A practical framework for evaluating innovation projects in organizations based on sustainability criteria

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Organizations have increased the search for innovation to promote the sustainability and to enjoy the benefits that it can bring. At the same time, characteristics inherent to innovation, such as being intrinsically risky and more erratic than other initiatives, require exceptional fault tolerance since it can bring exceptional results and great profits as well as it can lead to major failures or a return far below expectations. Additionally, there is a relationship between innovation and sustainability in the sense that innovation can generate value in the financial sphere, but also in social and environmental spheres. However, the decision makers normally consider only financial criteria to select and invest in innovation projects while it is not trivial to consider also social and environmental aspects in these decisions. In that context, this research presents a novel practical framework for evaluating innovation projects using sustainability criteria in order to support organizations in assessing and directing corporate resources for innovation projects. For that, financial, social, and environmental indicators were identified and combined with innovative ones, resulting in a total of 12 different indicators. All these indicators were organized in automatic and electronic worksheets developed with Microsoft Excel®. Then, when the data of an innovative project are inserted in these worksheets, the results are normalized and summarized in a sustainability score as well as are used to build a commented report. The practical framework is user-friendly and can contribute to increase innovation for sustainability practices in organizations.

Keywords: Innovation, Sustainability, Project evaluation.

I. INTRODUCTION

Innovation is a hot topic in the corporate world. It is increasingly evident that its correct application has significant impacts on the results of organizations, making them more competitive and sustainable. Large organizations, leaders in their markets and with decades of existence, have their success associated with their ability to innovate. At the same time, other large organizations that did not adapt and quickly lost their relevance attribute this to their failure to innovate.

Stimulated by the success attributed to disruptive innovation, many companies are seeking to increase the amount of innovation practiced to enjoy the potential benefits it can bring. According to the Oslo Manual of the Organization for Economic Cooperation and Development, these benefits include the introduction of new or improvements to existing products (physical or services), in processes, a new marketing method, a new organizational method of business practices, an organization of work environment or external relations (OECD, 2005).

Even with all these benefits, the great paradigm of innovation is that, just as it can bring exceptional results and

big profits to the organization that manages to be successful in applying it, it can also lead to big failures or a return lower than expected (HOLMSTRÖM, 1989). This is due a lot to the inherent characteristics of an innovation. According to Holmström (1989), in addition to the characteristic described above, innovation is also (i) unpredictable, as it is very difficult to predict future contingencies, (ii) long-term and in several phases, which comprise the invention, development and conclusion, since it can end between any of them, (iii) the organization's high need for physical and human resources for all phases; and (iv) idiosyncratic, as it is not easily comparable to other projects. Still, according to the author, these unique characteristics of innovation lead to two conclusions: (i) innovation is intrinsically risky and its progress is more erratic than other initiatives; and (ii) it requires exceptional fault tolerance.

Another relevant characteristic of innovation is its relationship with sustainability. According to Silva and Di Serio (2015), in the history of mankind there were five innovation waves, the first being the Industrial Revolution and the fifth, Information Technology, Communication and Networks. The current and ongoing wave is the Sustainability wave, which arose from the need for organizations to address social, political, and environmental issues through solutions that serve their consumers, increasingly aware of the role that organizations should play in this regard (SEEBODE, JEANRENAUD and BESSANT, 2012).

This broader concern of sustainable innovative organizations is justified since, as quoted by Barbieri (2012) in his lecture on sustainable innovative organizations, "there is no innovation that does not generate an impact along the supply chain, we cannot imagine an innovation that is not followed by positive and negative points".

This research addressed the main aspects and indicators that top management considers for analysis and commitment of the organization's resources to projects. In the literature, there are specific methods for evaluating innovation projects, being some of them related to sustainability, however, these methods address these aspects in isolation and with specific focuses, without a model that brings together and synthesizes the different methods in a single and practical framework, conceived and structured in an easier and more intuitive way for application at the organizational level, aiming to provide a complete characterization of an innovation project for the top management.

According to Brasil, Salerno, and Gomes (2018), the use of financial tools continues to be more attractive, and organizations are still looking for them to support this type of decision. Due to this, this research considered the various

financial analysis techniques of new projects, which include indicators such as Return on Investment, Net Present Value, Internal Rate of Return and Payback.

This research also assessed the relationship between innovation and sustainability and the main environmental and social indicators that can be considered in the analysis of innovation projects, along with the financial analysis. The inclusion of these factors supports the assessment and decision to invest in innovation projects and encourage the adoption of sustainability practices in an institutional way, supporting the creation of a sustainable innovative organization.

The financial analysis techniques described above are unable to deal with the unique characteristics of innovation, which creates challenges for valuing this type of project. Due to this, another contribution that this research brings is the evaluation of how to adapt, combine or add tools to the financial, social, and environmental criteria that consider these characteristics, thus supporting the evaluation by the top management and its decision regarding the directing corporate resources to projects through technical material that is easy to use and applied at an organizational level.

In a sense, the aim of this paper is reporting a practical framework for evaluating innovation projects based on sustainability criteria, aiming to support top management decision-making.

II. METHODOLOGY

A. Steps for the development of the research

The research followed the following steps:

1. Identification of the main sustainability aspects (financial, social and environmental) used in the evaluation of innovation projects for decision-making of corporate investments;
2. Systematization of these aspects in the form of indicators that allow characterizing innovation projects regarding sustainability aspects;
3. Creation of a framework for evaluating innovation projects contemplating the indicators identified and evaluated above, composed of a technical material that is easy to use at the organizational level that includes the following artifacts:
 - a. Creation of a pre-qualification form for the innovation project based on the indicators identified and evaluated;
 - b. Creation of a spreadsheet, developed in Microsoft Excel®, to collect these indicators;
 - c. Creation of a model of presentation of these indicators in the form of a slide deck to support the evaluation of the innovation project by senior management.

B. Identify the main sustainability aspects used in the evaluation of innovation projects for corporate investment decision making

The first step was to conduct a study based on data from the literature on what are the main aspects of sustainability used in the evaluation of projects and which are applicable for innovation projects for decision-making of corporate investments.

The analysis considered all indicators and techniques that have applicability for evaluation of innovation projects, but which can also be used in general in projects.

After analyzing the literature, 12 aspects were chosen, considering as a criterion of choice, the indicators that somehow support the evaluation of innovation products. Table 1 shows what these aspects are, and which were the reference authors for each of them. These aspects led to the construction of the framework for evaluating innovation projects

TABLE I: SUMMARY OF THE MAIN SUSTAINABILITY ASPECTS FOR EVALUATION OF INNOVATION PROJECT

Aspects	description	Authors
Qualitative benefits	Main qualitative benefits that will be achieved through innovation.	Mansfield (1996)
		Rasoto et al. (2012)
		Santos (2006)
		Murphy and Simon (2002)
Consider the risks and uncertainties of innovation in cash flow projections	The risks and uncertainties of innovation should be considered in cash flow projections and financial indicators. For this, the expected discount rate for this project must take into account the risks associated with innovation.	Žižlavská (2014)
		Doctor et al. (2001)
		Mansfield (1996)
		Kolk and Eager (2014)
Financial indicators	Considering the discount rate defined above, calculate the main financial indicators of the project: (i) ROI, (ii) NPV, (iii) IRR and (iv) Payback.	Brazil, Salerno and Gomes (2018)
		Rasoto et al. (2012)
		Grajewski (2013)
		Fonseca and Bruni (2003) for NPV and IRR
Monte Carlo Analysis	Due to the uncertainty that innovation brings to cash flow projections, a sensitivity analysis is performed through the Monte Carlo tool, demonstrating different results and predictions.	Ross et al. (2015) for NPV
		Costa and Azevedo (1996)
		Soares (2006)
		Harzer (2013)
Environmental indicators	Identify the material impact on the main environmental indicators, based on GRI standard.	Machado and Ferreira (2012)
		IBRI (2015)
		Hubbard (2009)
		Kocmanová and Šimberová (2014)
Social indicators	Identify the material impact on the main social indicators, based on the GRI standard.	Searcy (2012)
		GRI (2021)
		IBRI (2015)
		Hubbard (2009)
Next best existing alternative	Identify what would be the existing alternative if the novelty brought by innovation was not implemented, supporting the reference analysis to properly identify the incremental benefits that innovation would bring.	Kocmanová and Šimberová (2014)
		Searcy (2012)
		GRI (2021)
		Mansfield (1996)

Cost of not innovating	A company not investing in innovation implies potential cost and penalty. This step identifies what are the tangible and intangible impacts of not innovating (e.g., loss of share of wallet, loss of margin, computation of current products, etc.).	Kolk and Eagar (2014)
Database of similar projects	Maintain sophisticated databases with historical projects, which can serve as a comparison for new opportunities.	Kolk and Eagar (2014) PMI (2017)
Decision tree	In order to add confidence to calculations and analyses, a decision tree with the results of the different alternatives to the innovation project, the next best existing alternative and the scenario in which the project is not approved is presented.	Boer (2003) Kolk and Eagar (2014) Dey, 2002
Demonstrate performance in sustainability dimensions	Demonstrate performance in sustainability dimensions in a comprehensive and easy-to-understand way.	Finkbeiner (2010) Traverso et al. (2012) Amaral (2018)
Level of technological maturity	Demonstrate the level of technological maturity (TRL) of the innovation proposed by the project.	EARTO Impact Delivered (2014) NBR ISO 16290 (2015)

C. Systematize indicators to design a strategy that allows the characterization of innovation projects in terms of sustainability aspects

The next step was to perform an analysis in each of the aspects found in the literature, systematize them in the form of indicators and define how they should be collected and demonstrated to characterize the innovation project. This systematization defined the framework itself to support the evaluation of an innovation project by senior management. The strategy of characterization of innovation projects basically contemplated the following steps:

1. Pre-qualification of the innovation project, which is a simpler form of characterization, which considers the information available at an early stage of an innovation project, with lower level of detail and depth;
2. Detailed characteristic of the innovation project regarding sustainability requirements, as well as its presentation to senior management.

Fig. 1 illustrates the steps of characterization of innovation projects.

FIG.1: DIAGRAM SHOWING THE STEPS OF CHARACTERIZATION OF INNOVATION PROJECTS

III. RESULTS AND DISCUSSIONS

In this chapter are presented and discussed the main aspects of sustainability used in the evaluation of innovation projects for decision-making of corporate investments identified in the literature and the strategy to characterize the innovation project, delineating the proposed framework in its essence.

A. Sustainability aspects used in the evaluation of innovation projects

It was identified 12 aspects to be included in the framework for evaluating innovation projects. The discussion on each of these 12 aspects about how they should be systematized in the form of indicators and the strategy to use them to characterize the innovation project benefiting the evaluation of an innovation project by senior management will be carried out in the following topics.

Qualitative benefits

The collection of qualitative benefits was carried out in conjunction with the other basic information of the project. According to PMBoK (PMI, 2017), this information is collected in the initial phase of the project to formalize its beginning through a document called Project Charter, which documents:

1. Purpose of the project;
2. Measurable project objectives and related success criteria;
3. High-level requirements;
4. High-level description with key limits and deliveries;
5. Overall project risk;
6. Summary of the milestone schedule;
7. Pre-approved financial resources;
8. List of key stakeholders;
9. Requirements for project approval;
10. Project termination criteria;
11. Designated Project Manager;
12. Sponsor.

Based on what is documented in the Project Charter, the following basic information to be collected in conjunction with qualitative benefits were listed:

1. Project name: Title that the project will receive within the organization and how it will be identified in internal communications;
2. Project Manager: The responsible and authority for the project within the organization;
3. *Sponsor*: Main sponsor of the project within the organization and co-responsible for the project, along with the Project Manager;
4. Business Unit: Area that is demanding this project within the organization. This area can be an entire unit or internal teams, depending on how the organization divides (by product line, by discipline of knowledge, etc.);
5. Strategic planning: Inform if this project is connected with the strategic planning of the organization;
6. Start date: Expected start date for the project;
7. End date: Expected completion date for the project;
8. Description: Description of the main points of the project so that all the teams involved are contextualized about it. These main points may include the description of the scope (what is contemplated and what is outside), the justification, assumptions considered, restrictions already identified, key stakeholders involved, etc.;
9. Qualitative benefits: Description of the main qualitative benefits that will be achieved through the innovation project;
10. Milestone schedule: Demonstration of the main project deliveries on the timeline.

This framework only recommends what are the basic information for this initial collection, but each organization can remove or add items to this step.

The inclusion of the identification of qualitative benefits in the initial phase ensures that they are considered as part of the analysis, in addition to quantitative criteria such as financial indicators. This is in line with the one recommended by Mansfield (1996) that the analysis of an innovation project should start by identifying the qualitative benefits that will be achieved from innovation and Rasoto et al. (2012) which states that the analysis of innovation projects should consider, in addition to the financial and economic criteria, the imponderable and non-convertible cash criteria.

Consider the risks and uncertainties of innovation in cash flow projections

The risks and uncertainties of innovation in cash flow projections should be considered in the definition of the discount rate for the innovation project, which is the discount rate applied in future cash flows to bring them to present value. This rate is defined by the organization and, to support this definition, the discount rate will be composed of the sum of the risk-free rate, risk premium and risk factor associated with the innovation project as described below:

1. Risk-free rate: In this case, represented by Selic. The information can be updated regularly and consulted through the website

<https://www.bcb.gov.br/controleinflacao/taxase> lic or via another source that the organization has;

2. Risk premium: Expected return measure of a stock market in relation to a risk-free rate of return, such as government bonds (RIZÉRIO, 2021). There is no fixed and specific source for this indicator, and it is usually found in articles and research of financial institutions. For this research, the risk premium reported in this report by XP Investimentos <https://conteudos.xpi.com.br/acoes/relatorios/p-anorama-xp-novembro-o-que-esperar-da-bolsa/> (XP INVESTIMENTOS, 2020) was considered;
3. Risk factor of the innovation project: Measure related to the risk factor associated with the innovation project in question.

The person responsible for the project should define only the risk factor of the innovation project to reach the final value of the discount rate and inform which rationale for choosing the defined value. In this way, there will be transparency regarding the reasons for defining this risk factor, avoiding questions related to why the discount rate is so high or so low, in the evaluator's view. In addition, informing in advance the risk-free rate and risk premium, allowing the project manager to use both as a reference to define this risk factor.

By inserting a specific step to define the discount rate and include it as part of the calculation of the discount rate the factor directly related to the risk related to the project of innovation, this framework helps to ensure that the risks related to the innovation project are not neglected in the calculation of cash flow and are considered for the calculation of financial projections.

This is in line with what Mansfield (1996) states that projected cash flow should consider the different probabilities derived from uncertainties related to innovation projects by applying a discount rate. This is also in line with what Kolk and Eager (2014) said, that many organizations apply a discount factor related to the likelihood of success of an innovation project at different stages of the project.

Financial indicators

With the discount rate defined for the innovation project, it is possible to calculate the recommended financial indicators (ROI, NPV, IRR and Payback), and for this, the first step is the calculation of cash flow considering the new discount rate.

For the calculation of cash flow, the person responsible for the project should own and inform what are the investments planned for the innovation project and what will be the revenues brought by it, and these amounts should be reported annually, starting in the year in which the investment is made up to five years ahead. Planned investments are generally accumulated in year zero, and revenues brought in by the project are usually accumulated between year one and year five.

With investment and revenue information, you can

calculate Free Cash Flow (FCF), which is the result of revenue value minus the investment value for each year.

With the FCF, the discount rate is then used to calculate the present value (PV) of the FCF for each year between year zero and year five.

After that, the next step is to calculate this value in an accumulated way, that is, accumulating the FCF PV of one year in question added to the FCF PV of previous years. For example, the accumulated FCF PV value for year three is the sum of the present values of the FCF from year zero to year three.

After that, all the necessary cash flow information is available to proceed with the calculation of the four financial indicators indicated by Grajewski (2013): ROI, NPV, IRR and Payback.

The inclusion of a specific step for the calculation of financial indicators ensures that they are considered in the evaluation of the innovation project in question and, when using the discount defined above, it is ensured that the results of financial indicators consider the risk related to the innovation project. This is in line with what was proposed by Brazil, Salerno, and Gomes (2018) who confirm the attractiveness of these indicators to support the decision of investments and with Rasoto et al. (2012) who also recommends the investment analysis for this type of decision.

Monte Carlo Analysis

As there are three values that are inferred by the Project Manager in the cash flow projection, (i) the discount rate, (ii) the investments and (iii) the revenues, the recommendation is that these three variables go through a sensitivity analysis using the Monte Carlo method so that the presentation of financial indicators is more robust and reliable.

The option was to develop an electronic spreadsheet for Monte Carlo analysis based on the work of authors Machado and Ferreira (2012), with the following characteristics:

1. Three input variables: (i) discount rate, (ii) investment and (iii) revenues;
2. Triangular distribution for the three input variables;
3. Generation of 10,000 random numbers for triangular distribution;
4. Four output variables: (i) ROI, (ii) NPV, (iii) IRR and (iv) Payback;
5. Histogram generation and probability density curve for the four output variables.

The histogram and probability density curve generated by the spreadsheet allows the project manager to have the successful and unsuccessful scenarios for each of the four variables with their respective probabilities, providing a quantitative risk analysis that supports the project's analysis. The use of the Monte Carlo method for quantitative risk analysis in project management is one of the possible applications according to Machado and Ferreira (2012). Harzer (2013) also confirms that its application is feasible in investment analyses in uncertain environments, which is the case of an innovation project.

Environmental indicators

The set of GRI Standards and their contents were considered as the social and environmental indicators for the framework.

To identify the environmental impact of the innovation project, it is necessary that the project manager identifies, among these indicators, which has materiality with the innovation project and what is the impact that the project will bring, whether positive or negative.

To facilitate this analysis by the project manager, for each of the indicators two information were added: (i) Clear description of the KPI to identify the materiality and (ii) what is the success of this KPI. These two information were taken from the GRI standards documents as below:

1. KPI Description: This information was taken from the "Reporting Requirements" section of each of the 32 contents of the eight GRI Standards with environmental topics.
2. Indicator success criterion: This information was taken from the "Relevance" section for each of the contents that build the environmental indicators. In addition to it, there are other excerpts from this same document that also support the definition of the indicator's success criterion.

With these two additional information, the project manager will be able to clearly inform the impact that the innovation project will have on the indicators in which it scores as material, based on the KPI description, and whether this impact was positive or negative, based on the indicator's success criterion. With this, the evaluation can consider this impact to decide on the continuity or not of the project.

The addition of environmental criteria provides a greater range of information for decision making, according to IBRI (2015), and is in line with what Hubbard (2009) said about organizations' responsibilities being much broader than simply financial aspects and that environmental and social aspects should be added as the responsibility of organizations.

Social indicators

Like environmental indicators, it is necessary to identify the social impact of the innovation project, and, for this, it is necessary that the project manager identifies, among these indicators, which has materiality with the innovation project and what is the impact that the project will bring, whether positive or negative.

For each of the social indicators, the same two information were added.

With these two additional information, the project manager will be able to clearly inform the impact that the innovation project will have on the indicators in which it scores as material, based on the KPI description, and whether this impact was positive or negative, based on the indicator's success criterion. With this, the evaluation can consider this impact to decide on the continuity or not of the project.

Next best existing alternative

Next, the project manager should describe the next best existing alternative to the innovation project. In addition, for this next best existing alternative, it must follow the same previous steps as the original innovation project and reach financial, environmental, and social indicators for complete comparability. As this is the alternative to the innovation project, the decision to make the use of Monte Carlo analysis for financial indicators is up to the organization.

By including the identification of the next best existing alternative to the innovation project with the same level of information as the innovation project itself, it is possible to make a referential analysis of the two projects, allowing an easier identification of what are the differences between them, whether positive or negative. This supports the evaluation of which project is the best or what impact of choosing the innovation project rather than the next best existing alternative.

This converges with what Mansfield (1996) states with respect to how the presentation of this alternative supports the referential analysis of the innovation project, to properly identify the incremental benefits that it would bring to it.

Cost of not innovating

In addition to the next best existing alternative, it is also recommended to identify the tangible and intangible impacts of not innovating, that is, if the proposed innovation project is not approved. For this, three types of impact are suggested:

1. Product impact: Some examples are commoditization of products, current product does not meet customers' needs, etc;
2. Financial impact: Some examples are margin loss, market *share loss*, share of *wallet loss*, high production cost, low efficiency in current processes;
3. Market and competitors: Some examples are competitors innovating their products and gaining competitive advantage, inability to conquer new markets, being known for being a follower and not an innovator, low ability to retain and hire new talent, etc.

The impact definition will be described by the project manager and the types of impact can be changed depending on the project or organization, but the framework will start with these three aspects as an initial suggestion.

By including the identification of penalties if the organization chooses not to innovate, it allows the evaluator to be aware of what the impact is if he chooses not to approve the continuation of this project, called by Kolk and Eagar (2014) as "cost of doing nothing".

Database of similar projects

As this is a best practice for the organization it has not been added as a step of the framework and artifacts. The recommendation for the organization is that the database of innovation projects can be started with innovation projects that use this framework, as they will provide a good

information base to support the evaluation of future projects as affirmed by Kolk and Eagar (2014).

Use decision tree

To present all the different alternatives defined and discussed so far, a decision tree is used. It should contain the results of the different scenarios considered so far:

1. Innovation project: The innovation project node must be broken into two possibilities: (i) the successful project and (ii) the unsuccessful project, both with their respective probability generated in the Monte Carlo analysis. At the end of each of these two probabilities, financial indicators (NPV, ROI, IRR and Payback) and the description of the social and environmental impact should be included;
2. Next best existing alternative: The node of the next best existing alternative should include financial indicators (NPV, ROI, IRR and Payback) and the description of the social and environmental impact;
3. Cost of not innovating: The node of not innovating should contain the description of the impact of product, financial, market and competitors.

Considering that three different alternatives are presented for evaluation, the decision tree is an appropriate tool to show the results of each of the alternatives, facilitating the visualization of them and helping in the evaluation and decision of which to follow. This is in line with the recommended by Boer (2003) and Kolk and Eagar (2014) to present an innovation business proposal with the results of possible alternatives.

Demonstrate the performance of sustainability dimensions

The next step is to demonstrate the performance of the three dimensions of sustainability in a standardized way and for this, a score methodology was created for each of them, which will be presented in the next sections.

Score of financial indicators

To evaluate the four financial indicators, a score from 0 to 4 was defined, being:

1. 0: If the result of the indicator is unfavorable/negative;
2. 4: Favorable/positive result and much higher than expected;
3. 1, 2 and 3: Intermediate results between 0 and 4, according to the evaluation of the project manager, the closer to zero less favorable and the closer to the 4 more favorable.

Environmental indicators score

To evaluate the 32 environmental indicators, a score from 0 to 4 was defined, being:

1. 0: Worst case possible with the indicator keeping or worsening as a result of the innovation project;
2. 4: Best case possible;

3. 1, 2 and 3: Intermediate results between 0 and 4, according to the evaluation of the project manager being the closer to zero less favorable and the closer to the 4 more favorable.

Score of social indicators

To evaluate the 40 social indicators, a score from 0 to 4 was defined, adapted from the method presented by Amaral (2019) as below:

1. 0: Indicator keeping as is or getting worse;
2. 1: Improvement of the indicator, but still with high physical, pathological, safety or human rights risks;
3. 2: Improvement of the current indicator, but without meeting the expected basic requirements (regulatory or internal);
4. 3: Indicator meets the expected basic requirements;
5. 4: Improvement of the current indicator for excellent performance beyond the expected basic requirements.

Weigh the scores of the three sustainability dimensions for the same scale

The next step is to consider the scores of the three sustainability dimensions (financial, environmental, and social) for the same scale, and for this, it is necessary to arrive at a single value for each of these dimensions. To reach this single value, an arithmetic average of all the scores reported for each of the three dimensions will be made as below:

1. Financial: Arithmetic mean of the scores reported for ROI, NPV, IRR and Payback;
2. Environmental: Arithmetic mean of the scores reported for the 32 environmental indicators;
3. Social: Arithmetic mean of the scores reported for the 40 social indicators.

With a score value for each of the three dimensions, they will be weighted to the same scale based on the *Dashboard of Sustainability* (DoS) model, presented by Amaral (2019).

According to the author Traverso et al. (2012), the presentation of a score for the three dimensions of sustainability brings the benefit of presenting financial, economic, and social indicators together and is recommended to support the decision on a group of products with the same function, such as a comparison of several innovation projects.

Level of technological maturity

The last aspect to be considered is the identification of the level of technological maturity and, for this, the TRL scale was used.

For this definition, the project manager should indicate at which level of technological maturity (TRL) the project is based on the maturity of the innovation proposed by this project, nine being the maximum level corresponding to a technology at the highest possible maturity level.

Thus, each of the 12 aspects indicated by the literature was evaluated and they were systematized in the form of indicators to better characterize the innovation project

through the artifacts: (i) pre-qualification form, (ii) spreadsheet to collect the information from the indicators; and (iii) template for presentation of indicators in slide format based on the discussion.

B. Creation of artifacts for evaluation of innovation projects contemplating sustainability indicators

With the systematization of indicators, the next step was the creation of artifacts for evaluation of innovation projects composed of a technical material of easy use at the organizational level, which was carried out according to the following steps:

1. Creation of a pre-qualification form of the innovation project based on sustainability indicators;
2. Creation of a spreadsheet in Microsoft Excel® to collect the data;
3. Creation of a model of presentation of these indicators in a slide format to support the evaluation of the innovation project by senior management.

Pre-qualification form of the innovation project

Considering that a project in its initial phase does not have all the information that must be collected for the defined indicators and that, often, a project needs to go through several stages of internal approvals before being submitted for final approval of senior management, the recommendation is that the first step of the framework is to fill out a form for pre-qualification of the innovation project.

This form includes part of the indicators defined at a lower level of depth and for this, each indicator was evaluated to identify what would be the minimum information that could be collected in this pre-qualification stage, considering that, being an initial stage of a project, the project manager may not have or not be able to inform all of them. For example, for financial indicators, in this pre-qualification stage, cash flow and financial indicators (ROI, NPV, IRR and Payback) would not be calculated, and any sensitivity analysis would be performed, instead, only would be collected a macro idea of the investment of this innovation project, its return time and whether that investment is within the budget defined for the area or not.

In this way, the person responsible for the project can present the initial and available information at the time of the birth of a project in a faster and easier way and pre-approve it with its direct manager or board of directors before taking it for approval of the senior management. If the project is approved in this pre-qualification, the project manager can continue the detailed characterization of the project by collecting the complete information as described in the previous section.

Each of the aspects and indicators was evaluated in accordance with what would be important for a pre-qualification stage and what information would be available at an early stage of an innovation project and it was defined that only those described below would be part of the pre-qualification form:

1. Basic project information: All information

- defined in the previous section;
2. Evaluation of innovation: Indicate in more detail what is the innovation proposed by the project, what would be the next best existing alternative to this innovation project, what impact of not innovating and what level of technological maturity (TRL);
 3. Financial indicators: Indicate the investment required for this project, whether it is approved in the budget of the area or is something out of budget, what percentage of the budget of the area that this project will consume and what time is estimated for return;
 4. Environmental indicators: Indicate which of the eight GRI Standards with environmental topics has materiality with the project and indicate a score from zero to four to indicate the size of the impact brought by this project;
 5. Social indicators: Indicate which of the 19 GRI Standards with social topics has materiality with the project and indicate a score from zero to four to indicate the size of the impact brought by this project;
 6. Sustainability score: Indicate which of the three sustainability contexts are most important for the project and distribute a weight of 100% among them.

Spreadsheet for information collection

Because it is a framework that aims to be applied in organizations, the objective was that the collection of information was performed in the easiest and intuitive way for the person responsible for the project. Thinking about it, for each of the indicators, the information will be collected as below:

1. The tool chosen for the spreadsheet was Microsoft Excel®;
2. Each indicator has a tab on the spreadsheet with the information that needs to be collected;
3. For the indicators that required calculation, it was performed automatically by the spreadsheet.

Model for the presentation of indicators

After collecting all indicators in the spreadsheet, the next step was to define how they should be presented for senior management. To do this, a template was built in Apple's Keynote tool, which is a presentation application.

The presentation adopted the following structure:

1. Cover with the name of the project and the name of the person responsible for the project;
2. Initial slide showing an overview of the project in an one pager format informing (i) the name of the project, (ii) the financial, environmental and social indicators and (iii) the sustainability score. This helps the senior direction to have a high-level view of the project before proceeding with a detailed indicator-to-indicator analysis;
3. Index with indicators to be presented;

4. A section for each of the aspects, except for the database indicator of similar projects that does not apply in a presentation. Each specific section will demonstrate the most relevant information collected in the spreadsheet in Microsoft Excel® to support the decision of senior management.

The artifacts that are part of the method can be found in this link:
<https://drive.google.com/drive/folders/1EZVVaLCBtSZWB R8Gn1OEa51bLi8mdMBO?usp=sharing>

IV. CONCLUSIONS

The research proposed and made available a framework for evaluating innovation projects in organizations based on sustainability criteria (financial, environmental and social). One of the main contributions was to provide a practical framework composed by dedicated artifacts that can support the evaluation of innovation projects by senior management and consequently increase innovation practices within an organization. This framework was based on the main aspects of sustainability used in the evaluation of innovation projects collected from the existing literature, which confirm the relationship between innovation and sustainability and justify the use of the 3 pillars of sustainability (financial, environmental and social) in the evaluation of innovation projects. With this, another expected contribution is that organizations start to consider the environmental and social impacts in the evaluation and direction of corporate resources for their projects, in addition to the usual financial impacts. In addition to the research that found in the literature the importance of innovation for sustainability and the strong relationship between them, the constructed model provides the evaluation of the materialities of the 3 pillars of sustainability of each project and presents them in the form of a score, side by side, and the three results are weighted on the same scale, demonstrating the impact of the innovation project on the three sustainability indicators. To collect the information necessary for the aspects found in the literature, they were systematized in indicator format and presented using a technical material built to be intuitive and automated, facilitating the provision of information by the project manager. For the presentation of these 12 indicators for senior management, a slide show was constructed that includes the results and evaluations for each of these indicators and presents them in an executive and professional way, serving as an equivalent to a project business case. It is expected that more organizations will take this practical framework and that its effectiveness is proven, increasing the practice of innovation in each organization and contributing to consideration of the financial, environmental and social impact in the evaluation of their projects.

REFERENCES

- [1] AMARAL, K. G. C. *Avaliação da sustentabilidade no gerenciamento do lodo e biogás, em estação de tratamento de esgotos, utilizando a técnica de ACV*, 2018. Disponível em: <https://acervodigital.ufpr.br/bitstream/handle/1884/55822/R%20->

- %20T%20%20KARINA%20GUEDES%20CUBAS%20DO%20AMARAL.pdf?sequence=1&isAllowed=y
- [2] ASENSIO-LÓPEZ, D.; CABEZA-GARCÍA, L.; GONZÁLEZ-ÁLVAREZ, N. Corporate governance and innovation: a theoretical review. **European Journal of Management and Business Economics**, 2019, Vol. 28, No. 3, 2019, p. 266-284.
 - [3] BARBIERI, J. C. Organizações inovadoras sustentáveis. **Caderno de Inovação, [S.l.]**, 2012, v. 3, p. 5-9
 - [4] BARBIERI, J. C.; VASCONCELOS, I. F. G.; ANDREASSI, T.; VASCONCELOS, F. C. Inovação e Sustentabilidade: Novos Modelos e Proposições. ERA, 2010, v. 50, n. 2, 146-154.
 - [5] BAREGHEH, A.; ROWLEY, J.; SAMBROOK, S. Towards a multidisciplinary
 - [6] definition of innovation. **Management Decision**, 2009, Vol. 47 No. 8, 2009 pp. 1323-1339.
 - [7] BELLOC, F. Corporate Governance and Innovation: A Survey. **Journal of Economic Surveys**, 2011.
 - [8] BRASIL, V. C.; SALERNO, M. S.; GOMES, L. A. V. Valuation of innovation projects with high uncertainty: Reasons behind the search for real options. **Journal of Engineering and Technology Management**, 2018.
 - [9] BOER, F. P. Risk-Adjusted Valuation of R&D Projects. **Research-Technology Management**, 2003, 46:5, 50-58.
 - [10] COSTA, L. G. A.; AZEVEDO, M. C. L. **Análise Fundamentalista**. Rio de Janeiro: FGV/EPGE, 1996.
 - [11] DANILEVICZ, A. M. F.; RIBEIRO, J. L. D. Um modelo quantitativo para a gestão da inovação em portfólio de produtos. **Gest. Prod.**, 2013, vol.20, n.1, pp.59-75.
 - [12] DEY, P. K. Project Risk Management: A Combined Analytic Hierarchy Process and Decision Tree Approach. **Cost Engineering**, 2002, Vol. 44, No. 3.
 - [13] DOCTOR, R. N.; NEWTON, D. P.; PEARSON, A. Managing uncertainty in research and development. **Technovation**, 2001, Volume 21, Issue 2, 79-90.
 - [14] DRAKE, M. P.; SAKKAB, N.; JONASH, R. Maximizing Return On Innovation Investment. **Research-Technology Management**, 2006, 49:6, 32-41.
 - [15] EARTO IMPACT DELIVERED. The TRL Scale as a Research & Innovation Policy Tool, EARTO Recommendations. **Earto Impact Delivered**, 2014.
 - [16] ELIZABETH, S. Trilha de Inovação: Ideia, invenção e inovação. **Sandraelisabeth.com.br**, 2019. Disponível em <http://sandraelisabeth.com.br/trilha-de-inovacao-ideia-invencao-e-inovacao/>
 - [17] FINKBEINER, M.; SCHAU, E. M.; LEHMANN, A.; TRAVERSO, M. Towards Life Cycle Sustainability Assessment. **Sustainability** 2(10), 2010, 3309-3322.
 - [18] FONSECA, Y. D.; BRUNI, A. L. **Técnicas de avaliação de investimentos: uma breve revisão da literatura**, 2003. Disponível em: <http://repositorio.ufba.br/ri/handle/ri/25449>
 - [19] GIL, A. C. **Como elaborar projetos de pesquisa**. São Paulo: Atlas, 1991.
 - [20] GIZ, GVces. Guia para Implementação do ROI de Sustentabilidade: Como Analisar o Retorno Econômico-Financeiro de Projetos de Sustentabilidade. **Centro de Estudos em Sustentabilidade da Escola de Administração de Empresas de São Paulo da Fundação Getúlio Vargas**, 2018, p. 46.
 - [21] GRAJEWSKI, B. Analyze The ROI Of Your Innovation Idea, Step By Step. 2013. Disponível em:
 - [22] <https://www.forbes.com/sites/theyec/2013/12/27/analyze-the-roi-of-your-innovation-idea-step-by-step/#2f971efe4c76>
 - [23] Global Reporting Initiative (GRI). 2021. Disponível em: <https://www.globalreporting.org/>
 - [24] HALL, J. Sustainable development innovation: A research agenda for the next 10 years. **Journal of Cleaner Production**, 10, 2002, 195–196.
 - [25] HALOG, A.; MANIK, Y. Advancing Integrated Systems Modelling Framework for Life Cycle Sustainability Assessment. **Sustainability**, 3(12), 2011, 469-499.
 - [26] HANSEN, E.G.; GROSSE-DUNKER, F.; REICHWALD, R. Sustainability innovation Cube e a framework to evaluate sustainability-oriented innovations. **International Journal of Innovation Management** 13, 2009, 683-713.
 - [27] HARZER, J. H.; SOUZA, A.; DUCLOS, L. C. Método de Monte Carlo aplicado a análise de projeto: estudo de investimento em um empreendimento hoteleiro. **Congresso Internacional de Custos**, Porto, 2013.
 - [28] HOCKERTS, K. Managerial Perceptions of the Business Case for Corporate Social Responsibility. **CBS Working Paper Series, no. 03-2007**. 2008.
 - [29] HOLMSTROM, B. Agency Costs and Innovation. **The Research Institute of Industrial Economics (IUI)**, Stockholm, 1989.
 - [30] HUBBARD, G. Measuring Organizational Performance: Beyond the Triple Bottom Line. **Business Strategy and the Environment**, 2009.
 - [31] IBRI. Caderno - Série Sustentabilidade – Os Investimentos Responsáveis e os desafios para o RI. **IBRI**, 2015.
 - [32] KEMP, R.; PEARSON, P. Final report of the MEI project measuring eco innovation. **One Merit Maastricht**, 2007. Disponível em:
 - [33] <http://www.merit.unu.edu/MEI/deliverables/MEI%20D15%20Final%20report%20about%20measuring%20eco-innovation.pdf>
 - [34] KLINE, S. J.; ROSENBERG, N. An Overview of Innovation. **Studies on Science and the Innovation Process**, 2009, 173–203.
 - [35] KOCMANOVÁ, A.; DOČEKALOVÁ, M. Construction of the economic indicators of performance in relation to environmental, social and corporate governance (ESG) factors. **Acta univ. agric. et silvic. Mendel. Brun.**, 2012, LX, No. 4, p. 195–206.
 - [36] KOLK, M.; EAGAR, R. How to manage your return on investment in innovation: Reaping the most from innovation investments. **PRISM / 1**, 2014.
 - [37] MACHADO, N. R. S.; FERREIRA, A. O. Método de Simulação de Monte Carlo em Planilha Excel. São Paulo: **Revista de Ciências Gerenciais**, 2012, Vol. 16, No. 23.
 - [38] MANSFIELD, E. Estimating Social and Private Returns from Innovations Based on the Advanced Technology Program: Problems and Opportunities. **National Institute of Standards and Technology**, 1996.
 - [39] MCCAHERY, J. A.; VERMEULEN, E. P. M. Corporate Governance and Innovation Venture Capital, Joint Ventures, and Family Businesses. **ECGI Working Paper Series in Law**, 2006.
 - [40] MIOZZO, M.; DEWICK, P. Building competitive advantage: innovation and corporate governance in European construction. **Research Policy** 31, 2002.
 - [41] MOTAWA, I; Modelling risk effect using Monte Carlo Technique: an application for innovative projects. **Risk Management in Engineering and Construction**, 2019, chapter 2, 20-45.
 - [42] MURPHY, K. E.; SIMON, S. J. Intangible benefits valuation in ERP projects. **Info Systems J**, 2002, 301–320
 - [43] NBR ISO 16290:2015. Sistemas espaciais - Definição dos níveis de maturidade da tecnologia (TRL) e de seus critérios de avaliação. **Norma Brasileira**, 2015, primeira edição.
 - [44] OECD. **Oslo Manual: GUIDELINES FOR COLLECTING AND INTERPRETING INNOVATION DATA**. OECD Paris, 2005.
 - [45] O'SULLIVAN, M. The innovative enterprise and corporate governance. **Cambridge Journal of Economics**, 2000, 24, 393–416.
 - [46] PROJECT MANAGEMENT INSTITUTE. **A Guide to the Project Management**
 - [47] **Body of Knowledge – PMBOK® Guide 6th Edition**. Pennsylvania: Project Management Institute, Inc. 2017
 - [48] RASOTO, A.; GNOATTO, A. A.; OLIVEIRA, A. G.; ROSA, C. F.; ISHIKAWA, G.; CARVALHO, H. A.; LIMA, I. A.; LIMA, I. A.; TRENTIN, M. G.; RASOTO, V. I. **Gestão Financeira: enfoque em Inovação**. Curitiba: Aymarã Educação, 2012.
 - [49] RICE, M. P.; O'CONNOR, G. C.; PIERANTOZZI, R. Implementing a learning plan to counter project uncertainty. **MIT Sloan Manage**, 2008, Rev. 49 (2), 53–62.
 - [50] RIZÉRIO, L. O que esperar para o Ibovespa em 2021? Confira a projeção dos analistas (e as ações preferidas). **Infomoney.com.br**, 2021. Disponível em <https://www.infomoney.com.br/mercados/o-que-esperar-para-o-ibovespa-em-2021-confira-a-projecao-dos-analistas-e-as-acoes-preferidas/>
 - [51] ROSS, S. A.; WESTERFIELD, R. W; JAFFE, J. F.; LAMB R. **Administração financeira: versão brasileira de corporate finance**. São Paulo: AMGH Editora, 2015.
 - [52] SANTOS, J.L; GOMES J. M. M.; FERNANDES, L. A.; PINHEIRO, P. R.; SCHMIDT, P. et al. Ativos intangíveis: fonte de vantagem competitiva. Porto Alegre: Contexto, 2006, Vol. 6, n. 10, 29-46.
 - [53] SANTOS, A. B. A.; FAZION, C. B.; MEROE, G. P. S. Inovação: Um Estudo sobre a Evolução do Conceito de Schumpeter. São Paulo: **Caderno de Administração. Revista da Faculdade de Administração da FEA**, 2011, v.5, n. 1.
 - [54] SANTOS, G. S.; SANTOS, A. A. P.; SEHNEM, S. Como Mensurar a Sustentabilidade? - Um estudo das principais técnicas e indicadores. **Revista Organização e Sustentabilidade**, 2016, v. 4, n. 1, 3-48.
 - [55] SEEBODE, D.; JEANRENAUD, S.; BESSANT, J. Managing innovation for sustainability. **R&D Management**, 2012, 42, p. 195–206.
 - [56] SCHNEIDER, M.; TEJEDA, M.; DONDI, G.; HERZOG, F.; KEEL, S.; GEERING, H. Making real options work for practitioners: a generic model for valuing R&D projects. **R&D. Management** 38 (1), 2007, 85–106.

- [57] SCHUMPETER, J. A. The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle. **Harvard University Press**, 1949.
- [58] SEARCY, C. Corporate sustainability performance measurement systems: a review and research agenda. **Journal of Business Ethics**, 2012, 107(3), 239-253.
- [59] SHADAB, B. H. Innovation and Corporate Governance: The Impact of Sarbanes-Oxley. **U. Pa. Journal of Business and Employment Law**, 2008.
- [60] SHAPIRO, D.; TANG, Y.; MIAOJUN, W.; WEIYING, Z. The effects of corporate governance and ownership on the innovation performance of Chinese SMEs. **Journal of Chinese Economic and Business Studies**, 2015, 13:4, 311-335.
- [61] SHEPPERD M.; Schofield, C.; KITCHENHAM, B. Effort estimation using analogy. **Proceedings of the 18 International Conference on Software Engineering ICSE-18**, 1996, 170-175.
- [62] SILVA, C. L.; JUNIOR, E. F. C.; LIMA, I. A.; SILVA, M. C.; AGUDELO, L. P. P.; PIMENTA, R. B. **Inovação e Sustentabilidade**. Curitiba: Aymará Educação, 2012.
- [63] SILVA, G.; DI SERIO, L. C. The sixth wave of innovation: are we ready? **RAI Revista de Administração e Inovação**, 2016.
- [64] SOARES, J. A. R. A análise de risco, segundo o método de Monte Carlo, aplicada à modelagem financeira das empresas. **Universidade Federal do Rio Grande do Sul**, Porto Alegre, 2006.
- [65] SOUZA, M. C. A. **Crescimento econômico, inovação e empreendedorismo**. Porto Alegre, 2009.
- [66] TIDD, J.; BESSANT, J. **Gestão da Inovação**. Porto Alegre: Bookman, 2015.
- [67] TRAVERSO, M.; FINKBEINER, M.; JØRGENSEN, A.; SCHNEIDER, L. Life Cycle Sustainability Dashboard. **Journal of Industrial Ecology**, 2012.
- [68] TYLECOT, A.; VISINTIN, F. **Corporate Governance, Finance and the Technological Advantage of Nations**. Nova York: Routledge, 2007.
- [69] XP Investimentos. Panorama XP – Novembro: O que esperar da Bolsa?. **conteudos.xpi.com.br**, 2020. Disponível em <https://conteudos.xpi.com.br/acoes/relatorios/panorama-xp-novembro-o-que-esperar-da-bolsa/>
- [70] ŽIŽLAVSKY, O. Net Present Value Approach: Method for Economic Assessment of Innovation Projects. Brno: **Procedia - Social and Behavioral Sciences**, 2014, Volume 156, 506-512. "tion networks," *IEEE Trans. on Neural Networks*, vol. 4, pp. 570-578, July 1993.
- [71] J. U. Duncombe, "Infrared navigation—Part I: An assessment of feasibility," *IEEE Trans. Electron Devices*, vol. ED-11, pp. 34-39, Jan. 1959.
- [72] C. Y. Lin, M. Wu, J. A. Bloom, I. J. Cox, and M. Miller, "Rotation, scale, and translation resilient public watermarking for images," *IEEE Trans. Image Process.*, vol. 10, no. 5, pp. 767-782, May 2001.

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