recommendation (1989), simultaneous to the process of revision about the SGD discussions and the social and environmental challenges present in the region (in this case, Espirito Santo); the authors forged a partnership with FAPES, institution that executes the TECNOVA-ES program, to make documents available for the assessment of the projects, as well as support to clarify questions about the program and to conduct interviews.

On March 28 2019, the project held a meeting at FAPES to treat data availability and for a discussion on how to treat them initially. It was suggested that, besides the files available for public consultation on the FAPES website referring to the selection and hiring process within the companies, that the company also consulted other government bodies that had official information from reliable sources about the companies. Variables that would need treatment but weren't available in official institutions would be collected through surveys to be applied with the entrepreneurs responsible for the projected supported in the beneficiary companies.

Documentation analysis showed that 38 young (averaging 9.7 years) micro and small enterprises within TECNOVA_ES, mainly in the communication and information technology sector (CIT), located in the metropolitan region of Vitória (Leal et al., 2021).

Instrument development

The next step was the development of the impact assessment instrument. A preliminary survey was then developed based on Fape's documents and on the instrument built and validated by Leal et al. (2016), which was applied to a program similar to TECNOVA-ES.

Next, the preliminary version of the survey was discussed with FAPES, on October 21, 2019. The survey was adjusted and the terms of evaluation were perfected, taking into account data such as the age of the companies and property records did not have to be inserted in the survey, as they had already been extracted from official data.

For the purposes of this paper, two dimensions contemplated in the survey will be presented: i) the social dimension and ii) the environmental dimension.

The social dimension contained the following questions: What was the degree of your project's relevance to amplify access to 1) education services; 2) healthcare; and 3) security services?

The environmental dimension contained the following questions: What was your project's degree of relevance to 1) reduce the emission of pollutants; 2) amplify arable land; 3) reduce pollution in risk areas; 4) amplify the protection of species at risk for extinction; 5) expand selective waste collection; 6) expand the water supply and sewer system; 7) amplify the use of renewable energy and 8) reduce residue production.

The indicators analyzed in these dimensions are aligned with the social and environmental challenges in the state of Espírito Santo and in adherence to the 17 Sustainable Development Goals. The degrees of relevance were analyzed on a scale of four points: High, Medium, Low and None.

The adjusted version of the survey was discussed by project researchers, FAPES technicians and TECNOVA entrepreneurs on 2 March 2020.

Data collection

On 13 April 2020, the final version of the survey was made available to FAPES, which was then responsible for sending the document to the entrepreneurs for data collection.

Some considerations are worth making at this point. The fact FAPES is the agency responsible for funding the project is positive to get more entrepreneurs to answer the survey. FAPES can have more direct contact with the beneficiary entrepreneurs and, besides, in the very Grant of Financial Support that FAPES gives to its programs, there is a clause that talks about beneficiaries answering to FAPES about the project whenever asked to do so. However, upon receiving a survey asking about the development and commercialization of products coming from a call of papers funded by FAPES, there is the possibility of data bias.

Even though FAPES is the agency responsible for directly sending the surveys and the data of primary data collection for this research, 27 out of 38 beneficiaries answered the survey, representing 71% of the population. Data collection took place from 13 April 2020 to 18 May 2020.

Impact assessment

In order to measure impact, due to the lack of data referring to the projects that weren't funded by TECNOVA_EX, a counterfactual group was created based on the questioning of the development of R&D or lack thereof in the absence of public investment. Thus, the companies in question were organized in two groups: the companies that stated that they would not take part in the project in case there was not financial support from the government, called Type 1 companies, and those companies that would take part in the project even if there was not public support, Type 2 companies. This methodological resource was used by Link and Scott (2017) to measure the impact of the commercialization of the Small Business Innovation Research (SBIR), an American program of public support to innovation in small businesses (Link et Scott, 2017).

This way, it was initially asked to the companies if they would develop the project without TECNOVA-ES's financial support. Out of the 27 companies that answered the survey, 23 (85%) would not have developed the project in case public financial support was not provided and 4 (15%) would have developed their project regardless of public financial support, which already indicates the government's relevance to facilitate the execution of innovative projects.

DISCUSSIONS AND RESULTS

This section brings the results of the surveys answered by 27 entrepreneurs which benefitted from the TECNOVA-ES program considering the social and environmental impact of their projects. Then we bring a discussion contextualizing the scenario of Espírito Santo and the repercussions to development agencies.

Social impact

When it comes to social impact, the impact of TECNOVA-ES was considered in the three indicators mentioned in section 3.2, which relate to Sustainable Development Goals 03, 04 and 16 (namely, Good Health and Well-Being, Quality Education and Peace, Justice and Strong institutions).

The results showed that nearly 40% (39,13%) of Type 1 company projects did not have any social dimension impact. 50% of Type 2 company projects did not have any social impact either. This highlights the need to enhance the design of the program to

encourage attention to social issues and catalyze the social impact of the projects being supported. This matter is more critical when one considers Type 2 companies, for the government invested resources to accomplish innovation that would be achieved without their support and half of these innovation efforts did not bring social impact in the social indicators assessed.

Another point worth considering when it comes to social dimension indicators, when it comes to education, in the last 20 years, Espirito Santo, just like Brazil, substantially expanded its education offers on every level, especially on high school and higher education levels. Espírito Santo has a federal university with four campi, two of which are located in the metropolitan region around its capital, Vitória, and two in the countryside. The university's management reports highlight the expansion of projects and quality of the courses in the last few years, as it can be seen in UFES (2018 and 2019).

In the beginning of the century, Espírito Santo's Federal Institute (Ifes) boasted four campi. Today it offers 23 (Ifes 2022). In the countryside of the state, there are Ifes campi spread with a teaching offer that is a reference in technical and secondary education. The quality measured by the ENEM (the High School National Exam) and Enade (the National Exam of Student Performance) scores of the institution's courses have shown a growth tendency.

When it comes to elementary education, the quality measure by the Elementary Education Development Index is historically low, but the evolution of the state is evident in most recent years, as can be seen from INEP data (2020). In 2019, Espírito Santo reached its best Idea (4.7), ranking as the best in Brazil. However, the goal proposed for the state for this indicator in 2019 was 5.2. This shows that challenges remain when it comes to the consistent improvement of quality education.

Considering Type 1 companies supported by TECNOVA-ES, eight projects have had high/medium relevance (34,78%) to amplify access to education services, and out of these, six had high relevance. In the social dimension, it was the best indicator of best performance and point to the pertinence of designing policy that contemplates a higher number of projects that focus on the issue of education.

When it comes to healthcare, Espírito Santo was also successful in healthcare in this century, although there is still room for improvement especially regarding the COVID-19 pandemic. Of the projects developed by Type 1 companies, seven of them informed that the innovation developed had high/medium relevance in this dimension (30,43%). In that regard, something that practically every government has done during the pandemic is stimulating specific programs to develop healthcare solutions. In Espirito Santo, Fapes launched the call for projects 003/2020 contemplating specific solutions for the pandemic in every field, especially healthcare.

The security indicator is a historic challenge for Espirito Santo. Up until 2012, the state would alternate with Pernambuco as the second third most violent state of Brazil. By carrying out several programs, including Present state, Espirito Santo substantially reduced its violence rate (Cerqueira et al., 2020). In the security indicator, the projects supported within TECNOVA-ES positively impacted the area. A total of eight projects from the Type 1 company group had an impact on security, only three of them having high impact. Table 1 summarizes the results found in the social dimension.

Table 1 – Degrees of relevance attributed to social dimension indicators - Type 1 companies – n=23.

Degree of relevance	Education	Healthcare	Security
High	6	4	3
Medium	2	3	5
Low	3	3	1
None	12	13	14

Environmental Impact

Assessing the impact of public investment in any governmental sphere when it comes to environmental issues is crucial in any region (Bozeman et Youtie, 2017), especially in Espirito Santo. The state's wealth of natural resources has not been properly taken care of by the government and society (Leal et Villaschi, 2020). The Espirito Santo State boasts one of the biggest Atlantic forest reserves in the world, the second biggest mangrove in Latin America, rivers important to the state's development as the Doce River, among other environmental assets.

Even so, productive activities that were set up in Espirito Santo in the second half of the 20th century do not favor environmental conservation and are located in great urban centers, which disturbs the local population. Furthermore, in November 2015, Espirito Santo was the stage for the biggest environmental tragedy in the history of Brazil, the Samarco disaster that destroyed the Doce River and region around it, leaving thousands of people in dramatic conditions. This way, public policies and investments in innovation projects must be aware of their contribution to reduce environmental impact.

Upon investing BRL 13.5 million in the TECNOVA-ES projects, the government of Espirito Santo asked for little to nothing in terms of environmental solutions from the companies in the program. This can be seen in the criteria for the approval of the project which never attributed real weight to a commitment to environmental protection, especially because in the development of the project this impact was not (but should have been) explicit (FAPES 2013). Even so, 56,52% of the projects supported had positive environmental impact to the state.

One of the state's biggest vulnerabilities is arguably air quality. The emission of pollutants for industrial plants installed in the area near big urban centers created the need for a congressional investigation committee known as "Black dust", as it was known in the state in 2015.

> Before numerous reports from the public on the high level of air pollution in the state, especially in the region around the capital, Vitória, a state-level movement started, organizing parliament and society, seeking solutions to improve the situation as well as assess and investigate the emission of polluting particles, especially the ones known as "black dust" (...) Since the installation of Companhia Vale do Rio Doce, the Tubarão steel mill and Samarco, a constant battle began in our state against the undeniable environmental impact caused by activities developed by these companies. That is why the emissions polluting air particles in the Great Vitoria and Anchieta regions has been the focus of protests and requests of control and improvement of the environment in which we breathe. The high level of disturbance that 91% of the people interviewed suffer with the current state of air pollution, according to the preliminary study developed by Professor Neyval Costa Reis Júnior, director of research and graduate studies at UFES, at the request of IEMA and the Research Support Foundation (FAPES) (ESPÍRITO SANTO, 2015, p. 1 e 47).

Furthermore, Sustainable Development Goals 12 and 13 deal with sustainable consumption and production as well as changes against climate change, which relates to the reduction of pollutant emission, amplification of selective waste collection and reduction of residue production. Regarding this, considering strong evidence related to pollutant emission, 8 out of the 23 TECNOVA-ES projects from the Type 1 category developed innovation with impact in this area - representing 34,78% of projects. Only 3 of the 23 projects (13%) impacted selective waste collection and the reduction of residue production.

When it comes to expanding arable land, it is worth highlighting the relevance of agriculture for the development of the state's countryside. The occupation of the countryside is historically rooted in the cultivation of coffee. Besides coffee, the state's agriculture is well diversified. The expansion of arable land is strategic to the development of the state in order to increase food security (Sustainable Development Goal 2). In this indicator, 13% of Type 1 company projects funded by TECNOVA-ES had an impact on the expansion of arable land.

Recognizing that a great contingent of people has access to living conditions in extremely disorganized environments - whether it is because they lack a sewage system, public lighting, among other infrastructure conditions - and establishing integrated action to solve these matters (SDG 11) is crucial to Espirito Santo. This way, innovation funded

by the public sector should prioritize solutions for precarious housing conditions. In this indicator, 13% of projects supported by TECNOVA-ES had an impact in this area.

Water security and sewage systems are another of the state's vulnerabilities, especially in the north of Espirito Santo. SDG 6 talks about drinking water and sewage treatment - particularly in rural areas. In alignment with the state's challenges and SDGs, stimulating innovation that aims at solutions in these areas is therefore strategic to the state but practically no TECNOVA-ES project has made an impact in that regard: Just one project informed "Medium relevance" to expand the water and sewage system.

Finally, Espirito Santo has an energy grid that depends on non-renewable energy sources. According to Espirito Santo's Energy Balance (ARSP 2019), energy production from renewable sources in Brazil was 42,4%, whereas in Espirito Santo that percentage was 7,4%. In that same year petroleum took part in 77,3% of ES's energy production, while in Brazil its participation corresponded to 43,7%. The state has great potential to explore renewable energy sources, especially solar. Despite being little explored in the state, the increase in energetic production through renewable alternatives would contribute to expand the energy offer, reducing environmental impact (in alignment with SDG 7).

In the case of innovation developed in the context of TECNOVA-ES by Type 1 companies, 26% had an impact on the expansion of renewable energy. Mazzucato (2014) shows an abundance of examples featuring the state's leadership role in the planning and guiding of innovation necessary to sustainable development, especially when it comes to renewable energy.

In summation, although Espirito Santo's government has not explicitly stimulated the development of innovation contemplating social and environmental dimensions in the context of TECNOVA-ES, over 56% of projects developed in the context of the program had a relevant impact on the environment, especially solutions developed to reduce pollutant emission, as 34,78% of projects impacted this indicator. Table 2 summarizes the results found in the environmental dimension.

Table 2 – Degrees of relevance attributed to the social dimension indicators - Type 1 companies - n=23

Degree of Relevance	Pollutant emission	Arable land	Population in areas of risk	Protection of Endangered Species	Selective waste collection		Water supply and sewage system	Renewable energy	Residue
High	6	1	1	3	0	0	4	3	
Medium	2	2	2	3	1	1	2	3	
Low	2	2	1	1	4	4	1	3	
None	13	18	19	16	18	18	16	14	

CONCLUSION

The growing participation of governments in the funding of innovation in the beginning of this century has required the development of methodological studies for the evaluation of programs supported by the public sector and carried out by companies. Brazil has taken part in the development of methodologies and assessment of its programs (Salles Filho et al., 2011; Carrijo and Botelho, 2013; Leal et al. 2019). However, experience in the assessment of programs considering the social and environmental dimensions remain embrionary (Koeller et al., 2019).

Thus, this paper contributes to the literature on assessment of public innovation programs by assessing these programs considering both social and environmental aspects. It was argued that one of the challenges is the selection of indicators to make up these dimensions. As a starting point, the use of the Sustainable Development Goals and of an analysis of social and environmental dimensions of the region where the programs

were carried out was suggested.

In the assessment of the TECNOVA-ES program, the state's lack of monitoring or incentive for the innovation being funded to make a social or environmental impact, since neither the goal of the program nor the evaluation criteria mentioned this kind of impact.

Results showed that over 60% of Type 1 company projects (the ones that would not have come to fruition had it not been for the government's financial support) had a positive impact on the social dimension and 50% of Type 2 company projects (which would have come to fruition regardless of public support) also had a positive impact on this dimension, especially the ones which performed better in the 'Education' indicator. In the environmental dimension, over 56% of Type 1 projects had some positive impact, as did 75% of Type 2 company projects. In this dimension, the best performance was in the 'Reduction of pollutant emission' indicator.

In terms of public policy repercussions, this paper points to advising governments on the need to include the privilege of supporting innovation for social and environmental improvements in their incentive programs, and that government use their demand skills to lead and direct entrepreneurs in the development of products and sustainable services.

There is still potential and growing demand for sustainable innovation in Brazil and Espirito Santo. According to IBGE (2020), government subsidy and fiscal incentive to innovation were mentioned as the least frequent reasons for sustainable innovation development. Thus, it is expected that in future R&D projects, governments on different levels, especially in Espirito Santo, encourage innovation projects with positive social and environmental impact, necessary for sustainable development.

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